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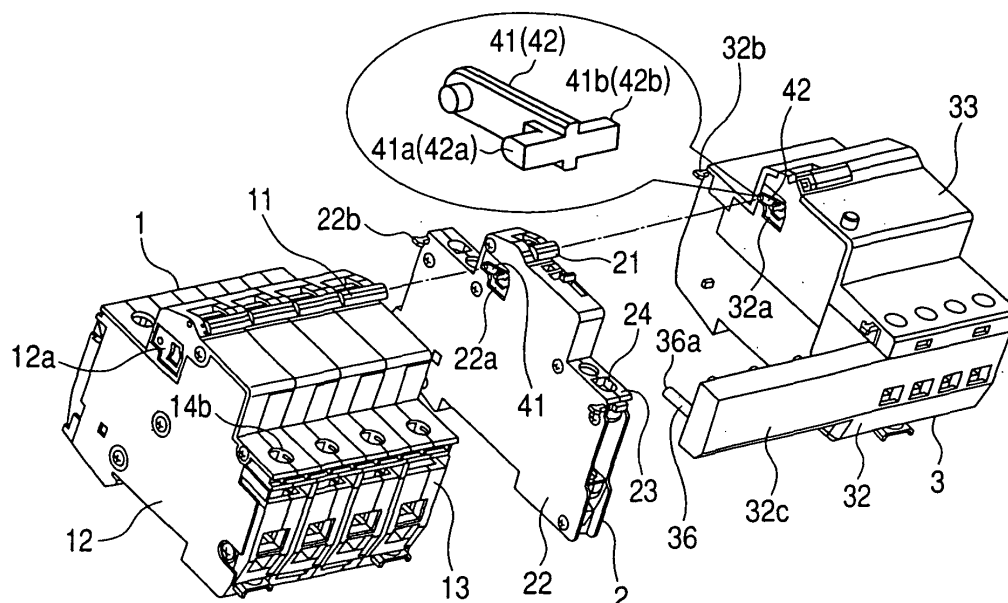
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AL BA HR MK YU(72) Inventor: **Kawakami, Tadashi****Chiyoda-ku****Tokyo 100-8310 (JP)**(74) Representative: **HOFFMANN EITLE****Patent- und Rechtsanwälte****Arabellastrasse 4****81925 München (DE)**(30) Priority: **25.01.2006 JP 2006016041**(71) Applicant: **MITSUBISHI ELECTRIC****CORPORATION****Chiyoda-ku****Tokyo 100-8310 (JP)****(54) Circuit breaking apparatus**

(57) A circuit breaking apparatus includes: a circuit breaker (1) including a first opening/closing mechanism portion (15) that moves a first movable contact (161); an external auxiliary unit (2) that is disposed on a side face of the circuit breaker and includes a second opening/closing mechanism portion (25) that moves a second movable contact (262); and a leakage detection unit (3)

including a third opening/closing mechanism portion (35) that is caused to operate by a trip coil (39). The first opening/closing mechanism portion and the second opening/closing mechanism portion are connected with a first coupling member (41), and the second opening/closing mechanism portion and the third opening/closing mechanism portion is connected with a second coupling member (42).

FIG. 2**EP 1 814 133 A1**

Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a circuit breaking apparatus in which an external auxiliary unit is disposed on a side face of a circuit breaker, particularly, a multiple-pole circuit breaker including a stack of plural single-pole circuit breakers each including an opening/closing mechanism for one pole and an overcurrent trip device, wherein the external auxiliary unit operates interlockingly with a trip operation of the multiple-pole circuit breaker and notifies the trip operation to the outside. More particularly, the present invention relates to a configuration in which a leakage tripping function or a leakage detecting function is added to such a circuit breaking apparatus.

2. Description of the Related Art

[0002] A circuit breaker such as a distribution circuit breaker or an earth leakage circuit breaker bears not only a function of opening and closing an electric path by operating a handle provided to the circuit breaker, i.e., a switching function, but also an important role of interrupting the electric path to prevent burning of an electric wire or a load apparatus due to a flow of an overcurrent, and an electrical shock or a fire due to a flow of a leakage current. The interruption of an electric path can be determined based on the position of the handle of the circuit breaker, or a leakage-indication button projected from the circuit breaker, and moreover can be known from, for example, a buzzer or a lamp in a central monitoring room with using an alarm contact incorporated in the circuit breaker.

[0003] As is known in the art, circuit breakers have various external shapes in accordance with the usage or the current capacity. In a small circuit breaker which is to be used in a household distribution panel, devices which are vital to a circuit breaker, such as an opening/closing mechanism portion relating to the above-mentioned switching function, a device for detecting an overcurrent and causing the opening/closing mechanism portion to operate, for example, an electromagnet device, and an arc-extinguisher which breaks contacts to cut off an arc generated must be mounted by top priority in a limited overall size. In this situation, the above-mentioned alarm contact is hardly incorporated in such a small circuit breaker. To comply with this, a configuration is known in which a separate case A other than a circuit breaker is provided with an alarm contact; and the case is disposed on a side face of the circuit breaker to be coupled with an opening/closing mechanism of the circuit breaker (for example, see JP-A-2005-243264). In the specification, "separate case A" is hereinafter referred to as "external auxiliary unit".

[0004] On the other hand, because of recent technical innovation, with respect to an earth leakage circuit breaker for interrupting a leakage current as described above, products of many manufacturers are usually configured so that an earth leakage circuit breaker has the same external shape as a distribution circuit breaker, that is, a distribution circuit breaker incorporates a leakage detecting function and the resulting external dimensions of the circuit breaker are equal to those of the original distribution circuit breaker. Also, in this case, such incorporation is hardly conducted in a small circuit breaker because of the above-mentioned reason. Then, a configuration is known in which components related to a main circuit, such as a zero-phase-sequence current transformer are incorporated in a leakage detection unit that is placed on the load side of a circuit breaker, components not directly related to the main circuit, such as a trip device are incorporated in a leakage trip unit that is placed on a side face of the circuit breaker, the leakage detection unit and the leakage trip unit are connected to each other by conductors, and an opening/closing mechanism of the circuit breaker is coupled to the leakage trip unit (for example, see JP-A-2000-197257).

[0005] In the earth leakage circuit breaker disclosed in JP-A-2000-197257, the leakage detection unit is disposed on the load side of the circuit breaker. In the case where the dimensions of a distribution panel are restricted, therefore, this configuration is not preferable. Consequently, another configuration is known in which components constituting a leakage detection unit are incorporated in a leakage trip unit, that is, a separate case B incorporating all components required for leakage detection is placed only on a side face of a circuit breaker, and the combination of the circuit breaker and the case is formed as an earth leakage circuit breaker. In the specification, "separate case B" is hereinafter referred to as "leakage detection unit".

SUMMARY OF THE INVENTION

[0006] In a small household circuit breaker, because of the reduced external shape, it is usual that functions other than the function related to overcurrent interruption, i.e., the functions related to an alarm contact and leakage interruption are disposed on a side face of the circuit breaker as described above. This constitutes a cause to impose restrictions on a possible combination of functions of the circuit breaker, as compared with a circuit breaker which has a relatively large external shape, and which is used in an incoming distribution panel, a power distribution panel, or the like. For example, it is a situation where it is very difficult to provide a small household earth leakage circuit breaker with an alarm contact output, and needs of the user cannot be satisfied. The invention has been conducted in order to solve the above-discussed problem. It is an object of the invention to obtain a circuit breaking apparatus in which, while a leakage detection unit having a leakage detecting function is disposed on

a side face of a circuit breaker to provide the circuit breaker with a leakage interrupting function, an external auxiliary unit that functions as an alarm contact for notifying the interrupting operation of the circuit breaker to the outside can be disposed on the side face of the circuit breaker.

[0007] According to an aspect of the invention, there is provided a circuit breaking apparatus including: a circuit breaker, an external auxiliary unit and a leakage detection unit. The circuit breaker includes: a first insulating case including a first cover and a first base; a first stator including a first stationary contact, the stator being attached to an inside of the first insulating case; a first movable contact that is opposed to the first stator to be contactable with and separable from the first stator; a first handle including a first handle portion, the first handle being provided for operating the first movable contact; a first opening/closing mechanism portion that moves the first movable contact; an electromagnet device that causes the first opening/closing mechanism portion to operate in response to an overcurrent; and first external terminals that are connected to the first stator and the first movable contact, respectively, the first external terminals being provided on an outside of the first insulating case. The external auxiliary unit that is disposed on a side face of the circuit breaker, the external auxiliary unit includes: a second insulating case including a second cover and a second base; a second stator including a second stationary contact, the second stator being attached to an inside of the second insulating case; a second movable contact that is opposed to the second stator to be contactable with and separable from the first stator; a second handle including a second handle portion, the second handle being provided for operating the second movable contact; a second opening/closing mechanism portion that moves the second movable contact; and second external terminals that are connected to the second stator and the second movable contact, respectively, the second external terminals being provided on an outside of the second insulating case. The leakage detection unit includes: an third insulating case including a third cover and a third base; a third handle including a third handle portion which is externally operable; a zero-phase-sequence current transformer that detects a leakage current of a main circuit; an electronic circuit portion that amplifies a signal detected by the zero-phase-sequence current transformer; a trip coil that operates in response to an output of the electronic circuit portion; a third opening/closing mechanism portion that is caused to operate by the trip coil; and third external terminals that are provided in an outside of the third insulating case and are positioned at both ends of a conductor that passes through the zero-phase-sequence current transformer. The first insulator case and the second insulator case are formed with first coupling holes for placing a first coupling member, respectively, the first coupling member being to connect the first opening/closing mechanism portion and the second opening/closing mechanism por-

tion. The second insulator case and the third insulator case are formed with second coupling holes for placing a second coupling member, respectively, the second coupling member being to connect the second opening/closing mechanism portion and the third opening/closing mechanism portion.

[0008] According to the invention, as described above, interruption information of the circuit breaker can be obtained while realizing a leakage detecting function. Therefore, it is possible to provide a circuit breaking apparatus in which a small household circuit breaker that meets various needs of the users is used as a core component.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009]

Fig. 1 is a front view of a circuit breaking apparatus of Embodiment 1 according to the invention.

Fig. 2 is an external perspective view of the apparatus of Fig. 1 which is disassembled into units.

Fig. 3 is a front view showing only a leakage detection unit.

Figs. 4A and 4B are internal structural views of a circuit breaker as seen in the direction of A in Fig. 1, Fig. 4A shows a trip state, and Fig. 4B shows an ON state.

Figs. 5A and 5B are internal structural views of an external auxiliary unit as seen in the direction of A in Fig. 1, Fig. 5A shows a trip state, and Fig. 5B shows an ON state.

Figs. 6A and 6B are internal structural views of a leakage detection unit as seen in the direction of B in Fig. 1, Fig. 6A shows a trip state, and Fig. 6B shows an ON state.

Fig. 7A to 7D are diagrams which schematically show a transmission method in the circuit breaking apparatus in Embodiments 1 to 3 of the invention, Fig. 7A shows Embodiment 1, Fig. 7B shows Embodiment 2, and Figs. 7C and 7D show Embodiment 3.

Fig. 8 is an assembly diagram of a circuit breaking apparatus of Embodiment 4 of the invention.

Fig. 9 is a bottom view showing only a circuit breaker in Fig. 8.

Fig. 10 is an external perspective view showing only an external terminal in Fig. 9.

Fig. 11 is a bottom view of a leakage detection unit in a modification of Embodiment 4 of the invention.

Figs. 12A and 12B are external perspective views of Fig. 11, Fig. 12A shows a replaceable terminal cover portion, and Fig. 12B shows a slide terminal cover portion.

Fig. 13 is an external perspective view showing conventional MCBs with an AL.

Fig. 14 is an external perspective view showing conventional RCBOs.

DETAILED DESCRIPTION OF THE INVENTION

Embodiment 1.

[0010] Fig. 1 is a front view of a circuit breaking apparatus of Embodiment 1 of the invention, and Fig. 2 is an external perspective view of the apparatus of Fig. 1 which is disassembled into units. Fig. 3 is a front view of the apparatus of Fig. 1 showing only a leakage detection unit, and particularly the internal wiring state by broken lines. Figs. 4 and 5 are internal structural views in which covers of a circuit breaker and an external auxiliary unit are detached, and which are as seen in the direction of A in Fig. 1. Fig. 6 is an internal structural view in which a cover 33 of the leakage detection unit is partially cut away, and which is as seen in the direction of B in Fig. 1. Figs. 4A, 5A and 6A show a (leakage) trip state, and Figs. 4B, 5B and 6B show an ON state.

[0011] As shown in Fig. 1, the circuit breaking apparatus 101 has a configuration in which an external auxiliary unit 2 functioning as an alarm contact is disposed on the right side face (in the sheet of the figure) of a stack of a plural number (in this case, four) of single-pole circuit breakers 1 (hereinafter, the stack is referred to as the circuit breaker 1), and a leakage detection unit 3 having a leakage detecting function is disposed on the right side face (in the figure) of the external auxiliary unit 2. A handle 11 (first handle) of the circuit breaker 1 and a handle 21 (second handle) of the external auxiliary unit 2 are coupled to each other by a pin which is not shown, so that the handle 21 is interlocked with manual ON (from the lower side to the upper side in the figure) and OFF (from the upper side to the lower side in the figure) operations on the handle 11. By contrast, a handle 31 (third handle) of the leakage detection unit 3 is engaged with the upper side (in the figure) of the handle 21 by an engaging portion 31a disposed on the handle 31. Namely, when the handle 31 is operated in the OFF direction, the handle 11 (and the handle 21) is interlockingly operated, but, when the handle 11 is OFF-operated, the handle 31 is not interlocked and remains at the ON position. Fig. 1 shows a state where leakage interruption is conducted or the handle 31 is operated in the OFF direction (this operation corresponds to simulated leakage interruption). From the above, as well known in the art, external terminals 14a of the circuit breaker 1 serve as power source side terminals, and external terminals 14b serve as load side terminals. The reference numeral 33a denotes a well-known leakage test button for checking whether the leakage detecting function can normally operate or not.

[0012] Then, a procedure of assembling the circuit breaking apparatus 101 will be described. As shown in Fig. 2, the circuit breaker 1 and the external auxiliary unit 2 are fixed to each other by claws 22b disposed on a base 22 constituting a case of the external auxiliary unit 2, and the handles 11, 21 are coupled to each other by the pin (not shown) and the like as described above. At this time, in order to transmit motion of an opening/closing

mechanism portion (which will be described later) of the circuit breaker 1 to the external auxiliary unit 2, a trip cam 41 is fitted into a coupling hole 22a disposed in the base 22. In a cover 13 of the circuit breaker 1, then, a coupling hole (not shown) which is identical with a coupling hole 12a of a base 12 (the coupling hole 12a is not used in the embodiment, and hence is closed) is disposed at a position opposed to the coupling hole 22a. Therefore, the trip cam 41 is engaged through the coupling hole with the opening/closing mechanism portion of the circuit breaker 1. According to the configuration, when the circuit breaker 1 trips, the alarm contact can be output from the external auxiliary unit 2.

[0013] To the configuration in which the circuit breaker 1 and the external auxiliary unit 2 are fixed to each other, the leakage detection unit 3 is further fixed by claws 32b disposed on a base 32 of the leakage detection unit 3. Unlike the fixation of the external auxiliary unit 2, the fixation of the leakage detection unit 3 requires also connection of a main circuit. That is, tip ends 36a of conductors 36 in which exposure is covered by a terminal cover portion 32c extending from the base 32 of the leakage detection unit 3 are fastened to the external terminals 14b of the circuit breaker 1 by terminal screws 14b1 (see Fig. 4A). As shown in Fig. 3, in order to prevent an inter-phase short circuit due to a mutual contact from occurring, the conductors 36 other than the tip ends 36a are covered by an insulating tube or the like.

[0014] The four conductors are collectively passed through a side face of the base 32, bent by about 90 degree in the upward direction in the figure, and then U-turned to be passed through a well-known zero-phase-sequence current transformer 37 for detecting a leakage current of an electric path. Thereafter, the conductors are connected to external terminals 34. As shown in Fig. 2, in the same manner as the external auxiliary unit 2, a coupling hole 32a is disposed in the base 32. A trip cam 42 is fitted into the coupling hole 32a, whereby motion of an opening/closing mechanism portion (described later) of the leakage detection unit 3, i.e., a leakage operation is transmitted to the opening/closing mechanism portion of the external auxiliary unit 2. This transmission is conducted by, in a cover 23 of the external auxiliary unit 2, disposing a coupling hole which is not shown (the hole which is identical with the coupling hole 22a of the base 22 is disposed also on the side of the cover 23), in the same manner as the transmission between the circuit breaker 1 and the external auxiliary unit 2.

[0015] When the circuit breaking apparatus 101 is to be used, for example, the user connects power source bars or the like to the external terminals 14a of the circuit breaker 1, and flexible load side wires to the external terminals 34 of the leakage detection unit 3, and the power supply to a load such as an electric lamp is started.

[0016] When an overcurrent or a fault current due to a short circuit is caused to flow by any reason, the electric path is interrupted by the circuit breaker 1, and the occurrence of the interruption is transmitted to the external

auxiliary unit 2 to cause the opening/closing mechanism portion of the external auxiliary unit 2 to operate, thereby causing, for example, a buzzer or a lamp (not shown) disposed in a place remote from the circuit breaking apparatus 101 to responsively operate. As a result, the user can know an abnormality of the electric path. When earth leakage occurs in the electric path, the opening/closing mechanism portion of the leakage detection unit 3 operates, and this operation is transmitted to the external auxiliary unit 2, and further to the circuit breaker 1. In the same manner as the case of the occurrence of an overcurrent, then, the electric path is interrupted by the circuit breaker 1, and an alarm is output from the external auxiliary unit 2. In Embodiment 1, the circuit breaking apparatus 101 is called RCBOs (an abbreviation of Residual Current operated circuit-Breakers with integral Overcurrent protection, i.e., an earth leakage circuit breaker with an overcurrent device), and the external auxiliary unit 2 is called AL (an abbreviation of ALarm switch). Furthermore, the trip cam 41 serves as a first coupling member that connects the opening/closing mechanism portion of the circuit breaker and the opening/closing mechanism portion of the external auxiliary unit. The trip cam 42 serves as a second coupling member that connects the opening/closing mechanism portion of the leakage detection unit and the opening/closing mechanism portion of the external auxiliary unit.

[0017] The above-described "transmission" between the units is the essential point of the invention, and hence will be further described in detail with reference to Figs. 4A to 6B. Referring to Fig. 4A, the handle 11 is swung in a clockwise direction in the figure, and a latch 151 and an arm 152 which constitute the opening/closing mechanism portion 15 (first opening/closing mechanism portion) are swung about a latch pin 153 in a counterclockwise direction in the figure. As is known, therefore, a movable contactor 161 (first movable contact) is contacted with a stator 162 (first stator) as shown in Fig. 4B to enable power supply to the load. When an overcurrent occurs in the closed state, a bimetal 17 or an electromagnet device 18 operates, the opening/closing mechanism portion 15 and the movable contactor 161 are moved to the positions shown in Fig. 4A. The detailed description of the above is omitted. As apparent from the difference of positions in Figs. 4A and 4B, therefore, the tip end 41a of the trip cam 41 which is fitted toward the circuit breaker 1 is moved between ON and trip. Also, the OFF state which is obtained by swinging the handle 11 from the state of Fig. 4B, i.e., the ON state in a counterclockwise direction in the figure is identical with that of Fig. 4A, but the moving speed of the above-mentioned tip end 41a is different.

[0018] As a result of this movement, as shown in Figs. 5A and 5B, also the tip end 41b which is fitted toward the side of the external auxiliary unit 2 is similarly moved between a latch 251 and an arm 252 which constitute the opening/closing mechanism portion 25 (second opening/closing mechanism portion) of the external aux-

iliary unit 2. As a result, a movable contact 261 (second movable contact) which constitutes a switch 26 incorporated in the external auxiliary unit 2 is swung, that is, the conduction with a stator 262 (second stator) which has been made is switched to that with a stator 263, whereby the load of external terminals 24 (second external terminals) connected to the stators 262, 263, such as the lighting pattern of a lamp is changed. In the embodiment, the external terminals 24 constitute so-called 1c contacts, and hence the number of the terminals is three. The number of the external terminals is not restricted to three, and may be two so that the external terminals constitute a 1a or 1b contact. A switch 27 is a so-called auxiliary contact (called AX (an abbreviation of AuXiliary switch)) which is interlocked with the opening/closing state of the circuit breaker 1, and which is switched in accordance with contact/non-contact operations of the movable contactor 161 irrespective of the OFF and trip operations. As described above, when only the position of the handle 11 of the circuit breaker 1 is known, it is not possible to determine whether the circuit breaker 1 is OFF-operated or an overcurrent occurs in the electric path.

[0019] By contrast, in the configuration where both the AL and the AX are mounted on the external auxiliary unit 2, it is possible to correctly know the state of the circuit breaker 1, and consequently the condition of the electric path. The AX is not directly related to the invention, and hence the detailed description of the AX and the above-mentioned difference of the moving speed of the tip end 41a is omitted.

[0020] By contrast, when earth leakage occurs in the state of Fig. 6B, unbalance of the currents flowing through the conductors 36 which is caused by the leakage current is detected by the zero-phase-sequence current transformer 37, and a signal indicative of the unbalance is sent to an electronic circuit portion 38. In the electronic circuit portion 38, the signal is amplified, and the amplitude and width of the amplified signal are compared with the reference level. If it is determined that the level is higher than that at which a leakage is to be detected, a trip coil 39 is excited. As a result of this excitation, a plunger 39a of the trip coil 39 is attracted in the rightward direction in the figure, and an opening/closing mechanism portion 35 (third opening/closing mechanism portion) is transferred from the closed state of Fig. 6B (the leakage detection unit 3 itself has no contact, but for the sake of convenience the terms of the closed state and the opened state are used in order to coincide with the descriptions of the circuit breaker 1 and the external auxiliary unit 2) to the opened state of Fig. 6A. Then, a tip end 42b of the trip cam 42 which is fitted into opening/closing mechanism portion 35 follows this transfer.

[0021] The trip cam 42 has also another tip end 42a which is fitted into the side of the external auxiliary unit 2. In accordance with the above-mentioned movement of the trip cam 42, therefore, also the external auxiliary unit 2 is transferred from the closed state (Fig. 5B) to the opened state (Fig. 5A) in the same manner as the above-

mentioned trip operation due to the overcurrent, and the switch 26 (and 27) is switched over. Furthermore, the trip operation of the opening/closing mechanism portion 25 of the external auxiliary unit 2 is transmitted to the side of the circuit breaker 1 via the trip cam 41, and the circuit breaker 1 can perform the trip operation, i.e., the leakage interruption.

[0022] As described above, the trip operation of the circuit breaker 1 due to occurrence of an overcurrent causes via the trip cam 41 the external auxiliary unit 2 to operate, and that of the leakage detection unit 3 due to occurrence of earth leakage causes via the trip cam 42 the external auxiliary unit 2 to operate, and via the trip cam 41 the circuit breaker 1 to operate. In both occurrences of an overcurrent and earth leakage, therefore, interruption of the electric path and an alarm output can be simultaneously conducted. This is mainly caused by the couplings of the opening/closing mechanism portions (15, 25, 35) with the trip cams 41, 42, and also by the structure in which the configurations of the opening/closing mechanism portions are approximated to prevent the trip cams 41, 42 from having a complicated shape, and also to facilitate the fittings of the trip cams. This will be described in more detail. The configurations of the units, particularly the leakage detection unit 3 are improved so that the opening/closing mechanism portion 15 of the circuit breaker 1, and the opening/closing mechanism portion 35 of the leakage detection unit 3 are arranged at approximately equal intervals on both the lateral sides of the opening/closing mechanism portion 25 of the external auxiliary unit 2, respectively. This improvement leads to the above-mentioned effect. As a result, even in a small household circuit breaker, it is possible to obtain an alarm output due to interruption of the breaker, and restrictions on the selection of, for example, important circuits which must be monitored from a remote place can be reduced.

Embodiment 2.

[0023] In the circuit breaking apparatus of Embodiment 1, in the case where, for example, leakage interruption is conducted, when the user goes to the place where the circuit breaking apparatus is installed, the user can know that the circuit breaking apparatus operates because of earth leakage, from the state where the handles (11, 21, 31) are at the OFF position (see Fig. 1). By contrast, from an operation of the device connected to the external auxiliary unit 2, such as the buzzer, it is impossible to determine whether the interruption of the electric path is caused by an overcurrent or by earth leakage. In the case where the output of an alarm can be restricted to at least the alarm output due to leakage interruption, however, such determination is enabled by improving the above-described "transmission" method. The improvement will be described as Embodiment 2. Figs. 7A to 7D are diagrams which schematically show engagements of the trip cams and the latches of the opening/closing mechanism portions, in order to facilitate the description

of Embodiment 2. In the figure, Fig. 7A shows above-described Embodiment 1 for comparison, Fig. 7B shows Embodiment 2, and Figs. 7C and 7D show Embodiment 3 which will be described later.

[0024] As shown in Fig. 7A, in Embodiment 1, i.e., the configuration where an alarm output is obtained in both occurrences of an overcurrent and earth leakage, the latch 251 which is one of the members constituting the opening/closing mechanism portion 25 of the external auxiliary unit 2 requires a first receiving portion 251a, a second receiving portion 251b, and a transmitting portion 251c. By contrast, in Embodiment 2, the first receiving portion 251a is omitted as shown in Fig. 7B. According to the configuration, when earth leakage occurs, the motion of the trip cam 42 which is interlocked with a latch 351 of the leakage detection unit 3 is transmitted to the second receiving portion 251b, and the latch 251 is moved. The motion of the latch 251 causes the trip cam 41 to be interlockingly moved, via the transmitting portion 251c, whereby the latch 151 of the circuit breaker 1 is operated to interrupt the electric path. To the contrary, when an overcurrent flows, the latch 151 is operated to interrupt the electric path, but the motion of the latch 151 causes only the trip cam 41 to be interlockingly moved, and the latch 251 of the external auxiliary unit 2 remains stationary.

[0025] Namely, when the electric path is interrupted by earth leakage, the latch 251 is operated, and hence an alarm output is conducted, but, when the electric path is interrupted by an overcurrent, the latch 251 is not operated, and hence an alarm output is not conducted. Therefore, the user can quickly determine that the responsive operation of the device connected to the external auxiliary unit 2, such as the buzzer is caused by leakage interruption. Consequently, an inspection or recovery work can be efficiently performed. In contrast to the AL which has been described in Embodiment 1, the external auxiliary unit 2 which is interlocked with the leakage interruption is called EAL (an abbreviation of Earth Alarm switch). The user can adequately select either of the AL or the EAL depending on the circumstances of the electric path and the like. When the EAL is attached, the pin by which the handle 11 of the circuit breaker 1 is coupled with the handle 21 of the external auxiliary unit 2 is not necessary.

Embodiment 3.

[0026] Then, Figs. 7C and 7D will be described as Embodiment 3. Embodiment 3 is characterized in that, when earth leakage occurs, the electric path is not interrupted.

[0027] In Fig. 7C, the transmitting portion 251c is omitted. According to the configuration, when earth leakage occurs, the motion of the trip cam 42 which is interlocked with the latch 351 of the leakage detection unit 3 is transmitted to the second receiving portion 251b, and the latch 251 is moved. Since the transmitting portion 251c is not disposed, however, the motion of the latch 251 is not

transmitted to the trip cam 41. Namely, even when earth leakage occurs, only the alarm output from the external auxiliary unit 2 is conducted, and the electric path is not interrupted. Since the embodiment is provided with the first receiving portion 251a of the latch 251, an alarm output is conducted also by overcurrent interruption.

[0028] In the same manner as Embodiment 1, the configuration of Fig. 7C is a circuit breaking apparatus on which the so-called AL is mounted, and in which it is impossible to determine whether the alarm output is caused by an overcurrent (interruption) or by earth leakage (non-interruption). By contrast, in the configuration of Fig. 7D, the latch 251 includes the above-described components, or the first receiving portion 251a, the second receiving portion 251b, and the transmitting portion 251c, but is not provided with the trip cam 41. Therefore, the configuration is a circuit breaking apparatus on which the so-called EAL is mounted, and in which the interrupting operation of the circuit breaker 1 is not transmitted to the external auxiliary unit 2, and therefore it is immediately determined that the alarm output is caused only by earth leakage (non-interruption). Anyway, as described above, when earth leakage occurs, only an alarm output is conducted, and the electric path is not interrupted. Therefore, Embodiment 3, i.e., the circuit breaking apparatuses 101 of Figs. 7C and 7D are called MCBs (an abbreviation of Miniature Circuit Breakers). The MCBs are effective in, for example, the case where, even when earth leakage occurs, it is first checked that the load, or particularly a mechanical apparatus or the like is in a safety position, the handle 11 of the circuit breaker 1 is then OFF-operated, and a check of the electric path, or the like is performed, i.e., the case where rapid leakage interruption is inadequate.

[0029] In Embodiments 1 to 3 which have been described above, the functions of the components of the latch 251 of the external auxiliary unit 2 are as listed below.

[0030] First receiving portion 251a: receives an overcurrent interrupting operation of the circuit breaker 1

[0031] Second receiving portion 251b: receives a leakage operation of the leakage detection unit 3.

[0032] Transmitting portion 251c: transmits the motion of the latch 251 due to a leakage operation to the circuit breaker 1.

[0033] Depending on the presence or absence of the above-mentioned components or the trip cam 41, the following product group can be built.

RCBOs with AL: corresponds to Fig. 7A (Embodiment 1)

RCBOs with EAL: corresponds to Fig. 7B (Embodiment 2)

MCBs with AL: corresponds to Fig. 7C (Embodiment 3)

MCBs with EAL: corresponds to Fig. 7D (Embodiment 3)

[0034] Namely, in addition to the compatibility of leakage detection and an alarm output enabled by the arrangement of the opening/closing mechanism portions (15, 25, 35) at equal intervals which has been described in Embodiment 1, the preparation of the external auxiliary unit 2 which is obtained by improving the components of the opening/closing mechanism portion 25 of the external auxiliary unit 2, and which meets needs of the user can provide even a small household circuit breaker with a function corresponding to a circuit breaker which has a relatively large external shape, and which is used in an incoming distribution panel, or a power distribution panel.

Embodiment 4.

[0035] The assembly procedure of the circuit breaking apparatus 101 has been described. In order to obtain the circuit breaking apparatus 101 in which leakage detection is compatible with an alarm output, it is preferable also from the viewpoint of effective use of existing units on the side of the user, to simply combine conventional circuit breaking apparatuses, or the MCBs having the AL shown in Fig. 13, and the RCBOs shown in Fig. 14 while their MCBs are shared, with each other, or specifically to laterally slide one of the circuit breaker 1 and the leakage detection unit 3, and mount the external auxiliary unit 2 in the space which is formed as a result of the sliding. In this combination, particularly, the connection between the external terminals 14b of the circuit breaker 1 and the conductors 36 of the leakage detection unit 3 must be considered. This will be described as Embodiment 4. Fig. 9 is a bottom view of the circuit breaker 1 in Embodiment 4 of the invention, and Fig. 10 is an external perspective view of the external terminal (14b). Figs. 11, 12A and 12B are bottom and external perspective views of a leakage detection unit which is a modification of Embodiment 4 of the invention.

[0036] As shown in Fig. 10, a wire receiving portion 14b2a which is positioned in a lower portion (in the figure) of a solderless terminal 14b2 constituting the external terminal 14b has a flat shape. As shown in Fig. 9, therefore, the conductor 36 of the leakage detection unit 3 can be fastened by a terminal screw 14b1 while moving the conductor in the rightward and leftward directions in the figure. Namely, in Fig. 9, the leakage detection unit 3 is adequately slid so that, in case of the RCBOs, the conductor 36 is placed at the position indicated by the solid lines, and, in the case where the circuit breaking apparatus 101 of the invention is used, or the external auxiliary unit 2 is inserted, the conductor 36 is placed at the position indicated by the broken lines. Therefore, it is possible to cope with a sudden change of the specifications, for example, a change from the RCBOs to the RCBOs with the EAL.

[0037] When the rated current of the circuit breaking apparatus 101 is increased, also the diameter of the conductor 36 must be naturally increased. In case where the rated current is at a certain level or larger, it is expected

that the leakage detection unit 3 is hardly slid because of the relationships between the diameter of the conductor 36 and the opening dimension of the solderless terminal 14b2. In such a case, when a flexible portion 36b is disposed in a part of the conductor 36 as shown in Fig. 11, the leakage detection unit 3 can be slid. Therefore, it is possible to provide the circuit breaking apparatus 101 which is further easy to use, or which is not affected by the level of the rated current. In this case, as shown in Fig. 12, one of alternatives may be used as the terminal cover portion 32c extending from the base 32 of the leakage detection unit 3 depending on the presence or absence of the external auxiliary unit 2 (in Fig. 12A, 32c or 32c'), or the terminal cover portion may be configured as a telescopic slide cover (in Fig. 12B, 32c").

Claims

1. A circuit breaking apparatus comprising:

a circuit breaker including:

a first insulating case including a first cover and a first base;
 a first stator including a first stationary contact, the stator being attached to an inside of the first insulating case;
 a first movable contact that is opposed to the first stator to be contactable with and separable from the first stator;
 a first handle including a first handle portion, the first handle being provided for operating the first movable contact;
 a first opening/closing mechanism portion that moves the first movable contact;
 an electromagnet device that causes the first opening/closing mechanism portion to operate in response to an overcurrent; and
 first external terminals that are connected to the first stator and the first movable contact, respectively, the first external terminals being provided on an outside of the first insulating case;

an external auxiliary unit that is disposed on a side face of the circuit breaker, the external auxiliary unit including:

a second insulating case including a second cover and a second base;
 a second stator including a second stationary contact, the second stator being attached to an inside of the second insulating case;
 a second movable contact that is opposed to the second stator to be contactable with and separable from the first stator;

a second handle including a second handle portion, the second handle being provided for operating the second movable contact;
 a second opening/closing mechanism portion that moves the second movable contact; and
 second external terminals that are connected to the second stator and the second movable contact, respectively, the second external terminals being provided on an outside of the second insulating case;

a leakage detection unit including:

an third insulating case including a third cover and a third base;
 a third handle including a third handle portion which is externally operable;
 a zero-phase-sequence current transformer that detects a leakage current of a main circuit;
 an electronic circuit portion that amplifies a signal detected by the zero-phase-sequence current transformer;
 a trip coil that operates in response to an output of the electronic circuit portion;
 a third opening/closing mechanism portion that is caused to operate by the trip coil; and
 third external terminals that are provided in an outside of the third insulating case and are positioned at both ends of a conductor that passes through the zero-phase-sequence current transformer,

wherein the first insulator case and the second insulator case are formed with first coupling holes for placing a first coupling member, respectively, the first coupling member being to connect the first opening/closing mechanism portion and the second opening/closing mechanism portion, and

wherein the second insulator case and the third insulator case are formed with second coupling holes for placing a second coupling member, respectively, the second coupling member being to connect the second opening/closing mechanism portion and the third opening/closing mechanism portion.

2. The circuit breaking apparatus according to claim 1, wherein the second opening/closing mechanism portion includes a latch having a first receiving portion engaged with the first coupling member that is interlocked with an operation of the first opening/closing mechanism portion operated by the electromagnet device of the circuit breaker.

3. The circuit breaking apparatus according to claim 1, wherein the second opening/closing mechanism portion includes a latch having a leakage trip mech-

anism including:

a second receiving portion engaged with the second coupling member that is interlocked with an operation of the third opening/closing mechanism portion; and
a transmitting portion that transmits a movement of the latch to the first coupling member.

4. The circuit breaking apparatus according to claim 3, wherein the first coupling member is not provided to the apparatus. 10
5. The circuit breaking apparatus according to any one of claims 2 to 4, wherein one of the first external terminals is wider than one end of the conductor passing through the zero-phase-sequence current transformer of the leakage detection unit so that when the one end is connected to the external terminal, the circuit breaker is allowed to move in order to interpose the external auxiliary unit between at least the circuit breaker and the leakage detection unit. 15 20
6. The circuit breaking apparatus according to any one of claims 2 to 4, wherein the conductor passing through the zero-phase-sequence current transformer includes a flexible portion so that when one end of the conductor is connected to one of the first external terminals, the leakage detection unit is allowed to move in order to interpose the external auxiliary unit between at least the circuit breaker and the leakage detection unit. 25 30

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FIG. 1

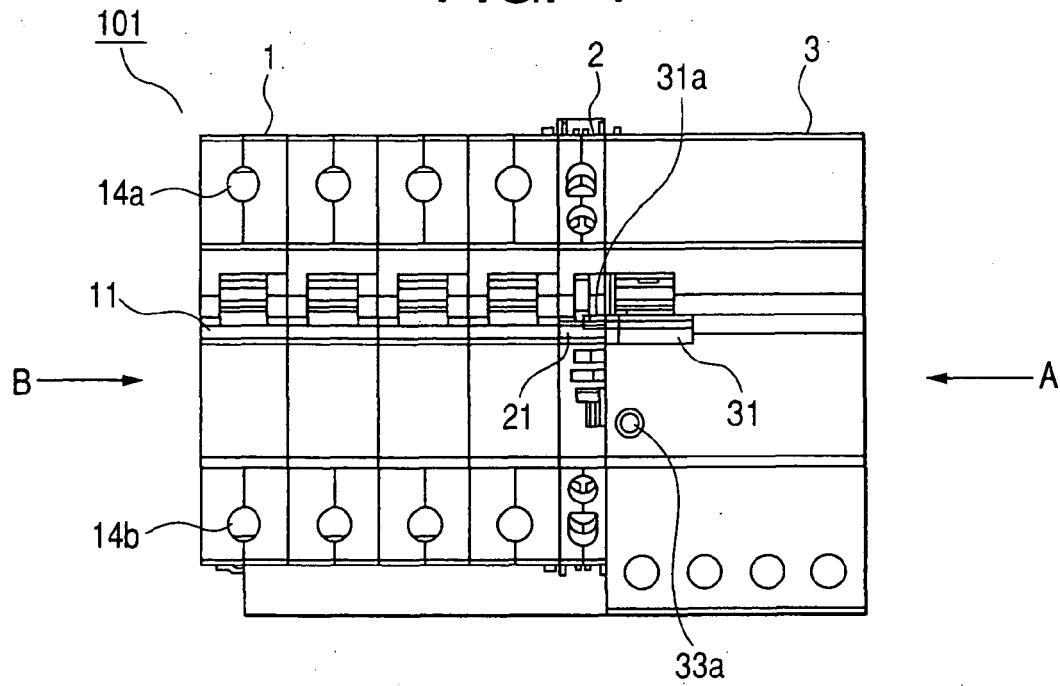


FIG. 2

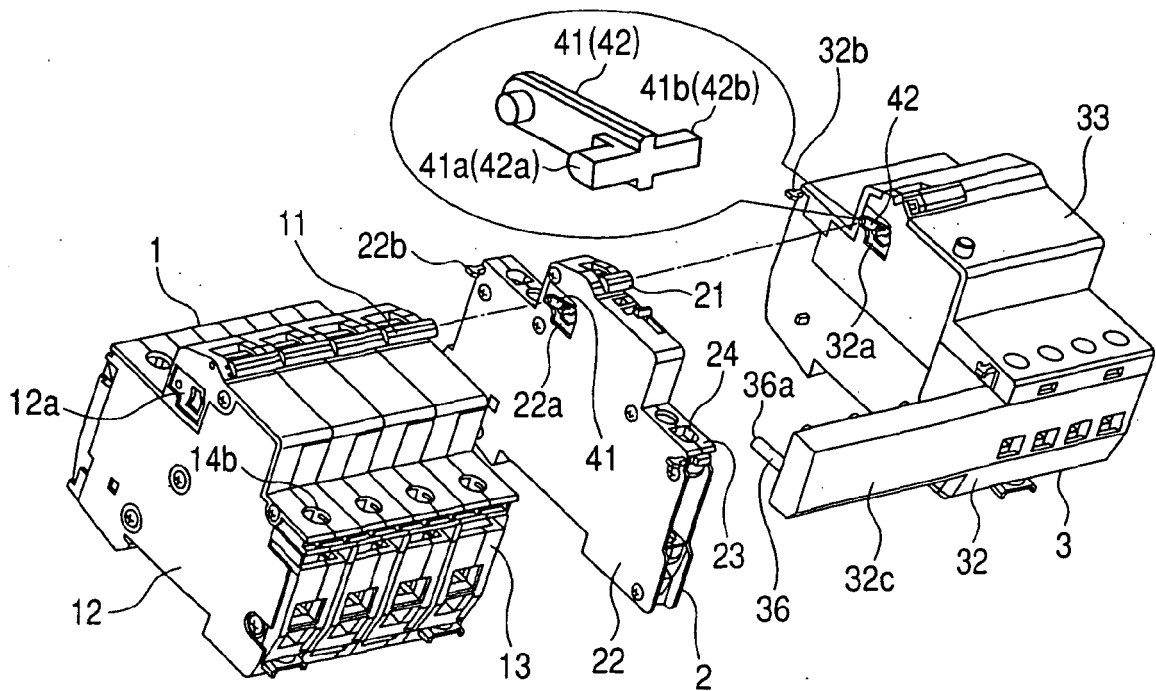


FIG. 3

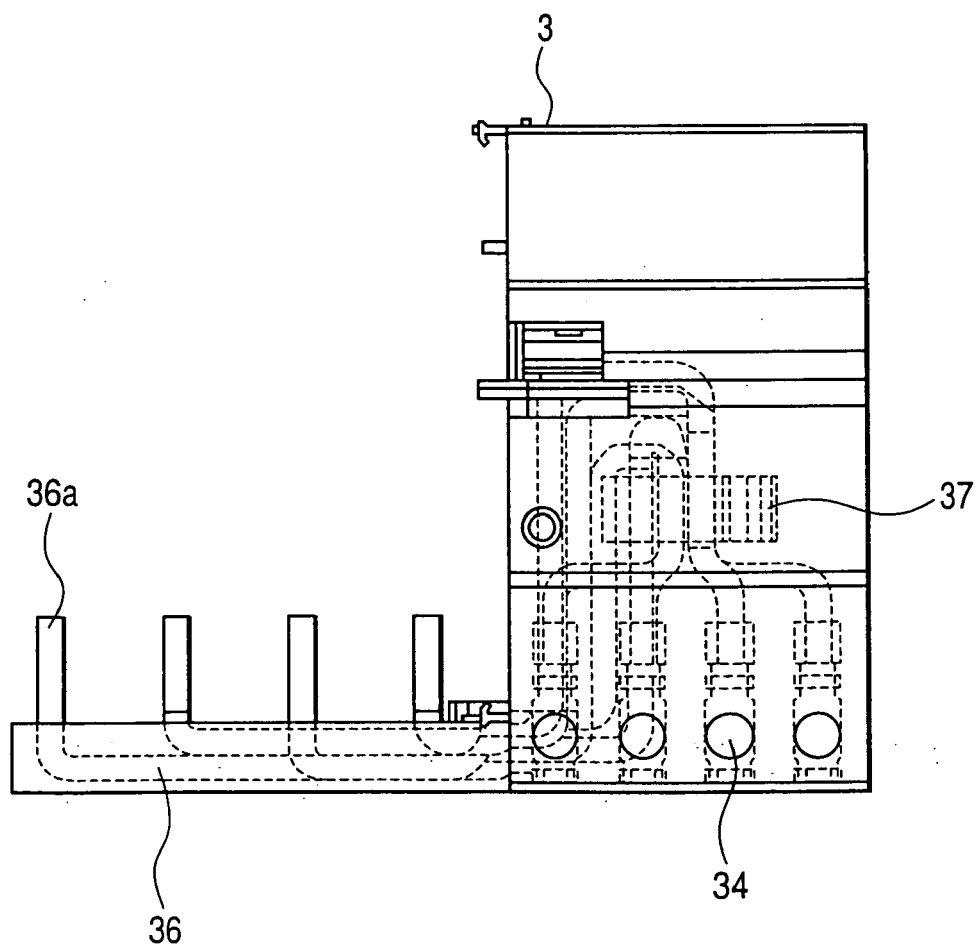


FIG. 4A

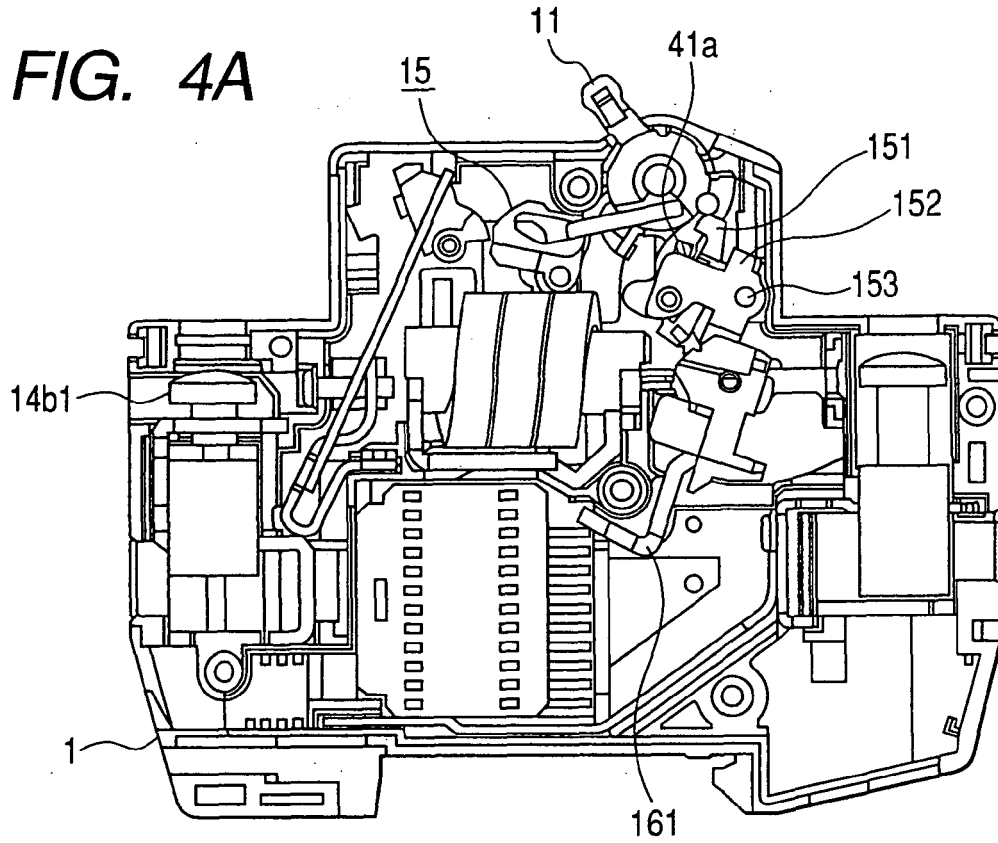


FIG. 4B

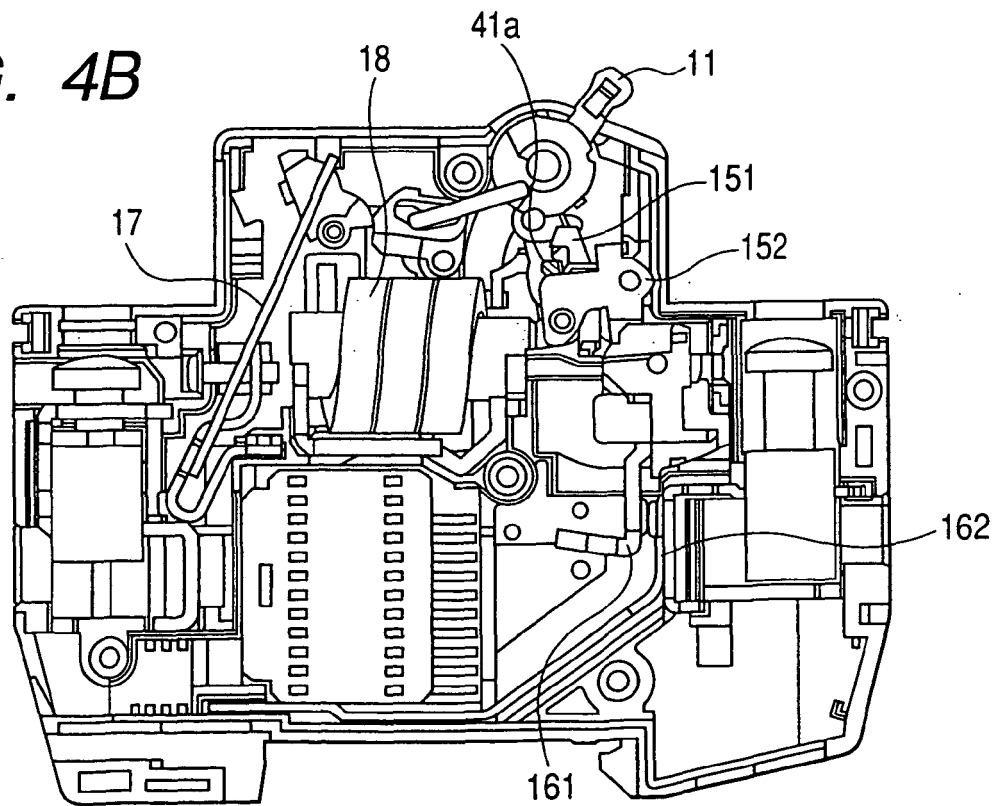


FIG. 5A

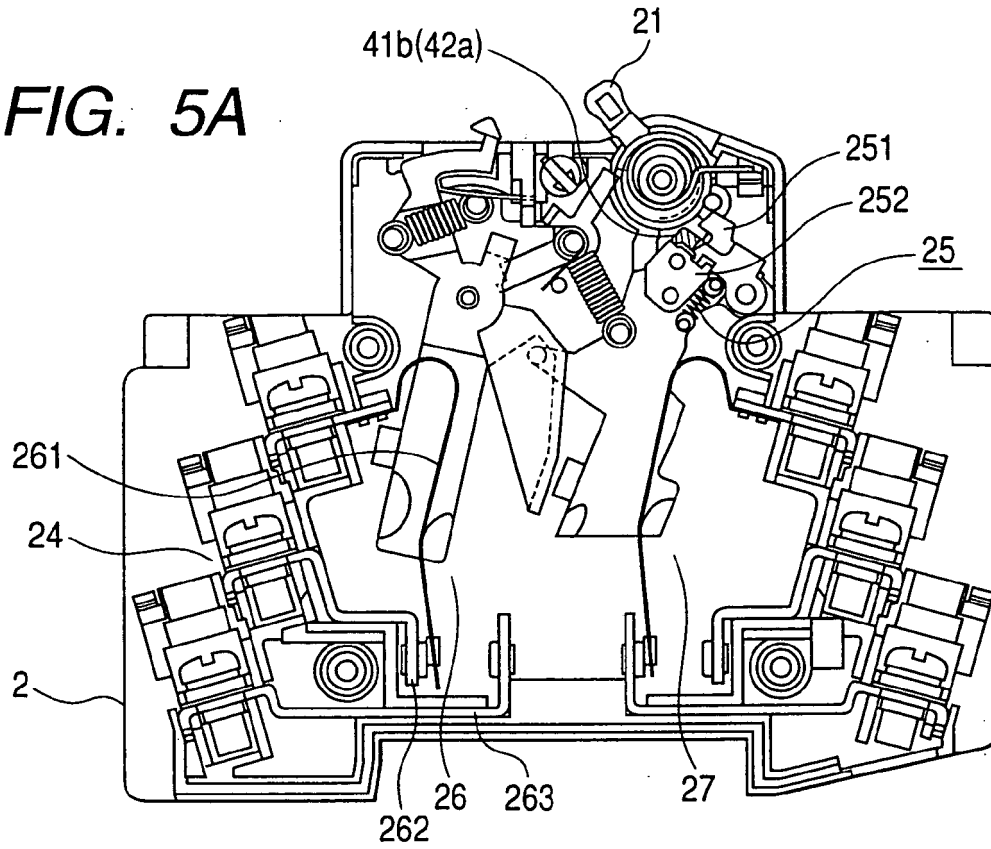


FIG. 5B

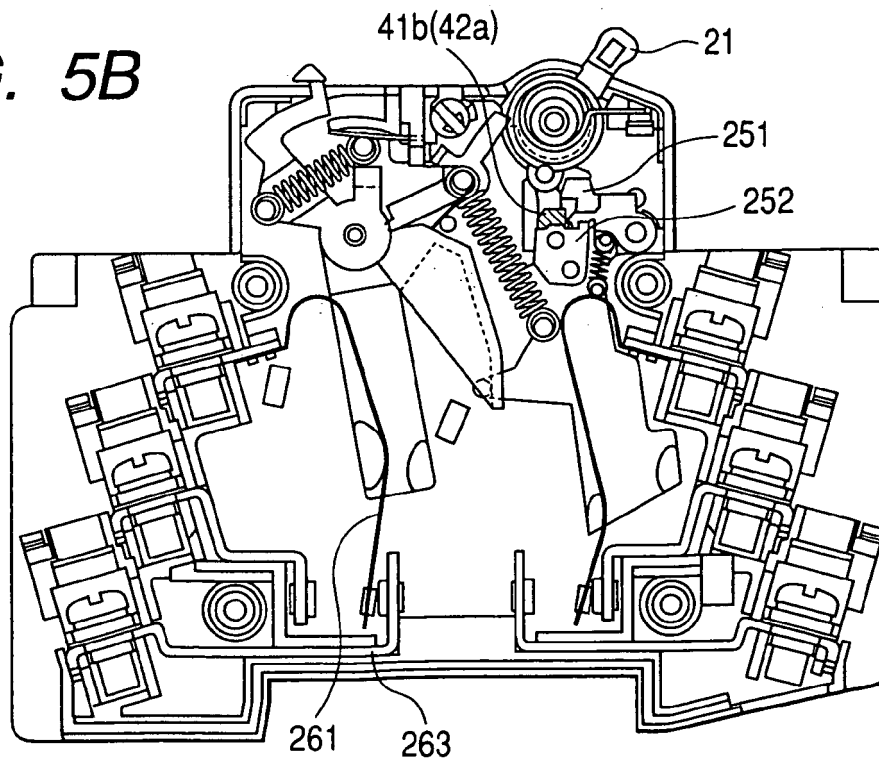


FIG. 6A

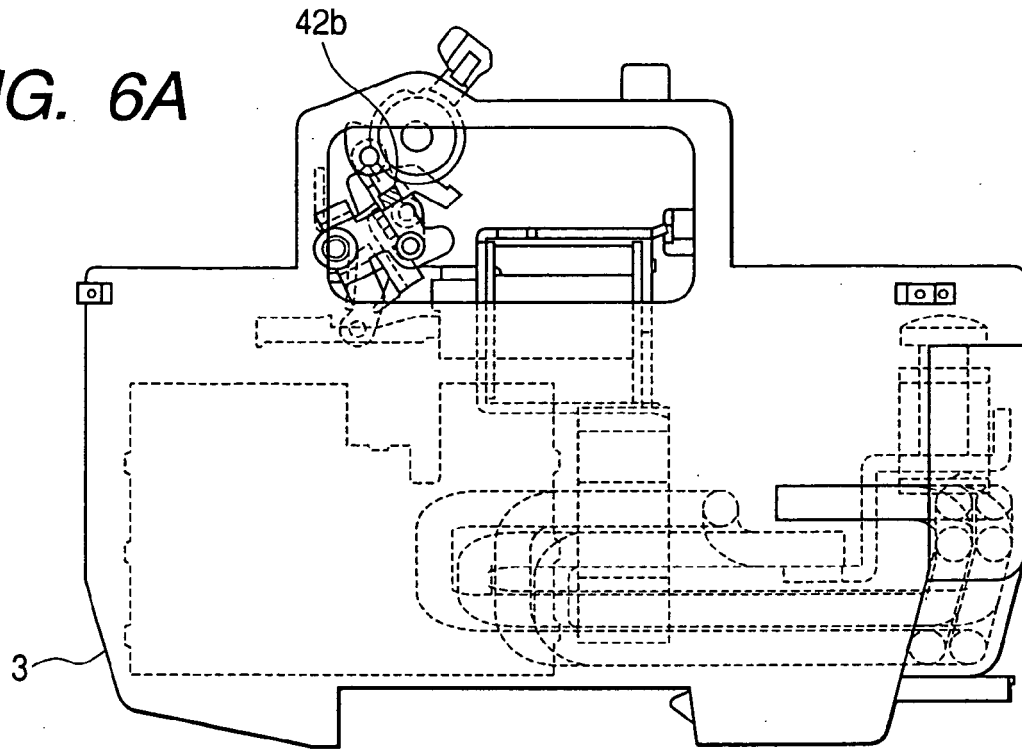


FIG. 6B

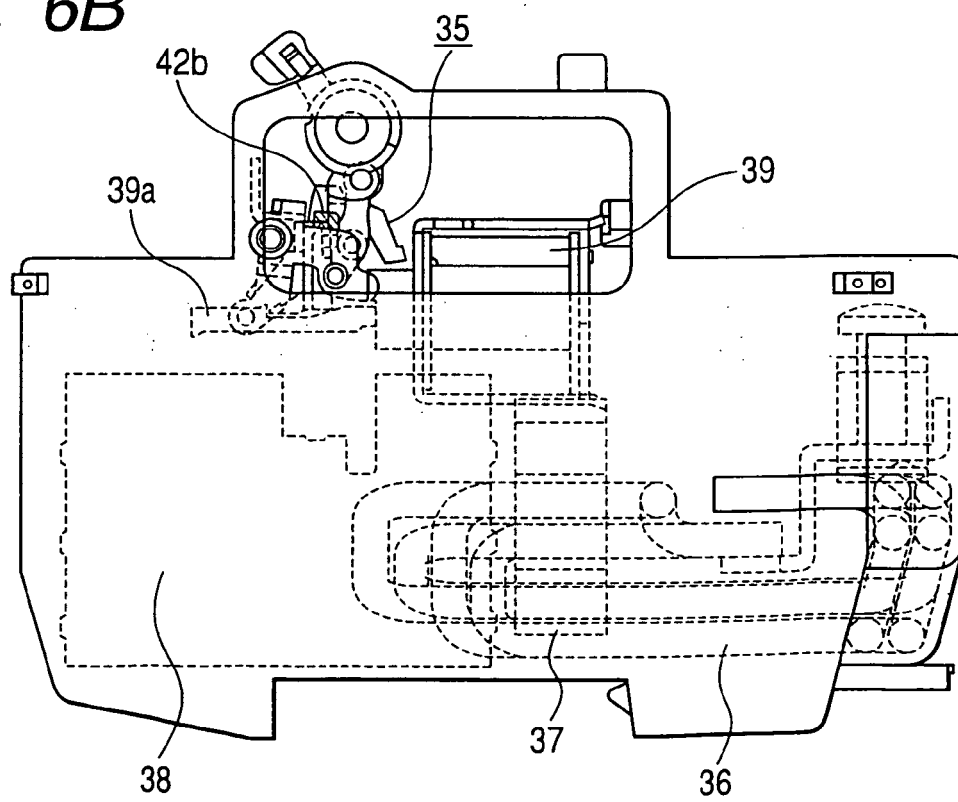


FIG. 7A

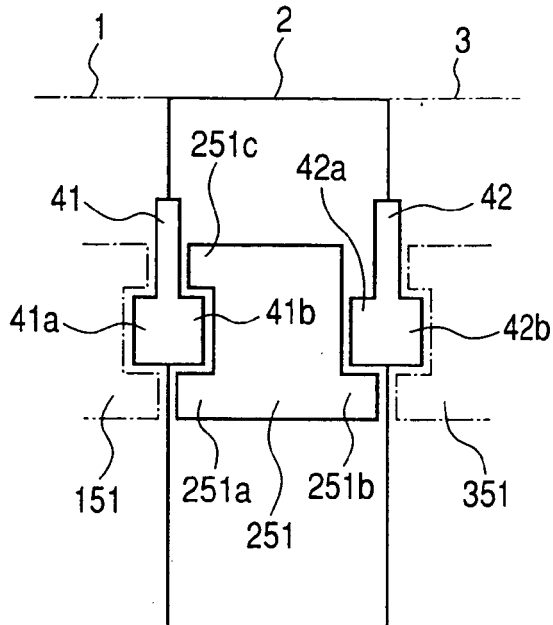


FIG. 7B

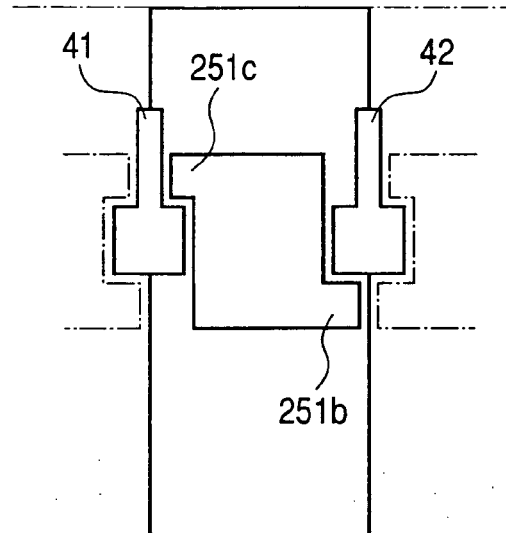


FIG. 7C

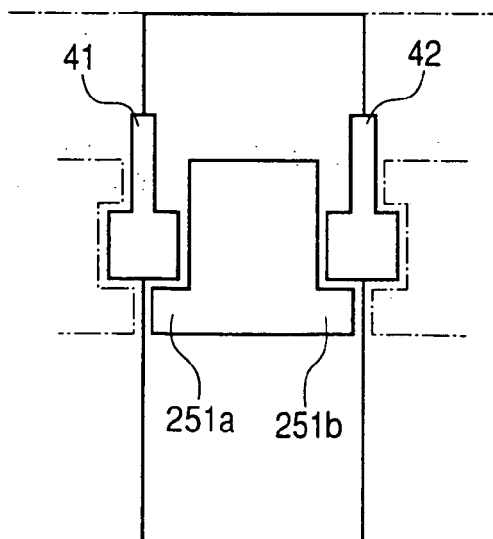


FIG. 7D

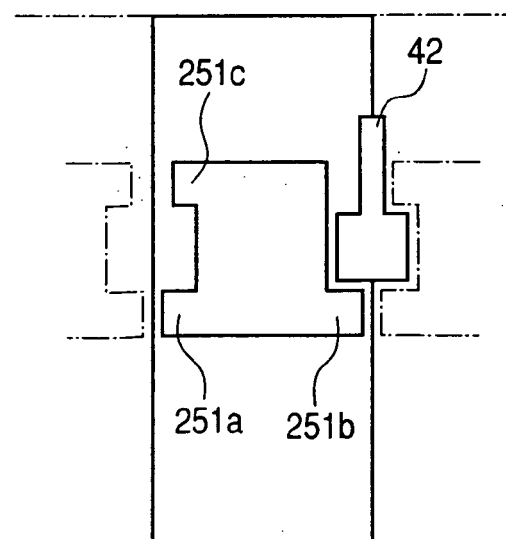


FIG. 8

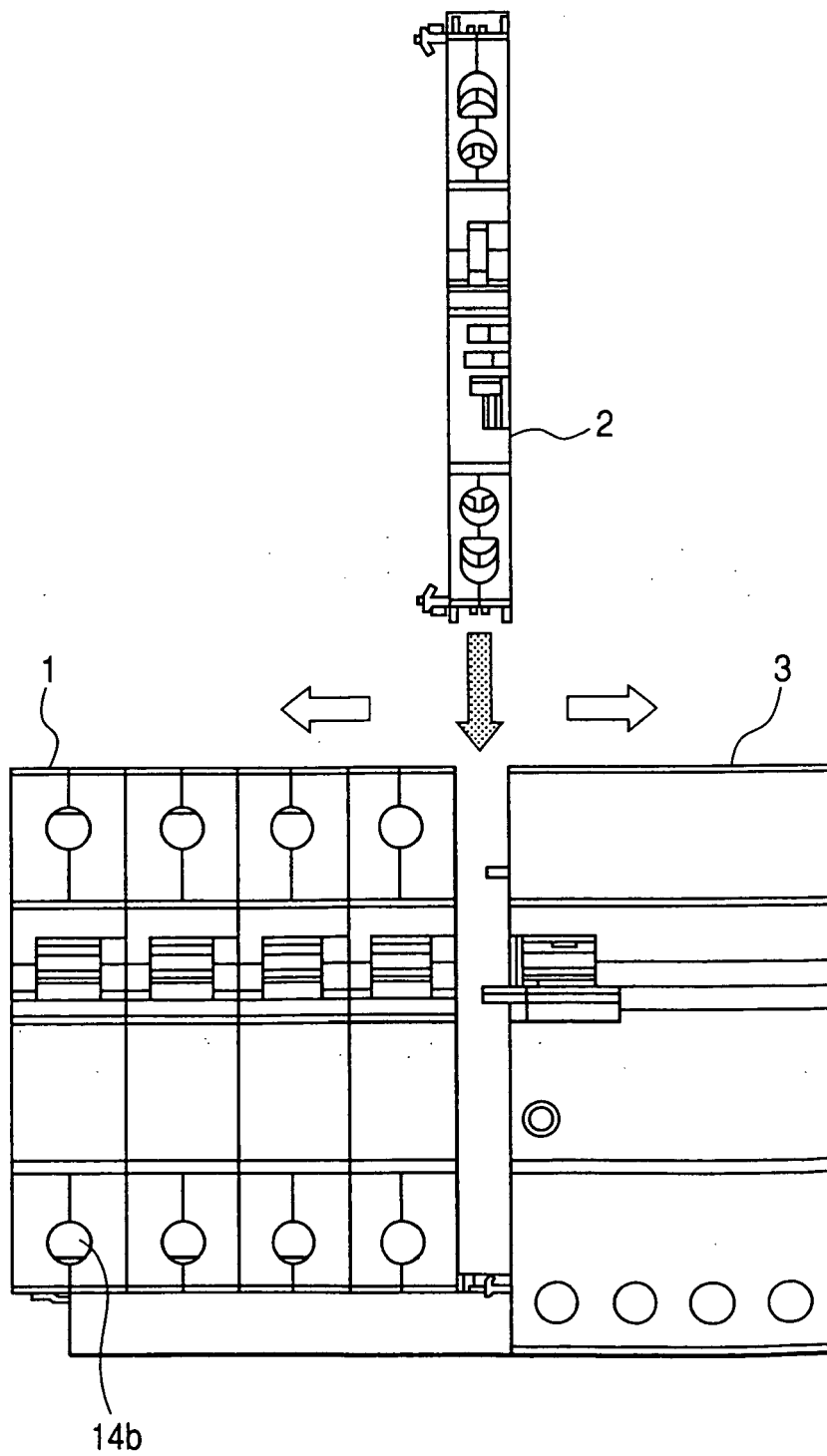


FIG. 9

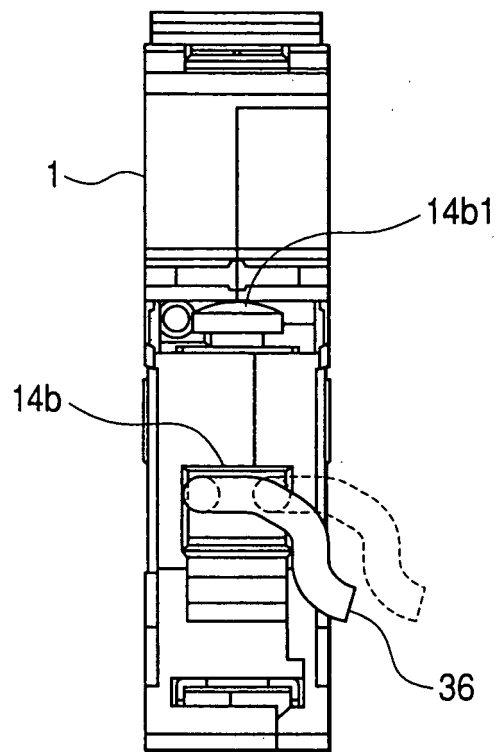


FIG. 10

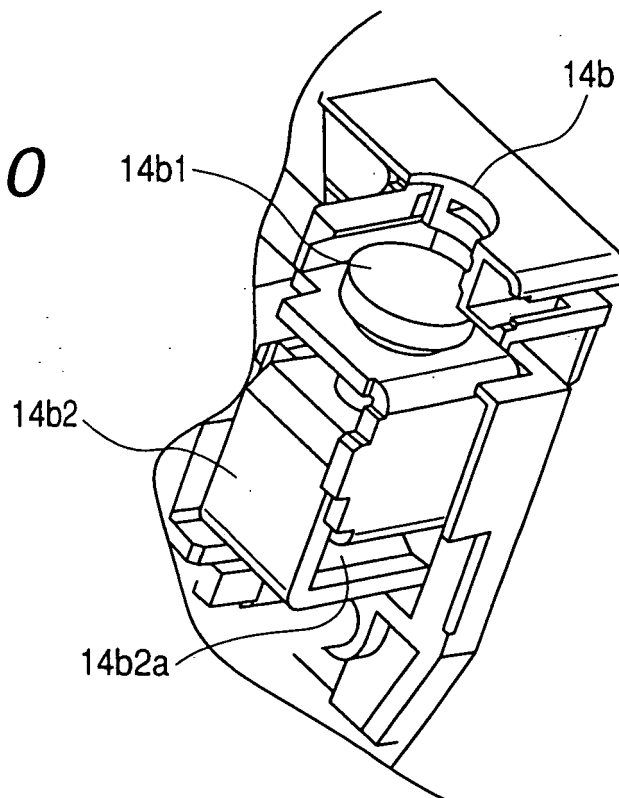


FIG. 11

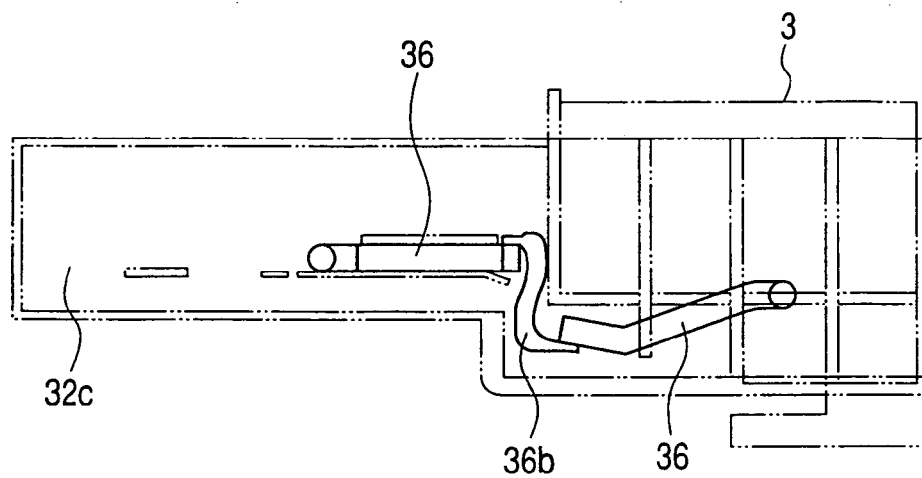


FIG. 12A

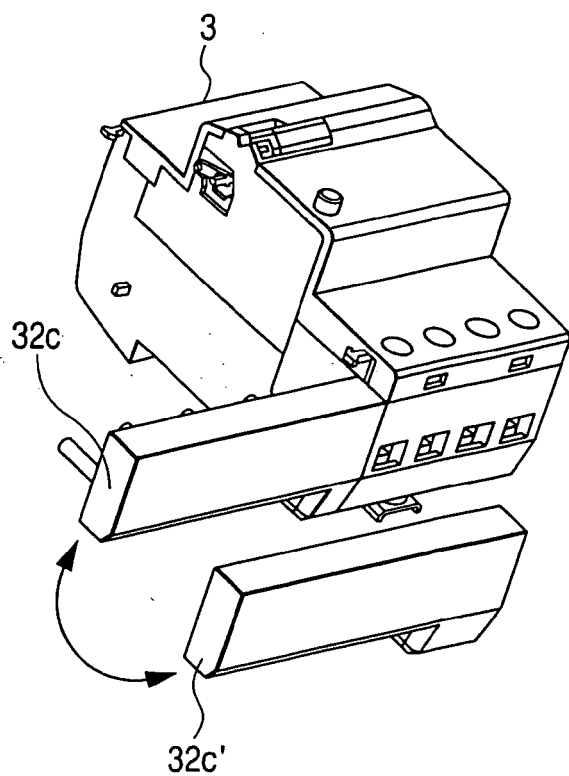


FIG. 12B

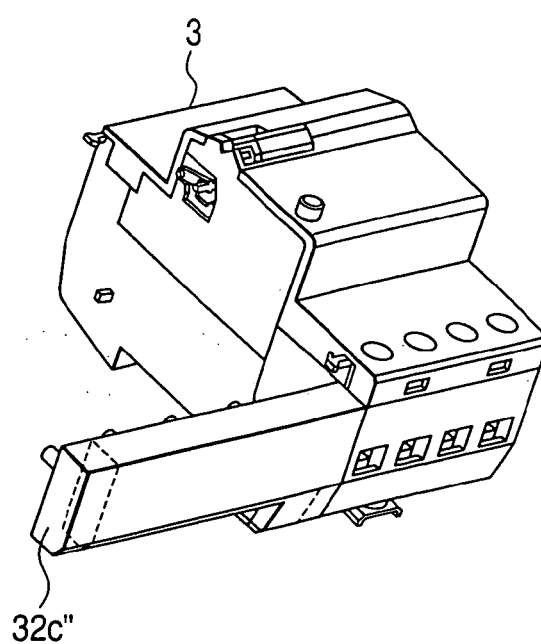


FIG. 13

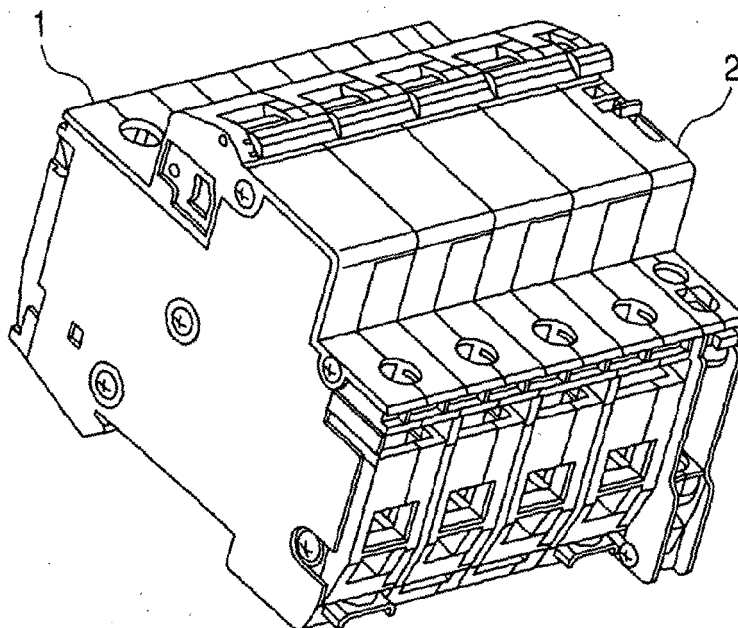
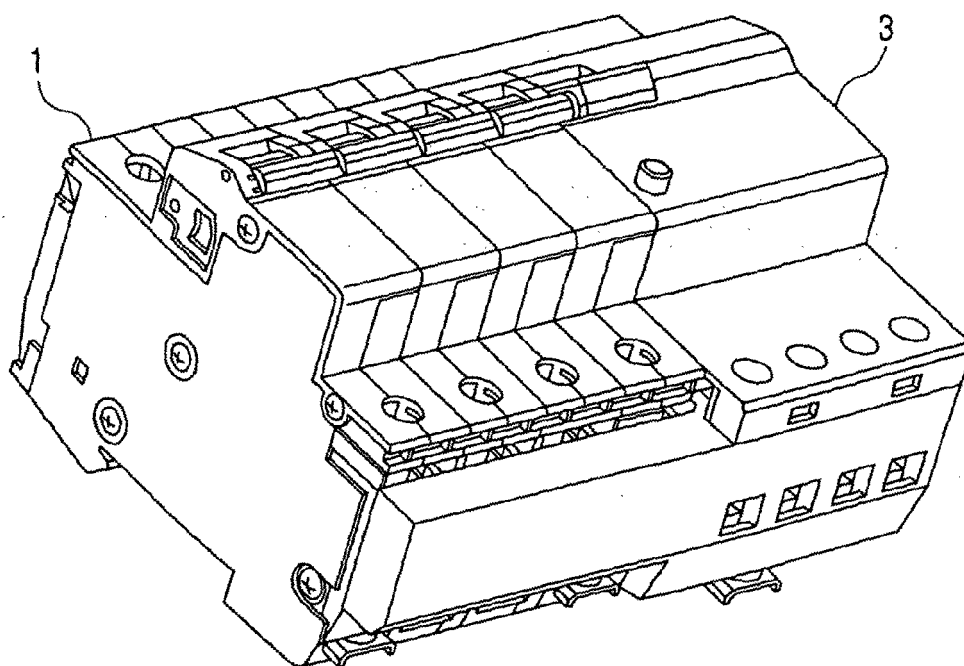


FIG. 14





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 06 01 4462

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Place of search Munich		Date of completion of the search 27 February 2007	Examiner Drabko, Jacek
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