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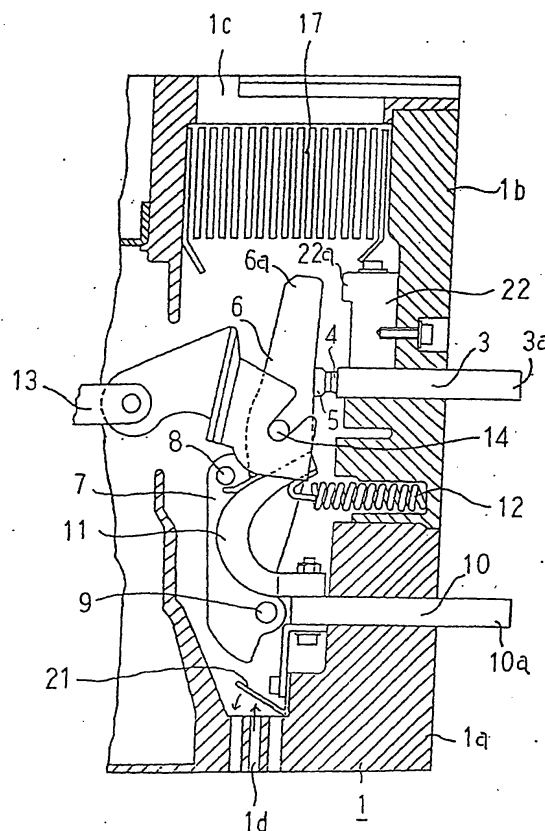
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(54) **AIR CIRCUIT BREAKER**

(57) Temperature rise at an opening/closing contact and a current-carrying portion near the contact due to heat generation is suppressed. A housing 1 includes a stationary conductor 3 fixed with a stationary contact 4, a moving member 6 fixed with a moving contact 5, and an arc extinguishing chamber 17 for extinguishing an arc generated between the two contacts. Further, an emission window 1c for emitting arc gas to outside, and a vent hole 1d facing the emission window 1c are provided in the housing 1. A valve member 21 for closing the vent hole 1c upon pressure rise is preferably provided. An arc block 22 with a stationary arcing contact 22a to conduct an electric power and transfer a heat from the stationary contact 4, and a moving arcing contact 6 to conduct the power and transfer the heat from the moving contact 5 are preferably provided.

Fig. 1



## Description

### Technical Field

**[0001]** The present invention relates to a structure for suppressing rise in temperature of a current-carrying conductor at a opening and closing contact as well as in the vicinity of the contact in an air circuit breaker at the time of applying an electric current to the conductor under normal conditions.

### Background Art

**[0002]** Fig. 3 is a side sectional view showing a conventional air circuit breaker described in, for example, the Japanese Patent Publication (unexamined) No. 303930/1993.

**[0003]** In the drawing, reference numeral 1 is a base housing comprised of a main base 1a and a secondary base 1b both formed of an insulating material. Numeral 1c is an arc gas emission window formed on the base housing 1. Numeral 2 is a cover housing, numeral 3 are stationary conductors disposed in parallel on the secondary base 1b and are the same in number as the poles of this air circuit breaker, and in which a stationary contact 4 is fixed onto one end of each stationary conductor, and the other end is led out from the base housing 1 and forms a terminal 3a on the power supply side. Numeral 5 is a moving contact that faces the stationary contact 4 and comes in contact with and separates from the stationary contact 4, and numeral 6 is a moving member to which the moving contact 5 is fixed. Numeral 7 is a contact arm rotatably holding the moving member 6, numeral 8 is a moving member stopper pin for blocking movement of the moving member 6 toward any unnecessary portion, and numeral 9 is a contact arm shaft rotatably supporting the contact arm 7 on the base housing 1. Numeral 10 is a terminal conductor, and a part of the terminal conductor fixed to the main base 1a and led out from the base housing 1 forms a load side terminal 10a. Numeral 11 is a flexible conductor for connecting the moving member 6 to the terminal conductor 10 so as not to regulate movement of the moving member 6.

**[0004]** Numeral 12 is a contact pressure spring for urging the moving member 6 in the opening direction, and numeral 13 is a switch mechanism part for opening and closing the moving member 6 connected to the contact arm 7 by a shaft 14. Numeral 15 is a trip relay part. The switch mechanism part 13 is comprised of a widely known toggle link mechanism and is latched on a D-shape latch 16 engaged with the trip relay part 15. Numeral 17 is an arc extinguishing chamber having an opening so that arc gas can be emitted to outside through the arc gas emission window 1c. Numeral 18 is a closing spring where closing drive force of the switch mechanism part 13 is accumulated, and numeral 19 is a ratchet mechanism where the closing spring 18 is compressed and accumulated by a handle 20 or a motor

not illustrated.

**[0005]** This type of conventional air circuit breaker detects an overcurrent flowing through a connected load or an excessive current caused by an accident or the like, and the trip relay part 15 releases the switch mechanism part 13 from the D-shape latch 16. Consequently, the switch mechanism part 13 is put into operation, the contact arm 7 is pushed upward turning round the contact arm shaft 9 by the force of the contact pressure spring 12. At the same time, the moving member 6 is rotated counterclockwise turning round the shaft 14, the moving contact 5 is moved away from the stationary contact 4, and the electric current flowing between the two contacts is interrupted. At this time, an arc between the contacts is induced and extinguished by the arc extinguishing chamber 17, and arc gas produced in this process is emitted through the arc gas emission window 1c.

**[0006]** A rated current of one thousand to several thousands amperes flows in this type of air circuit breaker, and a rise in temperature caused by the flowing rated current accelerates deterioration of parts. In order to prevent the deterioration, a maximum temperature of a current-carrying part is normalized by a standard. In the conventional air circuit breaker as described above, the stationary contact 4, the moving contact 5, and peripheral conductive passages such as the moving member 6, etc. are arranged in a closed space having only the arc gas emission window 1c in order to insulate a current-carrying charging part and shield an arc generated at the time of interrupting an excessive electric current and prevent arc gas from leaking to the switch mechanism part 13. As a result, when applying a rated current thereto, a heat generated due to contact resistance between the stationary contact 4 and the moving contact 5 and due to resistance of the peripheral conductive passages such as the moving member 6 stays and raises the temperature in the base housing 1. Hence, a problem exists in that the temperature of the current-carrying part rises above the normalized maximum temperature.

**[0007]** The present invention was made to solve the above-discussed problem and has an object of suppressing rise in temperature at the current-carrying part in the air circuit breaker by effectively radiating a heat generated in the air circuit breaker.

### Disclosure of Invention

**[0008]** An air circuit breaker according to the invention includes in a housing: a stationary conductor onto which a stationary contact is fixed; a moving member onto which a moving contact coming in contact with and moving away from the stationary contact by a switch mechanism is fixed; and an arc extinguishing chamber for extinguishing an arc generated between the mentioned two contacts; and the air circuit breaker is provided with an emission window formed on a part of the housing in

order to emit arc gas out of the housing and a vent hole that is opened at a portion facing the mentioned emission window and forms an air passage in the housing.

**[0009]** It is preferable that the mentioned air circuit breaker is provided with a valve member for closing the vent hole when a pressure rises in the housing.

**[0010]** It is preferable that an arc block provided with a stationary arcing contact extending toward the arc extinguishing chamber so as to conduct an electric power and transfer a heat from the stationary contact and a moving arcing contact coming into contact with the stationary arcing contact at the time of opening the two contacts are provided extending toward the arc extinguishing chamber so that the electric power may be conducted and the heat be transferred from the moving contact.

**[0011]** It is preferable that one pole is opened and closed by plural moving members, and each of the plural moving members is provided with the moving arcing contact extending toward the arc extinguishing chamber.

#### Brief Description of Drawings

##### **[0012]**

Fig. 1 is a sectional view of an essential part of an air circuit breaker according to the present invention.

Fig. 2 is a perspective view of a current-carrying part of the air circuit breaker according to the invention.

Fig. 3 is a side sectional view of a air circuit breaker according to the prior art.

#### Best Mode for Carrying Out the Invention

##### Embodiment 1.

**[0013]** Fig. 1 is a sectional view of an essential part of an air circuit breaker showing Embodiment 1 according to the present invention, and Fig. 2 is a perspective view of a current-carrying part of the air circuit breaker of Embodiment 1.

**[0014]** In the drawings, numerals 1, 3 to 13, and 17 are the same as those in the mentioned conventional air circuit breaker, and further explanation of them is omitted herein. Numeral 1d is a vent hole opened on the base housing 1 and located on a side opposite of the arc extinguishing chamber 17. Numeral 21 is a valve member of the vent hole 1d, and this valve member 21 allows air to pass from outside to inside of the base housing 1 under normal conditions and closes the vent hole 1d when the pressure in the base housing 1 rises. Numeral 6a is a moving arcing contact arranged by extending a moving member conductor from a portion where the moving contact 5 of the moving member 6 is fixed toward an end. Numeral 22 is an arc block that is mounted on the stationary conductor 3 in the direction of the arc extinguishing chamber 17, and in which one

face is closely fitted on the stationary conductor 3 and another face crossing at right angles is closely fitted on a bottom face of the base housing 1. This arc block 22 is provided with a stationary arcing contact 22a formed at a position facing the moving arcing contact 6a. Plural moving members 6 disposed in parallel form an opening and closing part of one pole as shown in Fig. 2. In addition, a recess groove 22b is formed on the arc block 22 at a portion with which the moving arcing contact 6a does not come in contact.

**[0015]** The air circuit breaker of above construction is installed with the power supply side terminal 3a upward, whereby the arc extinguishing chamber 17 is located at the top and the vent hole 1d is at the bottom side as illustrated in the drawing. Accordingly, an air passage is formed between the vent hole 1d and the arc gas emission window 1c.

**[0016]** Consequently, a heat generated at a portion where the moving contact 5 is in contact with the stationary contact 4 and at the peripheral conductive passages such as the moving members 6 when an electric current is applied, is cooled by natural convection from the vent hole 1d to the arc gas emission window 1c, whereby a rise in inside temperature is suppressed.

**[0017]** Further, when the applied electric current is interrupted, the valve member 21 closes the vent hole 1d by the produced arc gas pressure, and this prevents arc grounding to any metal material located below the vent hole 1d.

**[0018]** Now, operation of the moving arcing contact 6a and the stationary arcing contact 22a is described below. The moving members 6 connected to the switch mechanism part 13 are in an interlocking positional relation with the contact arm 7, the moving member stopper pin 8 and the contact arm shaft 9 so as to oscillate at the time of turning on/off. On the way of turning on, first the moving arcing contact 6a comes in contact with the stationary arcing contact 22a, whereby application of an electric current comes to start. The switch mechanism pushes in further, whereby the contact point comes to act as a fulcrum, and the moving contact 5 comes in contact with the stationary contact 4. Subsequently, the switch mechanism continues to push in, whereby the fulcrum shifts to the face where the moving contact 5 is in contact with the stationary contact 4. Consequently, the moving arcing contact 6a separates or moves away from the stationary arcing contact 22a, and the electric current flows through all over the face where the moving contact 5 is in contact with the stationary contact 4.

**[0019]** In the interruption of the electric current, with the raise of the moving members 6 by the switch mechanism, the moving contact 5 is slightly moved away from the stationary contact 4, and the electric current is applied to between the two contacts through an arc. Subsequently, the moving members 6 are pushed by the contact pressure spring 12 and rotated clockwise round the shaft 14, and the moving arcing contact 6a comes in contact with the stationary arcing contact 22a. At this

point of time, the current flows through the point where the moving arcing contact 6a is in contact with the stationary arcing contact 22a in parallel with the arc current between the two contacts. By a further raising operation of the switch mechanism, while keeping the moving arcing contact 6a in contact with the stationary arcing contact 22a, the moving contact 5 is widely moved away from the stationary contact 4 using the contact point acting as a fulcrum, thereby extending the arc between the contacts. With the extension of the arc, arc resistance is increased, and the current flow shifts mainly to the point where the moving arcing contact 6a is in contact with the stationary arcing contact 22a. With a further opening operation by the switch mechanism, the moving arcing contact 6a moves away from the stationary arcing contact 22a, and the arc generated there is induced and extinguished by the arc extinguishing chamber 17.

**[0020]** As described above, under the normal condition of application of electric current other than the opening and closing operation, the current flows through neither the moving arcing contact 6a nor the stationary arcing contact 22a, and therefore any heat generation due to the application of current does not take place at this portion. However, there may be any heat conduction from the contact portion, and this renders an advantage of increasing the heat radiation area.

**[0021]** The moving arcing contact 6a and the arc block 22 both connected with the contact face where the moving contact 5 is in contact with the stationary contact 4 and a heat is mainly generated, act as a heat radiation member cooled by convection air in the air passage between the vent hole 1d and the arc gas emission window 1c, and therefore the current-carrying part is restrained from rise in temperature.

**[0022]** Further, the opening and closing part of one pole is comprised of plural moving members 6 including the moving arcing contacts 6a arranged in parallel, and therefore the moving arcing contacts 6a have a large heat radiation area as a whole. The arc block 22 is provided with recess grooves 22b formed along the direction of airflow, and therefore the heat radiation area is increased and heat radiation effect is improved.

**[0023]** The arc block 22 forming the stationary arcing contact 22a has one face tightly fitted on the stationary conductor 3 and another face tightly fitted on the bottom face of the base housing 1, and therefore any heat in the stationary contact 4 is transferred to the arc block 22 via the stationary conductor 3. Then, the radiation of heat by the mentioned convection air and the radiation of heat from the rear face to the outside air through the bottom face of the base housing 1 are promoted, and the current-carrying part is suppressed from rise in temperature. In this sense, if the bottom rear face of the base housing 1 is corrugated to increase the heat radiation area in the bottom rear face, the heat radiation effect will be improved all the more.

## Industrial Applicability

**[0024]** As described above, an air circuit breaker according to the invention includes in a housing: a stationary conductor onto which a stationary contact is fixed; a moving member onto which a moving contact coming in contact with and separating from the stationary contact by a switch mechanism is fixed; and an arc extinguishing chamber for extinguishing an arc generated between the mentioned two contacts; and the air circuit breaker is provided with an emission window formed on a part of the housing in order to emit arc gas out of the housing and a vent hole that is opened at a portion facing the mentioned emission window and forms an air passage in the housing, and as a result, air convection from the vent hole to the emission window in the housing cools the contacts and a current-carrying part in the vicinity of the contacts, and a rise in temperature due to a heat generated by the flowing current is suppressed.

**[0025]** Further, the mentioned air circuit breaker is provided with a valve member for closing the vent hole when a pressure rises in the housing, and as a result, the valve member prevents arc gas from blowing out through the vent hole when the current is interrupted due to any accident.

**[0026]** Furthermore, an arc block provided with a stationary arcing contact extending toward the arc extinguishing chamber so as to conduct an electric power and transfer a heat from the stationary contact and a moving arcing contact coming into contact with the stationary arcing contact at the time of opening the two contacts are provided extending toward the arc extinguishing chamber so that the electric power can be conducted and the heat be transferred from the moving contact, and as a result, the arc block and the moving arcing contact, to which any electric current is not applied when the contacts are connected under normal conditions, can be increased in heat radiation area and cooled effectively.

**[0027]** Further, one pole is opened and closed by plural moving members, and each of the plural moving members is provided with the moving arcing contact extending toward the arc extinguishing chamber, and as a result, all of the moving arcing contacts act as radiation fins, and the heat radiation area is increased more. It is therefore possible to suppress rise in temperature of the current-carrying part of the air circuit breaker within a range of regulated maximum temperature.

## Claims

### 1. An air circuit breaker comprising:

- a stationary conductor onto which a stationary contact is fixed;
- a moving member onto which a moving contact coming in contact with and moving away from

said stationary contact by a switch mechanism is fixed; and  
an arc extinguishing chamber for inducing and extinguishing an arc generated between said moving contact and said stationary contact; 5  
said stationary conductor, said moving member and said arc extinguishing chamber being disposed in a housing; and  
said air circuit breaker being **characterized by** further comprising an emission window that is 10  
provided on a part of said housing to emit arc gas from said housing to outside of the housing and a vent hole that is opened at a portion facing said emission window and forms an air passage in said housing. 15

2. The air circuit breaker according to claim 1, **characterized by** further comprising a valve member for closing said vent hole when a pressure rises in said housing. 20

3. The air circuit breaker according to claim 1 or 2, **characterized in that:**

an arc block provided with a stationary arcing contact extending toward said arc extinguishing chamber so as to conduct an electric power and transfer a heat from said stationary contact, and a moving arcing contact coming into contact with said stationary arcing contact at the 25  
time of opening said two contacts and, are provided extending toward said arc extinguishing chamber so that the electric power may be conducted and the heat be transferred from said moving contact. 30  
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4. The air circuit breaker according to claim 3, **characterized in that** one pole is opened and closed by plural moving members, and each of said plural moving members is provided with the moving arcing contact extending toward said arc extinguishing chamber. 40

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Fig. 1

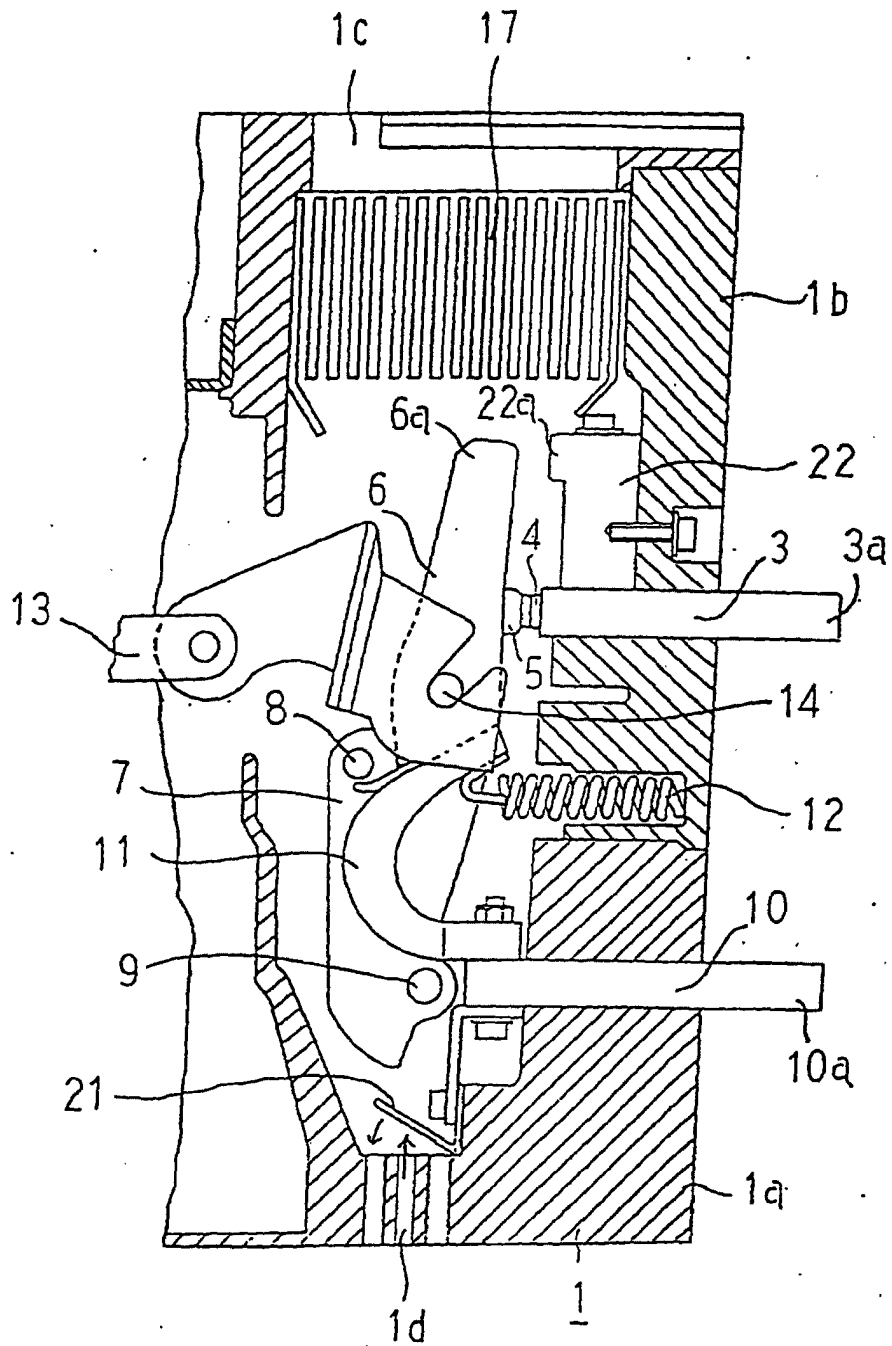


Fig. 2

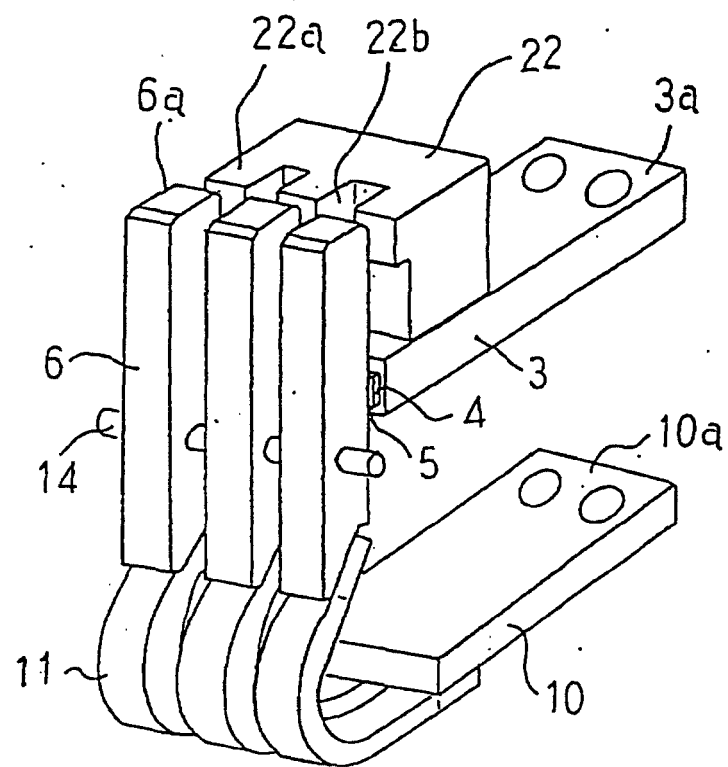
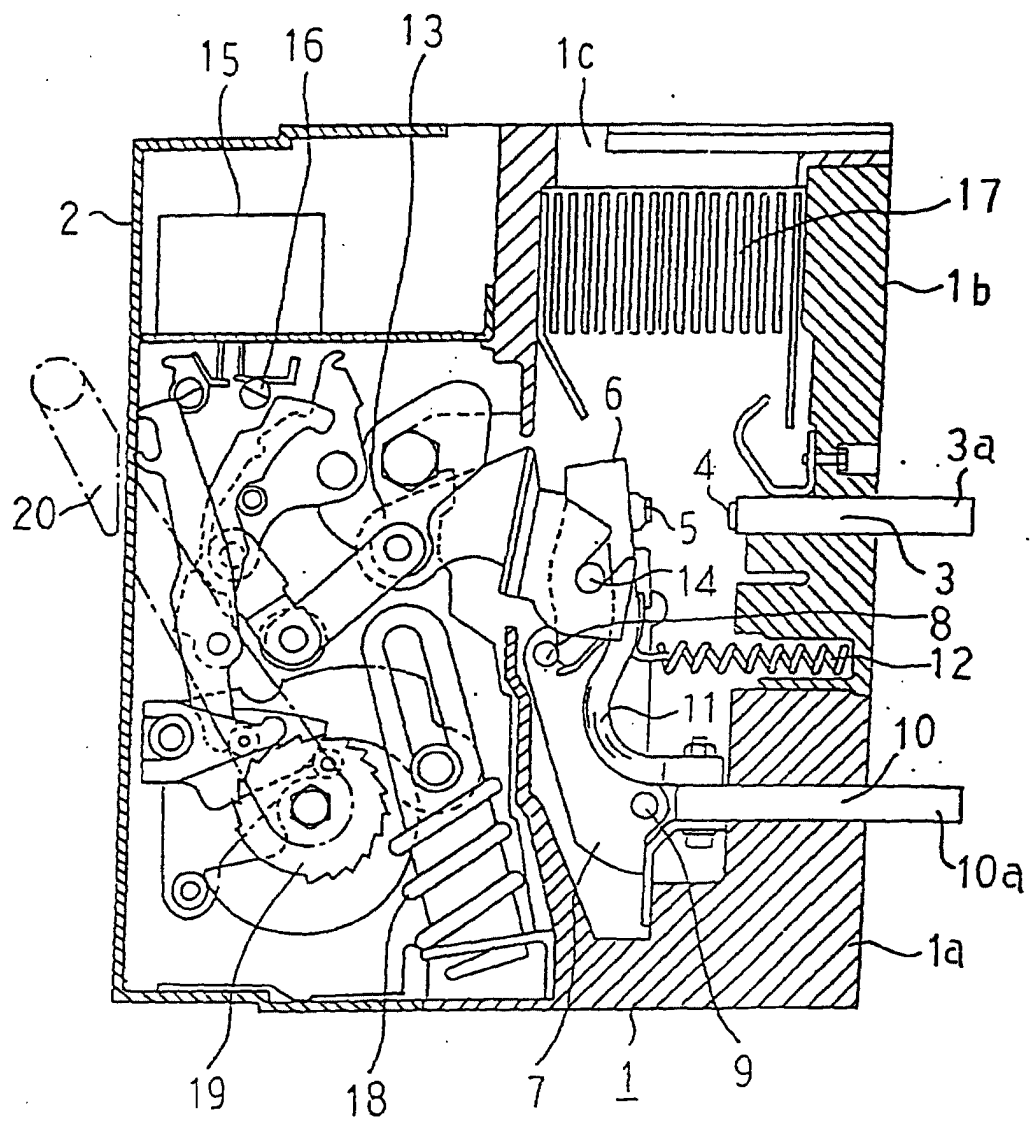


Fig. 3



## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP02/00739

| <b>A. CLASSIFICATION OF SUBJECT MATTER</b><br>Int.Cl <sup>7</sup> H01H33/53, H01H73/18<br>According to International Patent Classification (IPC) or to both national classification and IPC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                           |                                                                                 |
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| <b>B. FIELDS SEARCHED</b><br>Minimum documentation searched (classification system followed by classification symbols)<br>Int.Cl <sup>7</sup> H01H33/53, H01H73/18<br>Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched<br>Jitsuyo Shinan Koho 1940-1996 Toroku Jitsuyo Shinan Koho 1994-2002<br>Kokai Jitsuyo Shinan Koho 1971-2002 Jitsuyo Shinan Toroku Koho 1996-2002<br>Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                           |                                                                                 |
| <b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                           |                                                                                 |
| Category*                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Citation of document, with indication, where appropriate, of the relevant passages                                                                        | Relevant to claim No.                                                           |
| Y<br>A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | JP 5-303930 A (Mitsubishi Electric Corp.),<br>16 November, 1993 (16.11.93),<br>Full text; Figs. 1 to 13<br>(Family: none)                                 | 1<br>2-4                                                                        |
| Y                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | JP 58-82441 A (Mitsubishi Electric Corp.),<br>18 May, 1983 (18.05.83),<br>Full text; Figs. 1A to 5B<br>(Family: none)                                     | 1                                                                               |
| Y                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | JP 58-82440 A (Mitsubishi Electric Corp.),<br>18 May, 1983 (18.05.83),<br>Page 2, lower right column, lines 17 to 20; Figs.<br>5A to 6B<br>(Family: none) | 1                                                                               |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | JP 1-167921 A (Matsushita Electric Works, Ltd.),<br>03 July, 1989 (03.07.89),<br>Full text; Figs. 1 to 6 (Family: none)                                   | 2                                                                               |
| <input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                           |                                                                                 |
| * Special categories of cited documents:<br>"A" document defining the general state of the art which is not considered to be of particular relevance<br>"E" earlier document but published on or after the international filing date<br>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)<br>"O" document referring to an oral disclosure, use, exhibition or other means<br>"P" document published prior to the international filing date but later than the priority date claimed<br>"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<br>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone<br>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art<br>"&" document member of the same patent family |                                                                                                                                                           |                                                                                 |
| Date of the actual completion of the international search<br>16 April, 2002 (16.04.02)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                           | Date of mailing of the international search report<br>30 April, 2002 (30.04.02) |
| Name and mailing address of the ISA/<br>Japanese Patent Office                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                           | Authorized officer                                                              |
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## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP02/00739

| 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 8-31296 A (Fuji Electric Co., Ltd.),<br>02 February, 1996 (02.02.96),<br>Full text; Figs. 1 to 3<br>(Family: none) | 2                     |

Form PCT/ISA/210 (continuation of second sheet) (July 1998)