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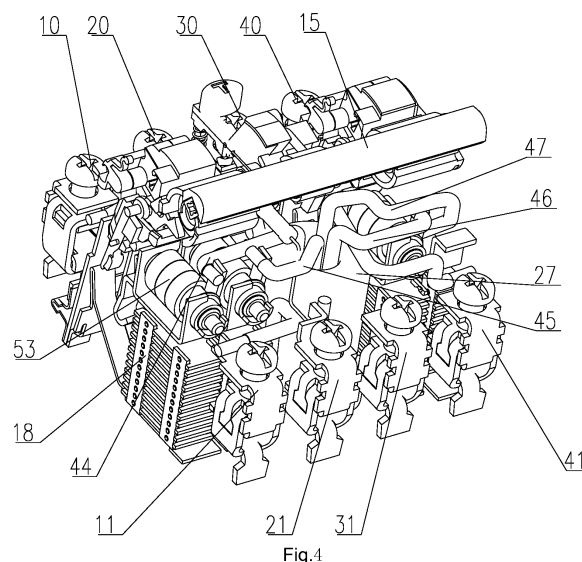
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(54) **LOW-VOLTAGE CIRCUIT BREAKER WITH RESIDUAL CURRENT TRIPPING DEVICE**

(57) The invention relates to a low-voltage circuit breaker with a residual current trip device. A plurality of circuit breaker poles which are arranged in parallel and the residual current trip device are arranged in a molded insulation shell, the circuit breaker poles are uniformly arranged at the two sides of the residual current trip device, adjacent circuit breaker poles at each side share a composite operating mechanism which is used for controlling the on and off of a movable contact and a static contact, each composite operating mechanism is provided with a handle, a trip connection rod pivotally arranged on a rotation plate and a trip rod. The residual current trip device comprises a residual current monitoring element, an electromagnetic relay, an auxiliary trip mechanism with an auxiliary handle, a rotation connection rod mechanically coupled with each composite operating mechanism and a test loop. A linkage element is in mutual mechanical connection and linkage with the auxiliary handle of the auxiliary trip mechanism of the residual current trip device and the handle of each of the composite operating mechanisms at two sides. By the low-voltage circuit breaker, a conductive loop of the circuit breaker poles is effectively reduced, rated current specification can be expanded into 40A, and the width is reduced by nearly one third compared with a spliced product.



Description

TECHNICAL FIELD

[0001] The present invention relates to a low-voltage circuit breaker, in particular to a small-sized integrated multi-pole circuit breaker having a residual current operated circuit breaker with overcurrent protection. Such circuit breaker is integrally composed of a three-pole, or three-pole four-line or four-pole circuit breaker unit module and a residual current trip device module.

BACKGROUND ART

[0002] Generally, multi-pole residual current operated circuit breakers with overcurrent protection as described in Chinese patent (CN88102711) "A Combined Circuit Breaker with Auxiliary Trip Unit and Multi-pole Circuit Breaker Unit Combined" and the Chinese Patent (CN95109668) "Multi-Pole Differential Circuit Breaker" are of a spliced structure respectively, and this kind of products are formed by combining circuit breakers of different number of poles and splicing an adaptive residual current trip device to one side of a circuit breaker combined module to constitute the multi-pole residual current operated circuit breaker with overcurrent protection. These products are large in volume, especially in a width direction, and occupy a relatively large installation space, thereby resulting in reduction of the number of installation loops of a terminal control cabinet under the same volume condition. In order to satisfy the requirements to the number of installation loops, only the number of the terminal control cabinets is increased or the size of each terminal control cabinet is increased, which causes more product consumables, increase of the use cost and relatively low installation convenience for the user.

[0003] In recent years, some foreign companies launched small-size integrated multi-pole current operated circuit breakers having overcurrent protection. These products are integrally made of a circuit breaker unit and a residual current trip device still placed at one side of the circuit breaker unit respectively. The compression in size of the product in a width direction is realized mainly by virtue of a small-sized design of each of the structure modules constituting the two devices. Because such design still follows a principle of a spliced structure, the residual current trip device is arranged at one side of the circuit breaker module. By means of such layout structure and connection manner, an electrical loop of a circuit breaker unit of a pole farther apart from the residual current trip device be relatively long, and in addition, due to more electrical connections and a complicated wiring structure, large power consumption in operation and use is caused to the products, and more valuable space is occupied, thus leading that the current specification of the product cannot be expanded (not beyond 25A at most). On the other hand, wires of the circuit breaker unit of each pole to penetrate through a zero sequence cur-

rent mutual inductor of the residual current trip device are complicated in wiring process and relatively difficult in connection, and therefore, the production cost is increased and there is still the problem that more process space is reserved. Furthermore, each circuit breaker unit must be equipped with an independent operating mechanism, or may not work normally, and each operating mechanism must occupy a relatively large valuable space.

[0004] Upon massive analysis of the prior art, the applicant finds that the existing multi-pole residual current operated circuit breaker product having overcurrent protection basically follows a principle of the spliced structure no matter of a spliced structure or an integrated structure, and it is very difficult to further increase a current specification or reduce the volume. Because the small-sized and high-current development trends of the low-voltage circuit breaker are inherently of a pair of mutually constrained contradictions, for example, if the current specification of the existing product is increased from 25A to 40A, it is at least necessary to increase a wire section and a heat insulation pitch inside the product. However, the crowding degree of the internal space of the existing product approaches an extreme limit, and therefore, it is obvious that the existing low-voltage circuit breaker with a residual current trip device fails to satisfy the use requirements of the user on small size, low cost and high-current specification, and especially fails to satisfy the small-size and integrated use requirements proposed by more and more users on the low-voltage circuit breaker having a residual current trip device of which the current specification reaches 40A.

SUMMARY OF THE INVENTION

[0005] An objective of the present invention provides a low-voltage circuit breaker with a residual current trip device, which is small in size, compact in structure and more reasonable in layout, against the defects of the prior art, not only the rated current specification can be expanded to 40A, and meanwhile, it is unnecessary to increase the volume of a small-sized integrated circuit breaker, but also the assembly convenience of the product is improved.

[0006] To achieve the objective, the invention adopts the following technical solutions.

[0007] It is provided a low-voltage circuit breaker with a residual current trip device, wherein a plurality of circuit breaker poles which are arranged in parallel and the residual current trip device are arranged in a molded insulation shell 8, each circuit breaker pole comprises a pair of input/output connecting terminals (10 and 11, 20 and 21, 30 and 31, and 40 and 41), an electromagnetic trip device (14 or 53) sensitive to a short-circuit current, a thermal trip device (26 or 60) sensitive to an overload current, a static contact 22 fixed on an integrated molded case, a movable contact 23 in closing/breaking fit with the static contact, and an arc extinguishing device 18,

wherein the circuit breaker poles are uniformly arranged at the two sides of the residual current trip device, adjacent circuit breaker poles at each side share a composite operating mechanism which is used for controlling the on and off of two pairs of movable contacts and static contacts, and each composite operating mechanism is provided with a handle 13, a rotation plate 54 provided with a contact connection mechanism for two movable contacts 23 of the two adjacent circuit breaker poles driven by the rotation plate 54, a trip connection rod 24 pivotally arranged on the rotation plate 54 and a trip rod 55. The residual current trip device comprises a residual current monitoring element, an electromagnetic relay 42, an auxiliary trip mechanism with an auxiliary handle 29, a rotation connection rod 35 mechanically coupled with each composite operating mechanism and a test loop 49. A linkage element 15 is in mutual mechanical connection and linkage with the auxiliary handle 29 of the auxiliary trip mechanism of the residual current trip device and the handle 13 of each of the composite operating mechanisms at two sides.

[0008] As a further improvement of the present invention, four circuit breaker poles are provided, which constitute two pairs of circuit breaker poles in a pairwise combination manner, wherein two circuit breaker poles in each pair of circuit breaker poles share a composite operating mechanism, and the residual current trip device is arranged between the two pairs of circuit breaker poles in parallel; or three circuit breaker poles are provided, wherein two of the circuit breaker poles constitute a pair of circuit breaker poles in which two circuit breaker poles share a composite operating mechanism, the rest single circuit breaker pole uses an operating mechanism singly, and the residual current trip device is arranged between the pair of circuit breaker poles and the single circuit breaker pole in parallel.

[0009] As another further improvement of the present invention, the circuit breaker further comprises a driving rod 28 which is in connection and linkage with the handle 13 of each of the composite operating mechanisms and the auxiliary handle 29 of the auxiliary trip mechanism of the residual current trip device.

[0010] As another further improvement of the present invention, the rotation connection rod 35 of the residual current trip device is provided with a mechanical coupling structure which can be in cooperative fit with short-circuit trip stubs (50 and 56) of the composite operating mechanisms of the circuit breaker poles at the two adjacent sides at the same time.

[0011] As another improvement of the present invention, a plurality of parallel baffles are arranged inside the molded insulation shell 8, a plurality of parallel chambers are formed inside the molded insulation shell 8 through the baffles, the residual current trip device is arranged inside the middle chamber, and the circuit breaker pole is arranged inside each of the chambers at two sides.

[0012] As another further improvement of the present invention, the handle 13 of each composite operating

mechanism is pivotally arranged on the molded insulation shell 8, the rotation plate 54 is pivotally arranged on the molded insulation shell 8, a U-shaped rod 52 is in hinge connection with the handle 13 and the trip connection rod 24 respectively, a trip rod 55 pivotally arranged on the rotation plate 54 is provided with two short-circuit trip stubs (50 and 56) which are matched with two electromagnetic trip devices (14 and 53) of two adjacent circuit breaker poles controlled by the trip rod 55, and is further provided with two overload trip stubs (58 and 59) which are matched with the two thermal trip devices (26 and 60) of the two adjacent circuit breaker poles controlled by the trip rod 55, a mechanical interlock 17 is arranged between the trip connection rod 24 and the trip rod 55, the elastic force of an energy storage spring is used for driving the composite operating mechanisms to trip, and the elastic force of a reset spring is used for driving the mechanical interlock 17 to lock.

[0013] As another further improvement of the present invention, the residual current monitoring element comprises an annular iron core 27, a primary winding 45 which penetrates through the annular iron core 27 and is electrically connected with the circuit breaker poles, and a secondary winding wound on the annular iron core 27, wherein the secondary winding is connected with an electromagnetic relay 42, and the electromagnetic relay 42 is mechanical and cooperative action with the composite operating mechanisms of the circuit breaker poles at two sides through the auxiliary trip mechanism and the rotation connection rod 35.

[0014] As another further improvement of the present invention, the auxiliary trip mechanism comprises an auxiliary handle 29, an auxiliary U-shaped rod 33, an auxiliary rotation plate 34, an auxiliary trip rod 51, a lock latch 36, a reset lever 37, an auxiliary energy storage spring and an auxiliary reset spring, wherein the lock latch 36 is mechanically coupled with the electromagnetic relay 42, and the auxiliary rotation plate 34 is mechanically coupled with two short-circuit trip stubs (50 and 56) of the two composite operating mechanisms of the circuit breaker poles at two sides through the rotation connection rod 35.

[0015] As a further improvement of the present invention, the primary winding of the residual current monitoring element is made of a flexible conductor which also serves as a flexible conductor of each circuit breaker pole, and one terminal of the flexible conductor is electrically connected with a corresponding outgoing terminal of the electromagnetic trip device (14 or 53) of the circuit breaker pole.

[0016] As a yet further improvement of the present invention, an opening for an electrical connection process is formed in the bottom of a corresponding position where the residual current trip device of the molded insulation shell 8 is arranged, and it is preferred that a detachable baffle block for mounting and debugging the electromagnetic relay 42 conveniently is arranged at the bottom of the electromagnetic relay 42.

[0017] Proceeding from simplification of the product

structure, the applicant performs an optimized design for the integrated layout and the specific structure of the low-voltage circuit breaker with a residual current trip device of the present invention, and therefore, a conductive loop of each circuit breaker pole is effectively reduced, the operation power consumption is reduced, the size of the circuit breaker in the width direction is reduced by nearly one third compared with a spliced product, and a valuable space is obtained for increasing the current specification and reducing the product volume at the same time. It is possible to promote the current specification to 40A on the premise of not increasing or reducing the volume, and an electromagnetic relay is arranged and debugged conveniently, the production process is optimized, the production efficiency is improved and the cost is reduced.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] The advantages and features of the present invention will be seen more clearly from the description of the embodiments as shown in drawings, wherein:

Fig. 1 is a stereoscopic schematic drawing of an appearance structure of a low-voltage circuit breaker with a residual current trip device according to a three-pole four-line embodiment of the present invention.

Fig. 2 is a planar schematic drawing of an internal structure of one circuit breaker pole in the low-voltage circuit breaker of the present invention.

Fig. 3 is a planar schematic drawing of an internal structure of the residual current trip device in the low-voltage circuit breaker of the present invention.

Fig. 4 and Fig. 5 are a stereoscopic schematic drawing of an internal structure of each module after a shell of the low-voltage circuit breaker as shown in Fig. 1 is removed, respectively.

Fig. 6 is a stereoscopic exploded drawing of the residual current trip device in the low-voltage circuit breaker of the present invention.

Fig. 7 is a stereoscopic structural schematic drawing of the composite operating structure of each circuit breaker pole in the low-voltage circuit breaker of the present invention.

Fig. 8 is a planar structural schematic drawing of the composite operating mechanism of each circuit breaker pole in the low-voltage circuit breaker of the present invention as shown in Fig. 7, which illustrates an integral installation relation between one circuit breaker pole and the composite operating mechanism.

Fig. 9 is an electrical connection schematic drawing of one circuit breaker pole of the low-voltage circuit breaker of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0019] Specific embodiments of a low-voltage circuit breaker with a residual current trip device are further illustrated as below in conjunction with the embodiments illustrated in Figs. 1 to 9. The low-voltage circuit breaker with the residual current trip device of the present invention is not limited to the description of the following embodiments.

[0020] The low-voltage circuit breaker with the residual current trip device of the present invention is illustrated mainly with a common three-pole four-line embodiment as shown in Figs. 1 to 8, wherein referring to Fig. 1, four pole modules constituting a circuit breaker unit and a residual current trip device are arranged in a molded insulation shell 8 and may be manufactured into a small-sized integrated low-voltage circuit breaker with a residual current trip device; a plurality of circuit breaker poles which are arranged in parallel and the residual current trip device are arranged in a molded insulation shell 8, each circuit breaker pole comprises a pair of input/output connecting terminals (10 and 11, 20 and 21, 30 and 31, and 40 and 41), an electromagnetic trip device (14 or 53) sensitive to a short-circuit current, a thermal trip device (26 or 60) sensitive to an overload current, a static contact 22 fixed on an integrated molded case, a movable contact 23 in closing/breaking fit with the static contact, and an arc extinguishing device 18, wherein the circuit breaker poles are uniformly arranged at the two sides of the residual current trip device, adjacent circuit breaker poles at each side share a composite operating mechanism which is used for controlling the on and off of two pairs of movable contacts and static contacts, and each composite operating mechanism is provided with a handle 13, a rotation plate 54 provided with a contact connection mechanism for two movable contacts 23 of the two adjacent circuit breaker poles driven by the rotation plate 54, a trip connection rod 24 pivotally arranged on the rotation plate 54 and a trip rod 55. One pair of adjacent circuit breaker poles share a composite operating mechanism which is used for controlling the on and off of the movable contact and the static contact, wherein manual operation means that handles 13 and 48 are driven by a linkage element 15, and automatic operation means a cooperative action through the thermal trip device 26 or 60 (the remaining device is not shown) and the electromagnetic trip device 14 or 53 (the remaining device is not shown). The residual current trip device comprises a residual current monitoring element, an electromagnetic relay 42, an auxiliary trip mechanism with an auxiliary handle 29, a rotation connection rod 35 mechanically coupled with each composite operating mechanism and a test loop 49. As specifically shown in Fig. 7, the rotation connection rod 35 is provided with a mechanical coupling structure which can be matched with short-circuit trip stubs (50 and 56) of the composite operating mechanisms of the circuit breaker poles at two adjacent sides

at the same time. A linkage element 15 is in mutual mechanical connection and linkage with the auxiliary handle 29 of the auxiliary trip mechanism of the residual current trip device and the handle 13 of each of the composite operating mechanisms at two sides.

[0021] The low-voltage circuit breaker with the residual current trip device of the present invention as shown in Fig. 1 comprises four circuit breaker poles having a protection function arranged in parallel, a residual current trip device and two composite operating mechanisms, which are arranged inside an integrated molded insulation shell 8. These circuit breaker poles include four connecting terminals (10 and 11, 20 and 21, 30 and 31, and 40 and 41) which can be used for controlling four paths of lines, that is, the four circuit breaker poles arranged in parallel include four pairs of connecting terminals, four electromagnetic trip devices, four thermal trip devices, four static contacts, four movable contacts and four arc extinguishing devices in total. The circuit breakers in such form may be in the following two actual use conditions: a three-pole four-line condition in which four paths of lines are three phases of live lines and one phase of neutral line respectively; and a four-pole condition in which four paths of lines are specific four poles respectively. In order to evade the difficulty to accurate description of poles in the circuit breaker caused by uncertainty of use conditions, the present application cites a term "circuit breaker pole" so as to accurately describe the concept related to poles in the circuit breaker preceding from the structure of the circuit breaker, that is: the "circuit breaker pole" described here refers to a combination of all the components configured on the same line controlled by the circuit breaker, and means one assembly, for example, a multi-pole circuit breaker having four circuit breaker poles, which can be used in a three-pole four-line or four-line circuit, or a multi-pole circuit breaker having three circuit breaker poles, which can be used in a two-pole three-line (live line, neutral line and ground line) or three-pole (three phases of live lines) circuit. The number of circuit breaker poles included in the embodiment of the low-voltage circuit breaker with the residual current trip device as shown in Fig. 1 is 4, most commonly 3 and 4. The number of the circuit breaker poles included in the low-voltage circuit breaker with the residual current trip device of the present invention is not limited to 4, or may be 3. The spliced structure of the prior art includes a circuit breaker unit and a molded shell, for example, a multi-pole circuit breaker which is formed by splicing four circuit breaker units and comprises a residual current trip function requires five molded cases. However, referring to Figs. 1, 2 and 3, only one integrated molded insulation shell 8 is available no matter how many circuit breaker poles are configured in the present invention, and therefore, the size of the circuit breaker in a width direction is reduced by nearly one third compared with an existing spliced product. For convenient installation and improvement of an insulated isolation performance, the molded insulation shell 8 is internally provided with a plurality of

baffles (not shown in drawings) which are arranged in parallel, a plurality of parallel chambers are formed inside the molded insulation shell 8 through the baffles, the circuit breaker pole is arranged inside each of the chambers at two sides, and the residual current trip device is arranged inside the middle chamber. Obviously, each circuit breaker pole has the same structure, and therefore each chamber in which the circuit breaker pole is arranged has the same shape and size.

[0022] Fig. 4 and Fig. 5 illustrate an overall layout structure in which the residual current trip device is arranged in the middle of four circuit breaker poles arranged in parallel, wherein for a three-pole product, a pole A is adjacent to a pole B, and the residual current trip device is arranged between the poles AB and a pole C; and for a three-pole four-line or four-line product, a pole A is adjacent to a pole B, a pole C is adjacent to a pole N, and the poles AB and the poles CN are symmetrically distributed at two sides of the residual current trip device. Referring to Figs. 1, 4 and 5, the plurality of circuit breaker poles of the present invention are arranged inside the integrated molded insulation shell 8 in parallel, and the residual current trip device is arranged in the middle of the plurality of circuit breaker poles arranged in parallel, wherein the so-called middle is completely different from a structure where a residual current trip device of the prior art is arranged at one side (for example, at the right side) of a circuit breaker unit. In order to make wires in the circuit breaker be shortest and electrical connection be least, and meanwhile realize an effect that two circuit breaker poles share one composite operating mechanism, the so-called middle here further refers to the following optimal layout structure: in the event that four circuit breaker poles are included, the circuit breaker poles constitute two pairs of circuit breaker poles in a pairwise combination manner, wherein two circuit breaker poles in each pair of circuit breaker poles share one composite operating mechanism, and the residual current trip device is arranged between two pairs of circuit breaker poles arranged in parallel (as shown in Fig. 4 and Fig. 5). In the event that three circuit breaker poles are included, two circuit breaker poles constitute a pair of circuit breaker poles and share one composite operating mechanism, and the remaining circuit breaker pole constitutes a single circuit breaker pole and uses an operating mechanism singly, and the residual current trip device is arranged between the pair of circuit breaker poles and the single circuit breaker in parallel. Obviously, an integral layout structure in which the residual current trip device is arranged in the middle of the plurality of circuit breaker poles arranged in parallel is a key means for increasing the current specification and reducing the product volume, but it is necessary to finish overall layout planning, structures of related parts and components (especially an operating mechanism), a wiring structure, and redesign and integrated optimized design of a control process and a transmission process converted among five states (closing, breaking, short-circuit trip, overload trip and re-

sidual current trip) in order to realize this overall layout structure.

[0023] Referring to Figs. 1, 3, 4, 5 and 6, the linkage element 15 is in connection and linkage with the handle 13 of each composite operating mechanism and the auxiliary handle 29 of the auxiliary trip mechanism of the residual current trip device, wherein such connection may be realized by a connection structure of a known form. The "enabling linkage of the handle 13 of each composite operating mechanism and the auxiliary handle 29 of the auxiliary trip mechanism" here refers that the action of any handle will drive all the remaining handles to act. The linkage element 15 is placed in a contact closing position and a contact breaking position of the circuit breaker in an artificial or mechanical manner, or automatically operates through a thermal trip device, an electromagnetic trip device or the residual current trip device. To improve the linkage performance among various circuit breaker poles and between each circuit breaker pole and the residual current trip device, an alternative scheme of the low-voltage circuit breaker with the residual current trip device of the present invention further comprises a driving rod 28 which is in connection and linkage with the handle 13 of each composite operating mechanism and the auxiliary handle 29 of the auxiliary trip mechanism of the residual current trip device. A specific connecting structure for the connection of the driving rod 28 here refers that: a rod hole (not shown in drawings) through which the driving rod 28 can be inserted is present in the handle 13 of each composite operating mechanism. The linkage between the handle 13 of each composite operating mechanism and the auxiliary handle 29 of the auxiliary trip mechanism by means of this connection refers that the action of any handle will drive all the remaining handles to act. In the event of more circuit breaker poles, it is more important to additionally arrange the driving rod 28. Due to the adoption of the technology of handles 13 of the composite operating mechanisms, the number of the handles 13 can be greatly reduced, and therefore, it is very easy to install and debug the additionally arranged driving rod 28 compared to the prior art.

[0024] Referring to Figs. 2, 6, 7 and 8, there may be a plurality of specific structure schemes of the composite operating mechanisms. A preferred scheme lies in that: each of the composite operating mechanisms comprises a handle 13 pivotally arranged on the molded insulation shell 8, a rotation plate 54 pivotally arranged on the molded insulation shell 8, a trip connection rod 24 pivotally arranged on the rotation plate 54, a U-shaped rod 52 in joint connection with the handle 13 and the trip connection rod 24 respectively, a trip rod 55 pivotally arranged on the rotation plate 54, an energy storage spring (not shown in drawings) and a reset spring (not shown in drawings), wherein a mechanical interlock 17 is arranged between the trip connection rod 24 and the trip rod 55, the elastic force of the energy storage spring drives the operating mechanism to trip, and the elastic force of the

reset spring drives the mechanical interlock 17 to lock. The rotation plate 54 is provided with a contact connection mechanism for two movable contacts 23 of the two adjacent circuit breaker poles driven by the rotation plate 54. The trip rod 55 is provided with two short-circuit trip stubs (50 and 56) which are in cooperative fit with two electromagnetic trip devices 14 and 53 of the two adjacent circuit breaker poles controlled by the trip rod 55. The trip rod 55 is further provided with two overload trip stubs (58 and 59) which are matched with two thermal trip devices (26 and 60) of the two adjacent circuit breaker poles controlled by the trip rod 55. The principle and structure of the mechanical interlock 17 can be realized just by a known type, where conversion of locking and unlocking between the trip connection rod 24 and the trip rod 55 can be performed under the control of the trip rod 55. The composite operating mechanism is allowed to perform a closing operation under a locked state, and the unlocking operation renders the composite operating mechanism to release and trip. A contact connection mechanism for mounting two movable contacts 23 on the rotation plate 54 is preferably a connection mechanism having an overturn function. The biggest difference from the prior art lies in that a rotation plate in the prior art is provided with a movable contact of one pole, while the rotation plate 54 in the present invention is provided with two movable contacts of two circuit breaker poles. The other difference from the prior art lies in that: a trip rod in the prior art is only matched with one electromagnetic trip device and one thermal trip device, while the trip rod 55 in the present invention are not only matched with two electromagnetic trip devices (14 and 53), but also matched with the two thermal trip devices (26 and 60).

[0025] Referring to Fig. 3 and Fig. 6, there are a plurality of specific structure schemes of the auxiliary trip mechanism. A preferred scheme lies in that the auxiliary trip mechanism comprises an auxiliary handle 29, an auxiliary U-shaped rod 33, an auxiliary rotation plate 34, an auxiliary trip rod 51, a lock latch 36, a reset lever 37, an auxiliary energy storage spring (not shown in drawings) and an auxiliary reset spring (not shown in drawings). The structure and principle of the auxiliary structure are similar to those of the composite operating mechanism, with the following differences: no movable contact needs to be arranged on the auxiliary rotation plate 34, the lock latch 36 is mechanically coupled with the electromagnetic relay 42, and the auxiliary rotation plate 34 is mechanically coupled with two short-circuit trip stubs (50 and 56) of two composite operating mechanisms of the circuit breaker poles at two sides.

[0026] Referring to Fig. 3 and Fig. 9, the residual current monitoring element comprises an annular iron core 27, a primary winding 45 penetrating through the annular iron core 27, and a secondary winding wound on the annular iron core 27, wherein the primary winding 45 is electrically connected with the circuit breaker poles, the secondary winding is connected with the electromagnetic

relay 42, and the electromagnetic relay 42 is in mechanical and cooperative action with the composite operating mechanisms of the circuit breaker poles at two sides through the auxiliary trip mechanism and the rotation connection rod 35. The primary winding of the residual current monitoring element is made of a flexible conductor, and the flexible conductor may serve as an electric connector between the electromagnetic trip device of each circuit breaker pole and the corresponding outgoing terminal, such that the assembly convenience of the product can be improved. One circuit breaker pole is equipped with one flexible conductor, wherein one terminal of each flexible conductor is connected with an outgoing terminal of the electromagnetic trip device (14 or 53) of the circuit breaker pole. Obviously, such electrical connection structure can realize optimized effects of shortest wiring distance and least electric connections. A preferred embodiment of the electrical connection of each circuit breaker pole is as illustrated in Fig. 9, which makes the wiring distance and the electrical connection be further optimized.

[0027] Referring to Fig. 3, to further optimize connection, installation and debugging processes, a preferred scheme is as follows: an opening for an electrical connection process is formed in the bottom of a position where the residual current trip device of the molded insulation shell 8 is arranged, and preferably, a detachable baffle block 43 is arranged at the bottom of a part of the electromagnetic relay 42 of the residual current trip device. After installation of the electromagnetic relay 42, connection between the electromagnetic relay 42 and the secondary winding and parameter debugging are accomplished, the electromagnetic relay is slid and arranged in place through the opening, and then the opening is sealed by a baffle block 43. The baffle block 43 may be detached, such that the electromagnetic relay can be mounted and debugged conveniently, and the production process is optimized. As shown in Fig. 3. The residual current trip device is in mechanically cooperative action with the circuit breaker operating mechanisms 5 at two sides through the trip mechanism and the rotation connection rod 35.

[0028] The operation process of the low-voltage circuit breaker with the residual current trip device of the present invention will be described.

[0029] When the circuit breaker is closed:

a manual or automatic device pushes the linkage element 15 clockwise to rotate to a closed position, the linkage element 15 drives the handles 13 and 48 to drive the U-shaped rod 52 and rotate the trip connection rod 24 about an axis anticlockwise, the trip connection rod 24 is coupled with the trip rod 55 to form a mechanical interlock 17, and the linkage element 15 is further pushed to rotate the rotation plate 54 about an axis clockwise and drive a contact support to rotate together, such that the contacts 22 and 23 are in contact and at the closed position. In a

process of pushing the linkage element 15 to rotate, the driving rod 28 coupled with the handles 13 and 48 drives the handle 29 of the residual current trip device to rotate about an axis clockwise to drive the U-shape rod 33 to rotate the trip rod 51 about an axis anticlockwise. The trip rod 51 is coupled with the lock latch 36 to form a mechanical interlock (not shown in drawings) and further push the linkage element 15 to rotate the rotation plate 34 about an axis clockwise. When movable and static contacts of each circuit breaker pole are in contact and at a closed position, the trip mechanism of the residual current trip device accomplishes energy storage and self-locking, an indication window 12 as shown in Fig. 1 displays white.

[0030] After the circuit breaker is off:

a manual or automatic device pushes the linkage element 15 anticlockwise to rotate to an off position, the handles 13 and 48 drive the U-shaped rod 52 and rotate the trip connection rod 24 about an axis clockwise, and meanwhile, the energy storage spring (not shown) of the operating mechanism releases energy, such that the rotation plate 54 rotates anticlockwise and drives a contact support to rotate together, such that the contacts 22 and 23 (the remaining contacts are not shown) are at the off position, as shown in Fig. 2. The trip mechanism of the residual current trip device is at an energy storage state, and the indication window 12 displays white.

[0031] When a short-circuit current is present in a circuit, the electromagnetic device 14 or 53 acts, a mandril 19 or 57 moves rightward and pushes the trip rod stub 50 or 56 (the remaining stubs are not shown) to act, such that the trip rod 55 rotates about an axis anticlockwise, and the mechanical interlock 17 formed by the trip rod 55 and the trip connection rod 24 is unlocked, the energy storage spring releases energy, the rotation plate 54 and the handles 13 and 48 rotate at the same time anticlockwise and drive the contact support to rotate together, such that the contact 22 and 23 are at an off position. The trip mechanism of the residual current trip device is at an energy storage state, and the indication window 12 displays white.

[0032] When an overload current is present in a circuit, a bimetal sheet 26 (the remaining bimetal sheet is not shown) of a thermal circuit breaking device is bent and deformed to drive an actuating rod to move rightward and drive the trip rod 55 to rotate about an axis anticlockwise by matching with a stub 58 or 59 of the actuating rod 25, such that the mechanical interlock 17 formed by the trip rod 55 and the trip connection rod 24 is unlocked, the energy storage spring releases energy, the rotation plate 54 and the handles 13 and 48 rotate at the same time anticlockwise and drive the contact support to rotate together, such that the contacts 22 and 23 are at an off

position. The trip mechanism of the residual current trip device is at an energy storage state, and the indication window 12 displays white.

[0033] When a residual current is present in the circuit and an action value is reached or a testing button 16 is pushed to generate a residual current in a testing loop, an electric signal generated by the secondary winding of the residual current monitoring element makes the electromagnetic relay 42 to act, the mandril 38 is popped up to push the rest lever 37 to rotate about an axis 39 anticlockwise and push the lock latch 36 to rotate about an axis anticlockwise, such that the interlock formed by the release connection rod 51 and the lock latch 36 is unlocked. The energy storage spring releases energy, the rotation plate 34 and the handle 29 rotate anticlockwise at the same time. The rotation plate 34 drives the rotation connection rod 35 to rotate anticlockwise about an axis to drive the trip rod stub 50 (not shown in the other side) of the composite operating mechanism of the circuit breaker units at two sides to move rightward, and the contacts are at an off position. In a process that the rotation plate 34 rotates to an unloading position anticlockwise, a color marker integrated with the rotation plate turns from white corresponding to the indication window 12 to red, that is the indication window 12 as shown in Fig. 1 displays red.

[0034] The above-mentioned embodiments are provided for those skilled in the art to implement and use the present invention, and those skilled in the art may make various modifications or variations without departing from the invention thought of the present invention. Therefore, the protection scope of the present invention will not be limited by the above-mentioned embodiments and should be of the maximum scope according with the innovation feature involved in claims.

Claims

1. A low-voltage circuit breaker with a residual current trip device, wherein a plurality of circuit breaker poles which are arranged in parallel and the residual current trip device are arranged in a molded insulation shell (8), each circuit breaker pole comprises a pair of input/output connecting terminals (10 and 11, 20 and 21, 30 and 31, and 40 and 41), an electromagnetic trip device (14 or 53) sensitive to a short-circuit current, a thermal trip device (26 or 60) sensitive to an overload current, a static contact (22) fixed on an integrated molded case, a movable contact (23) in closing/breaking fit with the static contact, and an arc extinguishing device (18), wherein the circuit breaker poles are uniformly arranged at the two sides of the residual current trip device, adjacent circuit breaker poles at each side share a composite operating mechanism which is used for controlling the on and off of two pairs of movable contacts and static contacts, and each composite operating

mechanism is provided with a handle (13), a rotation plate (54) provided with a contact connection mechanism for two movable contacts (23) of the two adjacent circuit breaker poles driven by the rotation plate (54), a trip connection rod (24) pivotally arranged on the rotation plate (54) and a trip rod (55); the residual current trip device comprises a residual current monitoring element, an electromagnetic relay (42), an auxiliary trip mechanism with an auxiliary handle (29), a rotation connection rod (35) mechanically coupled with each composite operating mechanism and a test loop (49); a linkage element (15) is in mutual mechanical connection and linkage with the auxiliary handle (29) of the auxiliary trip mechanism of the residual current trip device and the handle (13) of each of the composite operating mechanisms at two sides.

2. The low-voltage circuit breaker with a residual current trip device according to claim 1, wherein four circuit breaker poles are provided, which constitute two pairs of circuit breaker poles in a pairwise combination manner, two circuit breaker poles in each pair of circuit breaker poles share a composite operating mechanism, and the residual current trip device is arranged between the two pairs of circuit breaker poles in parallel; or three circuit breaker poles are provided, wherein two of the circuit breaker poles constitute a pair of circuit breaker poles in which two circuit breaker poles share a composite operating mechanism, the rest circuit breaker pole uses an operating mechanism singly, and the residual current trip device is arranged between the pair of circuit breaker poles and the single circuit breaker pole in parallel.
3. The low-voltage circuit breaker with a residual current trip device according to claim 1, wherein the circuit breaker further comprises a driving rod (28) which is in connection and linkage with the handle (13) of each of the composite operating mechanisms and the auxiliary handle (29) of the auxiliary trip mechanism of the residual current trip device.
4. The low-voltage circuit breaker with a residual current trip device according to claim 1, wherein a rotation connection rod (35) of the residual current trip device is provided with a mechanical coupling structure which can be in cooperative fit with short-circuit trip stubs (50 and 56) of the composite operating mechanisms of the circuit breaker poles at the two adjacent sides at the same time.
5. The low-voltage circuit breaker with a residual current trip device according to claim 1, wherein a plurality of parallel baffles are arranged inside the molded insulation shell (8), a plurality of parallel chambers are formed inside the molded insulation shell (8)

through the baffles, the residual current trip device is arranged inside the middle chamber, and the circuit breaker pole is arranged inside each of the chambers at two sides.

6. The low-voltage circuit breaker with a residual current trip device according to claim 1, wherein the handle (13) of each composite operating mechanism is pivotally arranged on the molded insulation shell (8), the rotation plate (54) is pivotally arranged on the molded insulation shell (8), a U-shaped rod (52) is in hinge connection with the handle (13) and the trip connection rod (24) respectively, the trip rod (55) pivotally arranged on the rotation plate (54) is provided with two short-circuit trip stubs (50 and 56) which are matched with two electromagnetic trip devices (14 and 53) of two adjacent circuit breaker poles controlled by the trip rod (55), and is further provided with two overload trip stubs (58 and 59) which are matched with the two thermal trip devices (26 and 60) of the two adjacent circuit breaker poles controlled by the trip rod (55), a mechanical interlock (17) is arranged between the trip connection rod (24) and the trip rod (55), the elastic force of an energy storage spring is used for driving the composite operating mechanisms to trip, and the elastic force of a reset spring is used for driving the mechanical interlock (17) to lock.
7. The low-voltage circuit breaker with a residual current trip device according to claim 1, wherein the residual current monitoring element comprises an annular iron core (27), a primary winding (45) which penetrates through the annular iron core (27) and is electrically connected with the circuit breaker poles, and a secondary winding wound on the annular iron core (27), wherein the secondary winding is connected with the electromagnetic relay (42), and the electromagnetic relay (42) is mechanical and cooperative action with the composite operating mechanisms of the circuit breaker poles at two sides through the auxiliary trip mechanism and the rotation connection rod (35).
8. The low-voltage circuit breaker with a residual current trip device according to claim 1 or 7, wherein the auxiliary trip mechanism comprises an auxiliary handle (29), an auxiliary U-shaped rod (33), an auxiliary rotation plate (34), an auxiliary trip rod (51), a lock latch (36), a reset lever (37), an auxiliary energy storage spring and an auxiliary reset spring, wherein the lock latch (36) is mechanically coupled with the electromagnetic relay (42), and the auxiliary rotation plate (34) is mechanically coupled with two short-circuit trip stubs (50 and 56) of the two composite operating mechanisms of the circuit breaker poles at two sides through the rotation connection rod 35.

9. The low-voltage circuit breaker with a residual current trip device according to claim 1 or 7, wherein the primary winding of the residual current monitoring element is made of a flexible conductor which also serves as a flexible conductor of each circuit breaker pole, and one terminal of the flexible conductor is electrically connected with a corresponding outgoing terminal of the electromagnetic trip device (14 or 53) of the circuit breaker pole.
10. The low-voltage circuit breaker with a residual current trip device according to claim 1, wherein an opening for an electrical connection process is formed in the bottom of a corresponding position where the residual current trip device of the molded insulation shell (8) is arranged, and it is preferred that a detachable baffle block for mounting and debugging the electromagnetic relay (42) conveniently is arranged at the bottom of the electromagnetic relay (42).

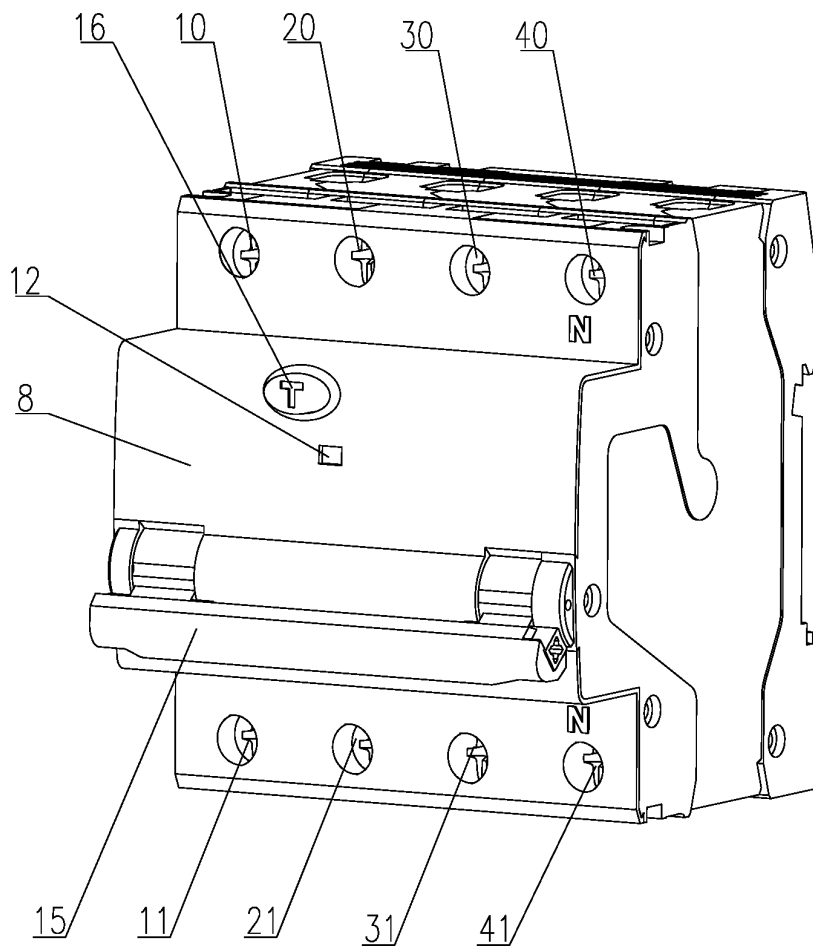


Fig.1

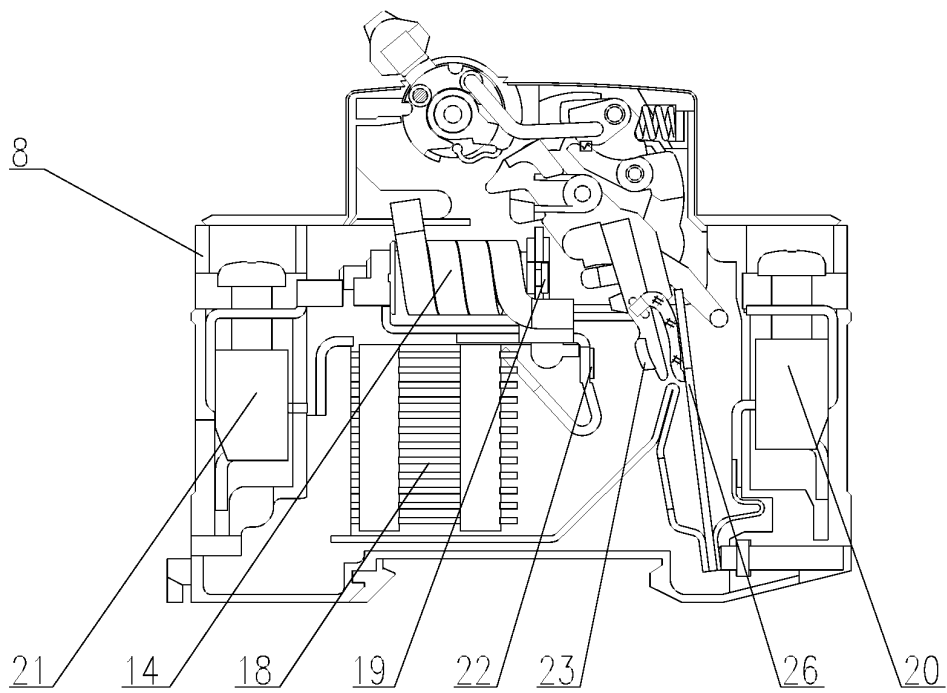


Fig.2

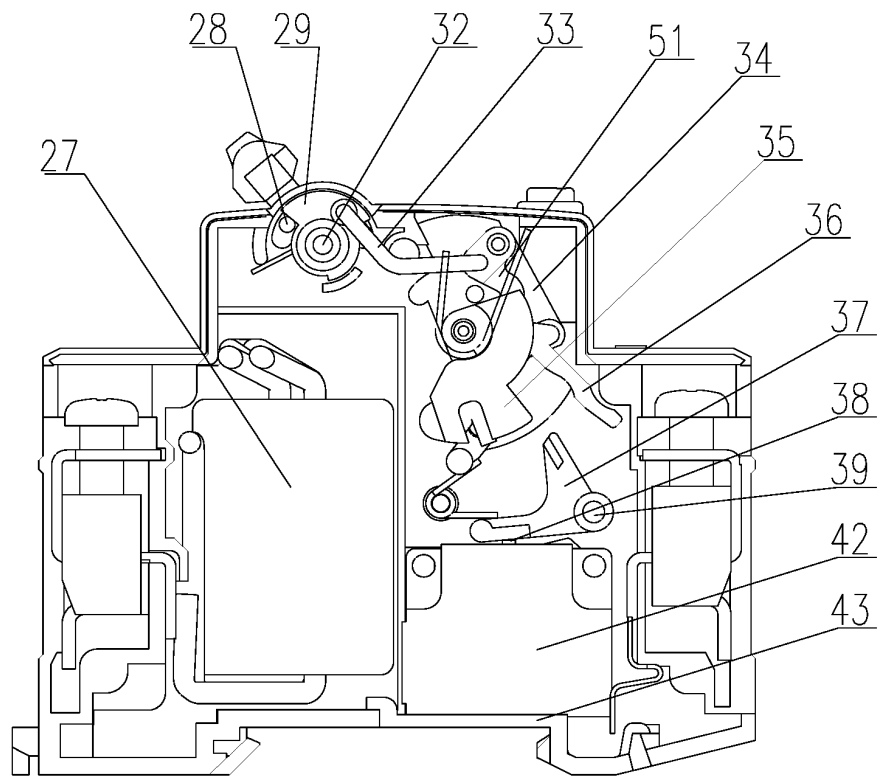


Fig.3

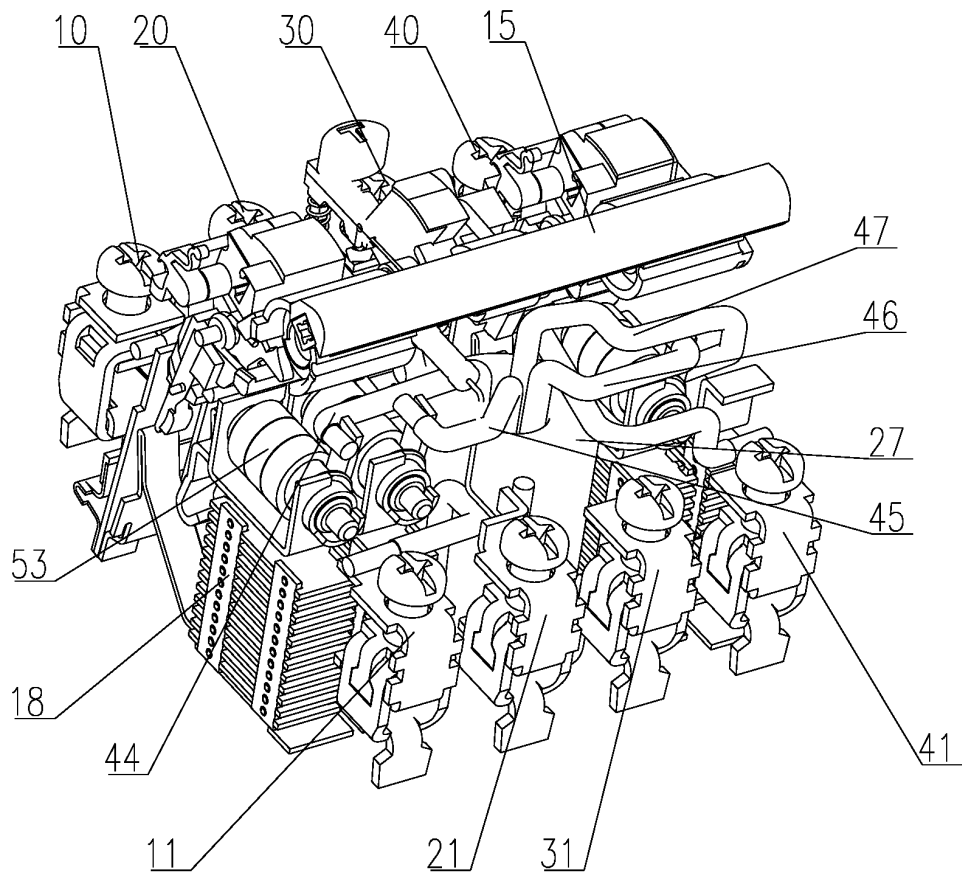


Fig.4

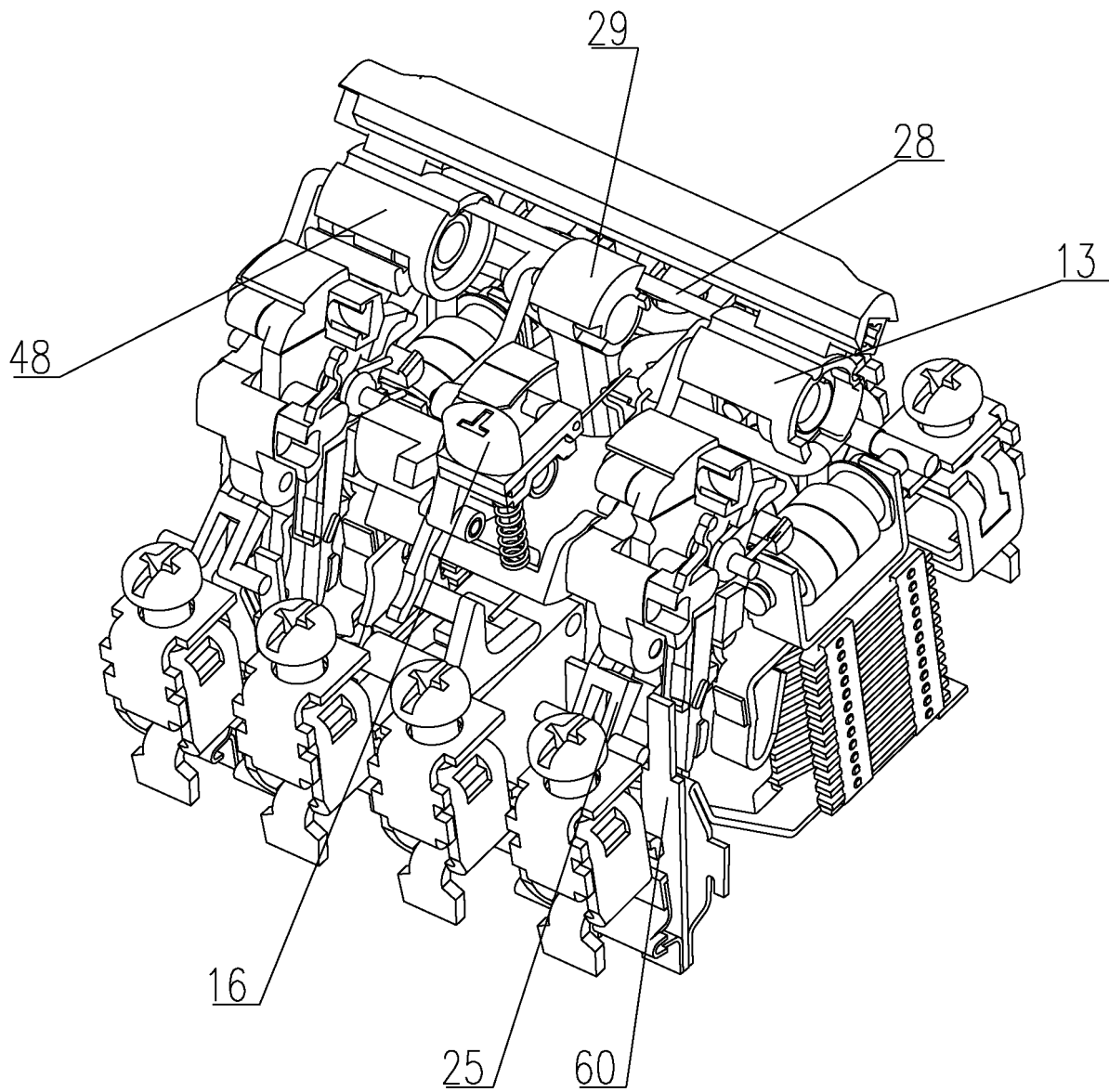


Fig.5

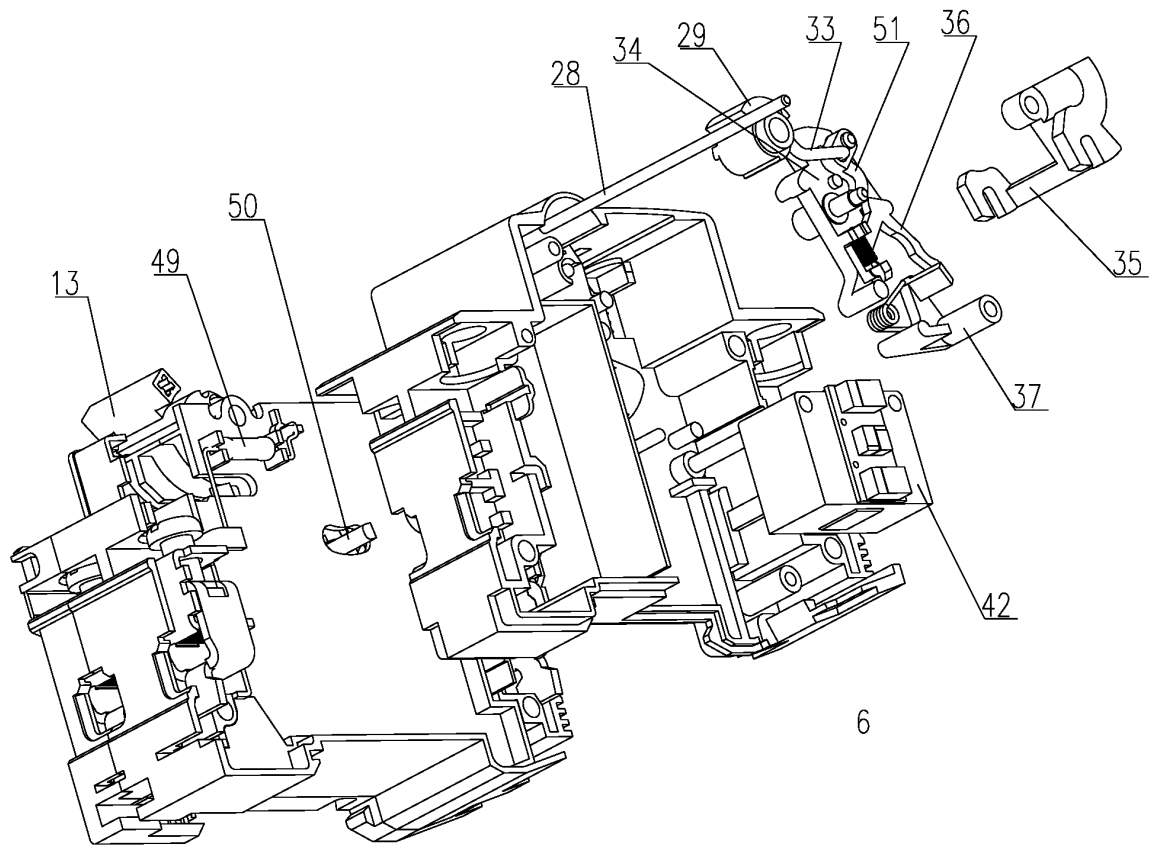


Fig.6

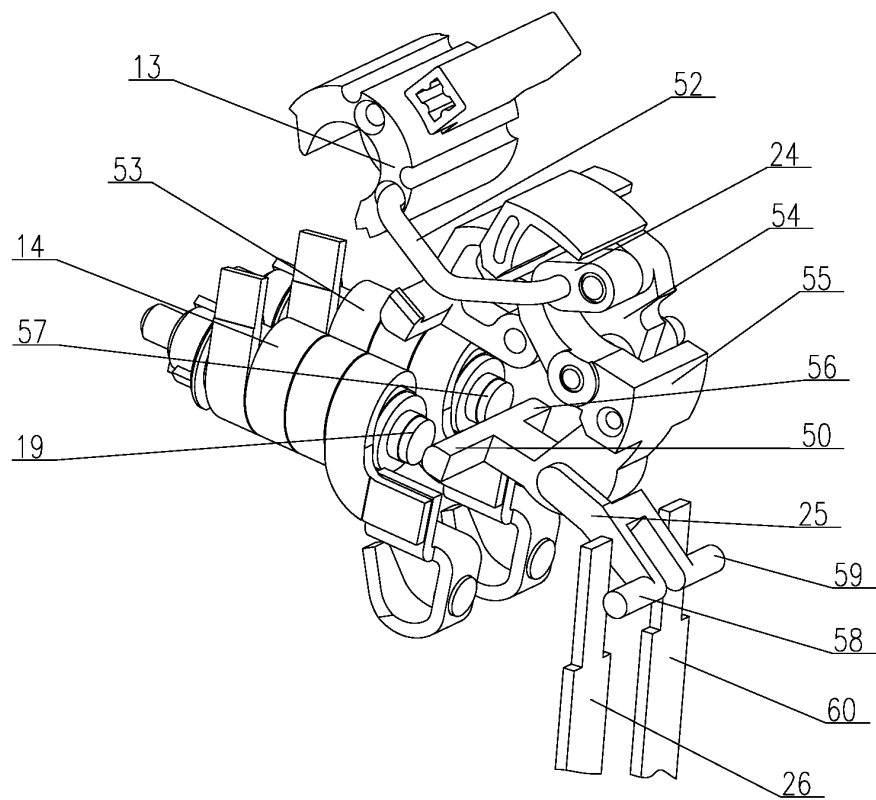


Fig.7

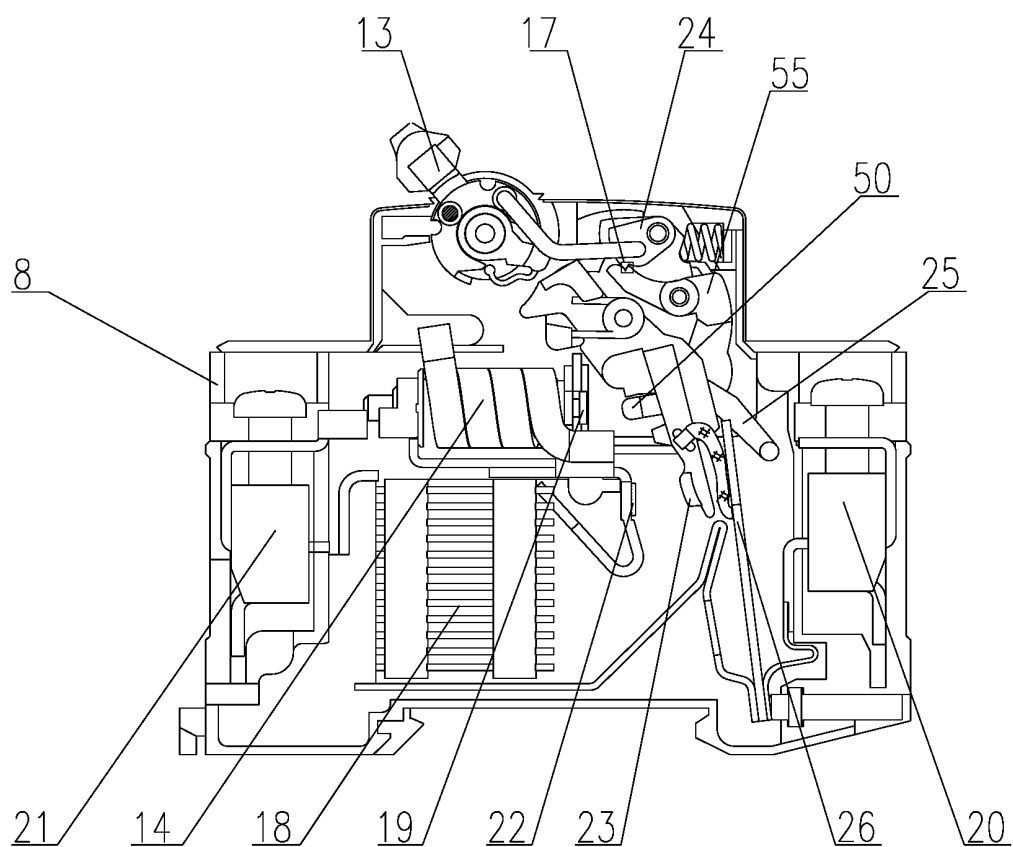


Fig.8

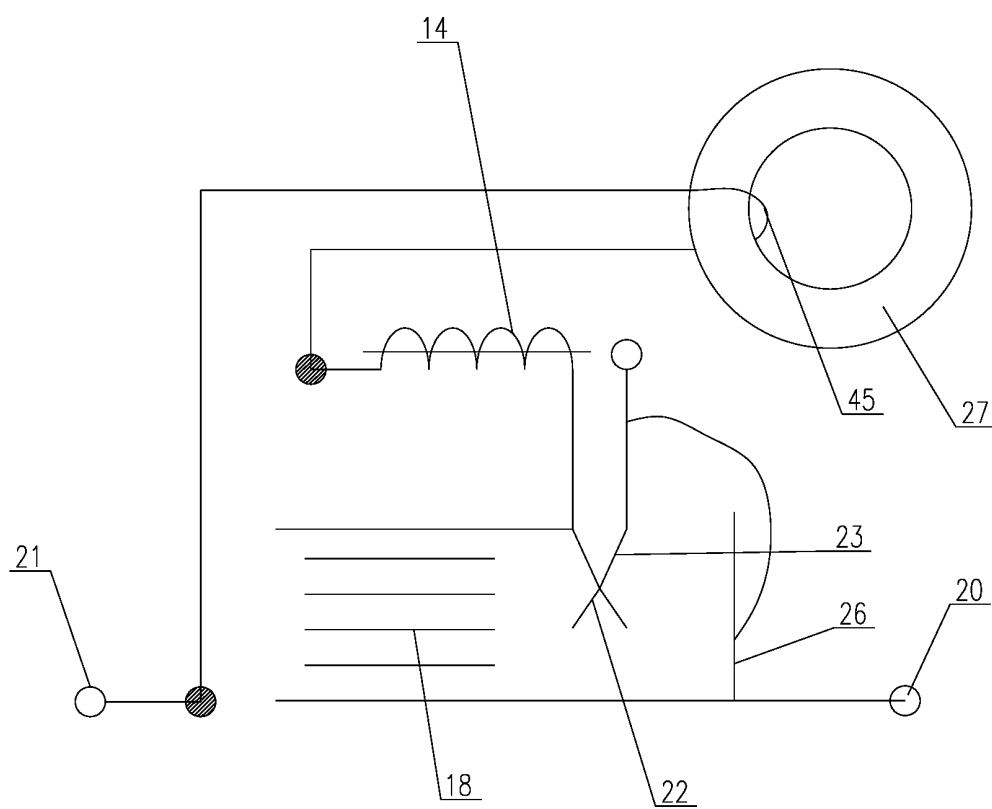


Fig.9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2015/071743

A. CLASSIFICATION OF SUBJECT MATTER

H01H 71/10 (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)

H01H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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

CNKI, CNPAT, WPI, EPODOC: breaker, shut 1w off, cut 1w off, creepage, protect, safeguard, trip+, contact, common+, control+,
operat+, driv+, link+, join+, border, pole, handle, dropout

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 104134589 A (CHINT GROUP CORP. et al.) 05 November 2014 (05.11.2014) claims 1-10	1-10
PX	CN 204029739 U (CHINT GROUP CORP. et al.) 17 December 2014 (17.12.2014) claims 1-10	1-10
A	CN 202142482 U (SHANGHAI ELECTRIC DIVISION ELECTRICAL TECHNOLOGY CO., LTD. et al.) 08 February 2012 (08.02.2012) description, paragraphs [0029]-[0039], [0044]-[0047], and figures 1, 7, and 8	1-10
A	CN 88102711 A (MERLIN GERIN) 30 November 1988 (30.11.1988) the whole document	1-10
A	CN 1906723 A (SIEMENS AG) 31 January 2007 (31.01.2007) the whole document	1-10
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A	CN 101604601 A (SHANGHAI NOARK ELECTRIC CO., LTD.) 16 December 2009 (16.12.2009) the whole document	1-10

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

* Special categories of cited documents:

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“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

“E” earlier application or patent but published on or after the international filing date

“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

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“O” document referring to an oral disclosure, use, exhibition or other means

“&” document member of the same patent family

“P” document published prior to the international filing date but later than the priority date claimed

Date of the actual completion of the international search
07 April 2015

Date of mailing of the international search report
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EP 3 171 386 A1

INTERNATIONAL SEARCH REPORT Information on patent family members

International application No.
PCT/CN2015/071743

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