(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 171 385 A1

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
**24.05.2017 Bulletin 2017/21**

(21) Application number: **15821567.3**

(22) Date of filing: **28.01.2015**

(51) Int Cl.:
***H01H 71/10*** *(2006.01)*

(86) International application number:
**PCT/CN2015/071748**

(87) International publication number:
**WO 2016/008298 (21.01.2016 Gazette 2016/03)**

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR**
Designated Extension States:
**BA ME**

(30) Priority: **17.07.2014 CN 201410341341**

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# (54) OPERATION DEVICE OF MULTI-POLE MINIATURE CIRCUIT BREAKER

(57) An operation device of a multi-pole miniature circuit breaker comprises a handle, a rotary plate pivotally mounted on a housing through a mandrel, two pairs of contacts capable of performing closing/breaking fit, two electromagnetic tripping devices arranged side by side, and two thermal tripping devices arranged side by side. A tripping connecting rod provided with a lock hook is pivotally mounted on the rotary plate through a first twisting shaft; a lock tooth, a control element capable of being matched with electromagnetic tripping devices of circuit breaker respectively, and an actuating rod capable of being matched with bimetallic sheets of thermal tripping devices of circuit breakers of two adjacent poles are arranged on a tripping rod which is pivotally mounted on the rotary plate through a second twisting shaft; two ends of a U-shaped rod are in hinge connection with the handle and the tripping connecting rod respectively; two short-circuit short columns arranged on the control element side by side are matched with actuating ejection rods of the two electromagnetic tripping devices in a triggering manner respectively; and two overload short columns arranged on the actuating rod side by side are matched with the bimetallic strips of the two thermal tripping devices in a triggering manner respectively. The tripping rod can be controlled by the two adjacent groups of independent tripping devices; and the operation device is small in size, compact in structure and more reliable in motion.

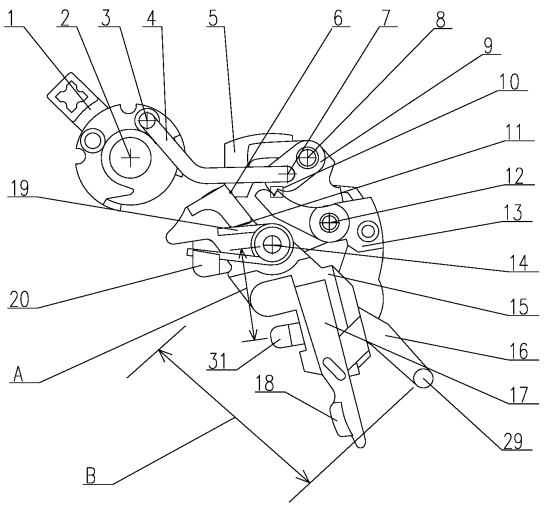


**Fig. 1**

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## Description

### TECHNICAL FIELD

**[0001]** The present invention relates to a miniature low-voltage circuit breaker, in particular to an operation device of a miniature circuit breaker, more particularly an operation device of a multi-pole miniature circuit breaker. The operation device is capable of cooperating with a circuit breaker unit. The circuit breaker may be a two-pole circuit breaker consisting of thermal tripping devices, electromagnetic tripping devices and contacts associated with the operation device and capable of performing closing and breaking, or may be a multi-pole circuit breaker cooperating with two or more operation devices.

### BACKGROUND ART

**[0002]** Generally, an operation mechanism of a low-voltage circuit breaker, especially a terminal type miniature circuit breaker has a modular standard requirement in an appearance size, and meanwhile is required to have short-circuit protection and overload protection functions. Additionally, there is often a need for residual current action protection, and therefore, most of the existing multi-pole miniature circuit breakers adopt a spliced structure in which a plurality of single-pole miniature circuit breakers are spliced into a multi-pole miniature circuit breaker, for example "Operation Mechanism of Low-voltage Electric Circuit Breaker" disclosed by the Chinese Patent CN1013816B and "Operation Mechanism of Miniature Circuit Breaker" disclosed by the Chinese Patent CN1018684B, etc. which are characterized in that: a shell of each single-pole miniature circuit breaker is internally provided with an independent operation device, a pair of separable movable and static contact groups having a broken position and a closed position, an electromagnetic tripping device for short-circuit protection and a thermal tripping device for overload protection, wherein the operation device can only be mechanically coupled with one electromagnetic tripping device and one thermal tripping device, that is, one operation mechanism can only control closing and breaking of a loop of a circuit breaker of one pole. Even though the existing operation mechanism can operate closing/breaking actions of two movable contacts, the two movable contacts are only switch contacts in the same control loop, rather than two pole contacts for controlling two different loops. For example, in "Operating Mechanism with Rocking Lever for a Phase plus Neutral Electrical Circuit Breaker" disclosed by the Chinese Patent CN1033833C, a rotary plate is adopted to synchronously drive closing and breaking of contacts of a phase and a neutral electric circuit, but a circuit breaking rod can only be controlled by a circuit breaking device. Although the operating mechanism can operate closing/breaking of two movable contacts and two static contacts, it should be understood that a pair of switching elements formed by two movable contacts and two static contacts are in a phase circuit and a neutral circuit respectively. However, in actual operation, the phase circuit and the neutral circuit are loaded and connected in series in one loop, and therefore, this circuit breaker only having one set of electromagnetic tripping device and thermal tripping device is not the real two-pole circuit breaker, and cannot be used for operating closing/breaking of two independent loops, while the multi-pole circuit breaker must have a set of electromagnetic tripping device and thermal tripping device in each pole.

**[0003]** As proved upon application practice of a circuit breaker, a flexible device of an existing operation mechanism for providing a contact pressure fails to satisfy a requirement on the contact pressure consistency among various poles of the multi-pole circuit breaker, by a reason that force arms of the elastic force of a spring acting on a needle rod and the acting force of two contact supports acting on the needle rod are difficult to be equal, and therefore, the elastic forces borne by the two contact supports from the spring may be balanced, but may not be equal. Therefore, the contact pressures when two movable contacts on the two contact supports and two movables contacts are closed respectively are not equal, and accordingly each pole of the existing multi-pole miniature circuit breaker is provided with an independent operation device. The operating mechanism described in above patents is either used for only controlling closing and breaking a loop of a circuit breaker of one pole, or is applicable to a phase plus neutral electric circuit breaker. At present, all the terminal type miniature circuit breakers are developed toward a miniature trend. The miniature trend not only refers to a volume of a circuit breaker product, but also refers to a width thereof, especially the width modulus of a multi-pole circuit breaker with more than two poles is greatly reduced to save a valuable space for mounting a terminal control cabinet of the circuit breaker, and has a key effect on promotion of a current specification of the circuit breaker product. In the event of adopting the technology of the above-mentioned operating mechanism, the two-pole circuit breaker requires two operating mechanisms arranged in parallel, the multi-pole circuit breaker requires a plurality of operating mechanisms arranged in parallel, and obviously, it is unlikely to satisfy the increasingly urgent demands of a circuit breaker for miniature and high breaking capacity. But, if two poles share one operation device, i.e., one operation device controls closing/breaking of movable contacts and static contacts of two poles, it is obvious that the volume of the circuit breaker product cannot be reduced. However, under the constraint of a modular standard of the existing multi-pole or single-pole miniature circuit breaker, the structure has been very compact, and it is necessary to solve the following technical problems: 1, the operation device must synchronously control two movable contacts to be closed/broken with/from the two static contacts respectively, and the contact pressures when the two movable contacts and the two static contacts are closed are equal; 2, the operation device must be mechanically cou-

pled with two electromagnetic tripping devices respectively, and the tripping action of any one of electromagnetic tripping devices can reliably renders the operation device to trip and release; 3, the operation device must be mechanically coupled with two thermal tripping devices respectively, and the tripping action of any one of the thermal tripping devices reliably renders the operation device to trip and release. Therefore, it is necessary to perform overall miniature structure optimization design to the operation device in order to solve these technical problems.

## SUMMARY OF THE INVENTION

**[0004]** To overcome the defects of the prior art, an objective of the present invention is to provide an operation device of a miniature multi-pole miniature circuit breaker, which may not only operate closing/breaking of the two groups of movable contacts and static contacts of two poles at the same time, but also achieves a functional effect of coupling with two electromagnetic tripping devices and two thermal tripping devices at the same time; and the operation device is small in size, compact in structure, reasonable in layout and more reliable in motion.

**[0005]** To achieve the objective of the present invention, the present invention provides the following specific technical solutions.

**[0006]** An operation device of a multi-pole miniature circuit breaker comprises a handle 1 pivotally mounted on a circuit breaker housing through a rotating shaft 2, a rotary plate 5 pivotally mounted on the circuit breaker housing through a mandrel 14, two static contacts 22, 27 and two movable contacts 18, 38 capable of performing closing/breaking fit with the static contacts 22, 27 respectively, an energy storage spring acting on the rotary plate 5 and a resetting member configured to drive a tripping rod 13 to reset; and two electromagnetic tripping devices 23 arranged side by side, each electromagnetic tripping device comprising an actuating ejection rod 24 which is capable of providing a short-circuit tripping action when a short-circuit current appears; and two thermal tripping devices arranged side by side, each thermal tripping device comprising a bimetal sheet 21 which is capable of providing an overload tripping action when an overload current appears. The operation device further comprises: a tripping connecting rod 9 provided with a lock hook 42, which is pivotally mounted on the rotary plate 5 by a first twisting shaft 8; a tripping rod 13 which is provided with a lock tooth 41, a control element 40 capable of being matched with electromagnetic tripping devices of circuit breakers of two adjacent poles, and an actuating rod 16 capable of being matched with bimetallic sheets of thermal tripping devices of the circuit breakers of the two adjacent poles, the tripping rod 13 being pivotally mounted on the rotary plate 5 through a second twisting shaft 12 and being capable of doing a finite rotation about the second twisting shaft 12; a U-shaped rod 4 of which two ends are in joint connection with the handle 1 and the tripping connecting rod 9 respectively, the U-shaped rod 4 being capable of driving the tripping connecting rod 9 to move anticlockwise or clockwise about the first twisting shaft 8; two short-circuit short columns 31, 32 arranged on the control element 40 of the tripping rod 13 side by side, the two short-circuit short columns 31, 32 being matched with actuating ejection rods 24, 24 of the two electromagnetic tripping devices 23 in a triggering manner respectively; two overload short columns 29 and 30 arranged on the actuating rod 16 of the tripping rod 13 side by side, the two overload short columns 29 and 30 being matched with the bimetallic sheets 21,21 of the two thermal tripping devices in a triggering manner respectively.

**[0007]** According to another embodiment of the present invention, the control element 40 is fixedly connected with the tripping rod 13; or the control element 40 and the tripping rod 13 are integrally formed.

**[0008]** According to another embodiment of the present invention, the control element 40 or the tripping rod 13 is provided with an axle hole 33, and the actuating rod 16 is provided with a pillow block 34 which is inserted into the axle hole 33 to form installation connection.

**[0009]** As another embodiment of the present invention, the actuating rod 16 is fixedly connected with the tripping rod 13; or the actuating rod 16 and the tripping rod 13 are integrally formed.

**[0010]** As yet another embodiment of the present invention, two contact supports 15, 35 are pivotally mounted on the mandrel 14, and are connected with the rotary plate 5 respectively through two overtravel mechanisms; the two movable contacts 18, 38 are arranged on corresponding contact arms 17, 39 respectively and are fixedly connected with the two contact supports 15, 35 respectively.

**[0011]** According to yet another embodiment of the present invention, the contact arms 17, 39 are integrally formed with the contact supports 15, 35 respectively.

**[0012]** According to a further embodiment of the present invention, each overtravel mechanism comprises an overtravel spring 19, a first stopper 11 arranged on the contact supports 15, 35, a second stopper 20 arranged on the rotary plate 5, and a first clutching surface and a second clutching surface which are arranged on the contact supports 15, 35 and the rotary plate 5 respectively to form a clutching mechanism 6, wherein one end of the overtravel spring 19 is connected with the first stopper 11, the other end of the overtravel spring 19 is connected with the second stopper 20, under a state in which the movable contacts 18, 38 are broken from the static contacts 22, 27, the clutching mechanisms 6 are engaged, and under a state in which the movable contacts 18, 38 and the static contacts 22, 27 are closed, the clutching mechanisms 6 are disengaged; rotation centers of the two contact supports 15, 35 and the rotary plate 5 are concentric with an axis of the mandrel 14 respectively.

**[0013]** According to another embodiment of the present invention, a positional distance B between the overload short columns 29, 30 and the second twisting shaft 12 is larger than a positional distance A between the short-circuit short columns 31, 32 and the second twisting shaft 12.

**[0014]** According to a further preferred embodiment of the present invention, the control element 40 and the actuating rod 16 are located in a space D between the two contact supports 15, 35.

**[0015]** According to another embodiment of the present invention, the two short-circuit short columns 31, 32 are stretched respectively toward two lateral sides of the control element 40 to form a T shape.

**[0016]** According to another embodiment of the present invention, the two overload short columns 29, 30 are stretched respectively toward two lateral sides of the actuating rod 16 to form a T shape.

**[0017]** According to a further preferred embodiment of the present invention, the two contact supports 15, 35 are in contact fit with two surfaces of the rotary plate 5 respectively.

**[0018]** Due to the adoption of any technical solution of the present invention, the tripping rod can be controlled by two adjacent groups of independent circuit breaking devices, so that the volume of the multi-pole miniature circuit breaker is greatly reduced, and especially the width having a modular requirement can be reduced significantly; in addition, the driving force of the electromagnetic circuit breaking devices at two sides is effectively reduced, such that a thermal circuit breaking force generated by bimetal sheets under an overload current can be reduced as much as possible, and therefore the operation device is more reliable in motion, and the current specification of the miniature circuit breaker can be further promoted while the minimization of the multi-pole miniature circuit breaker is realized.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0019]** 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 planar structural schematic drawing of an operation device of a multi-pole miniature circuit breaker of the present invention.

Fig. 2 is a planar structural schematic drawing in which movable contacts and static contacts of the operation device of the multi-pole miniature circuit breaker of the present invention are at a broken state.

Fig. 3 is a planar structural schematic drawing in which movable contacts and static contacts of the operation device of the multi-pole miniature circuit breaker of the present invention are at a closed state..

Fig. 4 and Fig. 5 are stereoscopic structural schematic drawings in which the operation device of the multi-pole miniature circuit breaker of the present invention is matched with circuit breaking devices, wherein Fig. 5 is a stereoscopic structural drawing when the operation device is at a contact closing position, and Fig. 4 and Fig. 5 illustrate coupling connection relationships among the control element 40, the actuating rod 16 and two electromagnetic tripping devices and among the control element 40, the actuating rod 16 and two thermal tripping devices respectively.

Fig. 6 is a part stereoscopic exploded drawing in which the control element 40 and the actuating rod 16 of the operation device of the multi-pole miniature circuit breaker of the present invention are articulated, and illustrates shape structures of the control element 40 and the actuating rod 16 and an assembly structure therebetween.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

**[0020]** Specific embodiments of an operation device of a multi-pole miniature circuit breaker of the present invention are further illustrated as below in conjunction with the embodiments illustrated in Figs. 1 to 6. The operation device of the multi-pole circuit breaker of the present invention is not limited to the description in the following embodiments.

**[0021]** As shown in the structural schematic drawing of Fig. 1, the operation device of the multi-pole miniature circuit breaker of the present invention is mounted in an insulation housing (not shown in Fig. 1) of a circuit breaker, and mainly comprises a handle 1, and a rotating shaft 2 axially connected to the housing; a four connecting rod mechanism formed by a U-shaped rod 4, a rotary plate 5 and a mechanical lock 10 on the rotary plate 5, wherein the handle 1 is pivotally mounted on the insulation housing of the circuit breaker through the rotating shaft 2, the rotary plate 5 is pivotally mounted on the circuit breaker housing through a mandrel 14, and two ends of the U-shaped rod 4 are in hinge connection with the handle 1 and the tripping connecting rod 9 respectively; a tripping rod 13 which is pivotally mounted on a second twisting shaft 12 of the rotary plate 5 and can do a finite rotation about the second twisting shaft 12; an energy storage spring (not shown in Fig. 1) acts on the rotary plate 5, and a resetting member (not shown in Fig. 1) drives the tripping rod 13 to reset. The handle 1 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 circuit breaking device. The multi-pole miniature circuit breaker provided by the present invention may be an integrated miniature two-pole circuit breaker which comprises two groups of switching elements with two adjacent static contacts 22, 27 and movable contacts 18, 38 which are in closing/breaking fit with the static contacts 22, 27, two adjacent electromagnetic circuit breaking devices 23, 23 sen-

sitive to a short-circuit current, and two corresponding thermal circuit breaking devices sensitive to an overload current and having bimetal sheets 21, 21. Or the multi-pole miniature circuit breaker may be an integrated multi-pole miniature circuit breaker which cooperates with two operating devices and is provided with a plurality of groups of switching elements and corresponding electromagnetic circuit breaking devices and thermal circuit breaking device, and the circuit breaker can control circuit breakers of a plurality of independent loops, and may be a three-pole four-line circuit breaker in which three poles are three phases of live lines and the rest pole is a neutral line; or may be a four-pole circuit breaker in which four poles are provided with electromagnetic breaking devices and thermal circuit breaking devices respectively. Or the multi-pole miniature circuit breaker may be applied to an integrated multi-pole miniature residual current operated circuit breaker.

**[0022]** Referring to Figs. 2-6, the operation device of the multi-pole miniature circuit breaker of the present invention comprises two electromagnetic devices 23 arranged side by side and two thermal tripping devices arranged side by side, wherein each electromagnetic tripping device 23 comprises an actuating ejection rod 24 (refer to Fig. 4) which can provide a short-circuit tripping action in the event that the short-circuit current appears. When the short-circuit current is present in a control loop of the pole where the electromagnetic tripping device 23 is located, the electromagnetic force of the electromagnetic tripping device 23 drives the actuating ejection rod 24 to move transversely, that is, the actuating ejection rod 24 can provide a short-circuit tripping action in the event that the short-circuit current appears. Each thermal tripping device comprises a bimetal sheet 21 which can provide an overload tripping action in the event that an overload current appears, and when the overload current is present in a control loop of the pole where the thermal tripping device is located, a free end of the bimetal sheet 21 is thermally deformed to swing and shift, that is, the bimetal sheet 21 can provide an overload tripping action in the event that the overload current appears. The two electromagnetic tripping devices 23 and the two thermal tripping devices can be realized by adopting a known structure, wherein one electromagnetic tripping device and one thermal tripping device are connected in series with one group of movable and static contacts to form a switching unit of one pole for controlling the on/off of one pole and realize short-circuit/overload protection of one pole, and the other electromagnetic tripping device and the other thermal tripping device are connected in series with the other group of movable and static contacts to form a switching unit of the other pole for controlling the on/off of the other pole and realize short-circuit/overload protection of the other pole. The operation device further comprises a tripping connecting rod 9 with a lock hook 42 (refer to Fig. 5), which is pivotally mounted on the rotary plate 5 through a first twisting shaft 8 and is mechanically connected to the handle 1 through the U-shaped rod 4 in a manner of shaft connecting points 3 and 7 as shown in Fig. 1 to form a transmission device of a four connecting rod mechanism; a tripping rod 13 with a lock tooth 41 (refer to Fig. 6), which is pivotally mounted on the rotary plate 5 through a second twisting shaft 12; two short-circuit short columns 31, 32 (refer to Fig. 4) which are arranged on a control element 40 of the tripping rod 13 side by side and are matched with the actuating ejection rods 24 of the two electromagnetic tripping devices respectively in a triggering manner; two overload short columns 29, 30 (refer to Fig. 4) which are arranged on an actuating rod 16 of the tripping rod 13 side by side and are matched with the bimetal sheets 21 of the two thermal tripping device respectively in a triggering manner; two contact supports 15, 35 which are pivotally mounted on a mandrel 14 and are connected with the rotary plate 5 through two overtravel mechanisms respectively; two contact arms 17, 39 which are provided with the movable contacts 18, 38 respectively and are fixedly connected with the two contact supports 15, 35 respectively.

**[0023]** A specific pivoting structure (not shown in drawings) where the handle 1 is pivotally mounted on the circuit breaker housing through the rotating shaft 2 may be implemented by a plurality of ways, but such following functions must be realized no matter which way is adopted: the handle 1 only has one freedom degree of rotation relative to the circuit breaker housing, and the rotation angle of the handle 1 is limited; or to say, the handle 1 has two positions defined corresponding to a closed state and a broken state of the operation device, and the two defined positions also define the rotation angle of the handle 1.

**[0024]** The specific pivoting structure where the rotary plate 5 is pivotally mounted on the circuit breaker housing through the mandrel 14 is of the following composite hinge structure, that is, the rotary plate 5 is provided with an axle hole (not shown in drawings), wherein the axle hole is sheathed on the mandrel 14 in a rotatable fit manner, and the mandrel 14 is fixedly connected with the circuit breaker housing. Because two contact supports 15, 35 are also pivotally mounted on the mandrel 14, that is, the two contact supports 15, 35 are provided with an axle hole (not shown in drawings) respectively, the axle holes are sheathed on the mandrel 14 in a rotatable fit manner, and it can thus be seen that a structure where two contact supports 15, 35 and one rotary plate 5 are sheathed on one mandrel 14 constitutes the composite hinge structure. Such composite hinge structure comprises two ways, namely an eccentric structure and a concentric structure. A preferred way of the present invention is the concentric way, that is, the rotation centers of the two contact supports 15, 35 and the rotary plate 5 are concentric with an axis of the mandrel 14 respectively. The two contact supports 15, 35 are in contact fit with two surfaces of the rotary plate 5 respectively, that is to say, the two contact supports 15, 35 and the rotary plate 5 are sheathed on the mandrel 14 in such a manner: the

two contact supports 15, 35 not only are positioned at two sides of the rotary plate 5, but also are in contact fit with two surfaces of the rotary plate 5 respectively, and by means of such contact fit, the two contact supports 15, 35 and the rotary plate 5 have a freedom degree of relative rotation, rather than a freedom degree of axial shift. Obviously, the design of the present invention overcomes the traditional structure defect that contacts only support connection with the rotary plate, and adopts the composite hinge structure, especially a concentric structure, such that the operation device is more compact in structure and can reduce the volume of the operation device greatly to satisfy the requirement on a small-size design. Especially the two contact supports 15, 35 can rotate about one mandrel 14 independently and symmetrically to effectively ensure the action precision and reliability of movable contacts, ensure the closing/breaking action synchronism of two movable contacts and ensure the consistency of the contact pressure when two groups of movable contacts and static contacts are closed.

**[0025]** The rotary plate 5 and a mechanical lock 10 arranged thereon in Fig. 1 are formed by a lock hook 42 (Fig. 5) on the tripping connecting rod 9 and a lock tooth 41(Fig. 5) on the tripping rod 13, wherein the mechanical interlock 10 controls stable closing or fault tripping of the operation device. To be specific, the lock hook 42 is in contact with the lock tooth 41, such that the mechanical interlock 10 is locked, and the operation device can perform successful closing and keep stable closing as long as the mechanical lock 10 is locked. The mechanical interlock 10 is unlocked when the lock hook 42 is separated from the lock tooth 41. Under a closed state, if the mechanical interlock 10 is unlocked, the operation device automatically trips under the driving of the elastic force of the energy storage spring (not shown in drawings), and the operation device cannot perform successful closing when the mechanical interlock 10 is unlocked. Locking/unlocking of the mechanical interlock 10 is controlled by rotation of the tripping rod 13 about the second twisting shaft 12, and the rotation of the tripping rod 13 is multiply driven by the actuating ejection rods 24 of the electromagnetic tripping devices 23, the bimetal sheets 21 of the thermal tripping devices and a resetting member (not shown in drawings). To be specific: when each actuating ejection rod 24 moves transversely to trigger short-circuit short columns 31, 32 of the control element 40 on the tripping rod 13, or when the free end of each bimetal sheet 21 swings and shifts to trigger overload short columns 29, 30 on the actuating rod 16 on the tripping rod 13, the rotation of the tripping rod 13 will be driven, and this rotation makes the mechanical interlock 10 be unlocked; the resetting member can provide a flexible elastic force acting on the tripping rod 13, and the flexible elastic force drives the rotation of the tripping rod 13, such that the mechanical interlock 10 is automatically locked. The resetting member may adopt a known structure, and a flexible elastic force of the resetting member drives the mechanical interlock 10 to recover locking and maintain locking. The energy storage spring acting on the rotary plate 5 may adopt a known structure. By means of such structure, the elastic force of the energy storage spring acting on the rotary plate 5 always drives the rotary plate 5 to rotate toward a breaking direction, that is: the energy storage spring stores energy when the operation device is under a closing operation process and at a closed state; the energy storage spring releases energy when the operation device is under a broken process, and the released energy drives the operation device to execute a tripping action; the energy storage spring is at an energy release state when the operation device is at a broken or tripped state.

**[0026]** The control element 40 arranged on the tripping rod 13 may have two preferred specific structure forms, that is: the control element 40 is fixedly connected with the tripping rod 13; or the control element 40 and the tripping rod 13 are integrally formed. The "fixedly connected" here refers that the control element 40 and the tripping rod 13 are of two parts, wherein the control element 40 is fixed to the tripping rod 13 through a fixed connection structure, and such structure has the advantage that a position of the control element 40 relative to the tripping rod 13 may be debugged. "The control element 40 and the tripping rod 13 are integrally formed" refers that the control element 40 and the tripping rod 13 are of the same part, and such structure has the advantage that the production efficiency can be improved and is applicable to large-scale production. Two short-circuit short columns 31, 32 of the control element 40 are arranged side by side and are in contact fit with actuating ejection rods 24 of the two electromagnetic tripping devices, i.e., one short-circuit short column 31 is matched with the actuating ejection rod 24 of one electromagnetic tripping device in a triggering manner, and the other short-circuit short column 32 is matched with the actuating ejection rod 24 of the rest electromagnetic tripping device in a triggering manner. To realize symmetrical distribution of triggering forces of the two actuating ejection rods 24 and optimize a force system structure of the operation device, a preferred scheme is as follows: the two short-circuit short columns 31, 32 are stretched toward two lateral sides of the control element 40 to form a T shape as shown in Fig. 6. There are two specific connecting structures between the actuating rod 16 on the tripping rod 13 and the tripping rod 13: an integrally formed structure and a split formed structure. The latter structure is a preferred structure, to be specific: the control element 40 or the rotary plate 5 is provided with an axle hole 33, the actuating rod 16 is provided with a pillow block 34 which is inserted into the axle hole 33 to form installation connection, and the pillow block 34 may be movable fit or static fit with the axle hole 33. Two overload short columns 29, 30 of the actuating rod 16 are arranged side by side and are matched with bimetal sheets 21 of the thermal tripping devices in a triggering manner, i.e., one overload short column 29 is matched with the bimetal sheet 21 of one thermal tripping device in a triggering

manner, and the other overload short column 29 is matched with the bimetal sheet 21 of the rest thermal tripping device in a triggering manner. To realize symmetrical distribution of triggering forces of the two metal sheets 21 and optimize a force system structure of the operation device, a preferred scheme is as follows: the two overload short columns 29, 30 are stretched toward two lateral sides of the actuating rod 16 to form a T shape as shown in Fig. 6. To make the structure of the operation device more compact and further optimize a force system structure of the operation device, a preferred scheme is as follows: a positional distance B between the overload short columns 29, 30 and the second twisting shaft 12 is larger than a positional distance A between the short-circuit short columns 31, 32 and the second twisting shaft 12, and the triggering force of the bimetal sheets 21 can be reduced even the triggering force of the bimetal sheets 21 has a longer force arm than a triggering force of the actuating ejection rods 24.

**[0027]** The two contact supports 15, 35 are connected with the rotary plate 5 respectively through two overtravel mechanisms having the same structure. The two overtravel mechanisms may have a plurality of specific structure schemes, wherein one preferred scheme is as follows: each overtravel mechanism comprises an overtravel spring 19, a first stopper 11 arranged on the contact supports 15, 35, a second stopper 20 arranged on the rotary plate 5, and a first clutching surface (as shown in a clutching mechanism 6 in Fig. 2 and Fig. 3) and a second clutching surface (as shown in the clutching mechanism 6 in Fig. 2 and Fig. 3) which are arranged on the contact supports 15, 35 and the rotary plate 5 respectively to form the clutching mechanism 6, and preferably, the two contact supports are further provided with two torsional springs 19, wherein one end of each torsional spring is matched with the first stopper 11, and the other end of the torsional spring is matched with the second stopper 20 on the rotary plate 5 to ensure that the contact supports form effective engaging 6 with the rotary plate when the rotary plate 5 finitely rotates between a broken position and a closed position where contacts 22, 27, 18, 38 are located. Referring to Fig. 1, the torsional springs 19 provide an acting force when the contacts 22, 27, 18, 38 are at a closed position. To be specific, one end of each overtravel spring 19 is connected with the first stopper 11, the other end of the overtravel spring 19 is connected with the second stopper 20. The clutching mechanisms 6 are engaged under a state where the movable contacts 18, 38 are broken from the static contacts 22, 27, and the clutching mechanisms 6 are disengaged under a state where the movable contacts 18, 38 and the static contacts 22, 27 are closed. The first clutching surface may be arranged on the contact supports 15, 35 by adopting a known manner, that is, each contact support is provided with a first clutching surface. The second clutching surfaces may be arranged on two surfaces of the rotary plate 5 by adopting a known manner, that is, two surfaces of the rotary plate 5 are provided with a second clutching surface respectively. After two contact supports 15, 35 and one rotary plate 5 are sheathed on the mandrel 14, the two contact supports 15, 35 are in contact fit with two surfaces of the rotary plate 5 respectively, and therefore, two surfaces of the rotary plate 5 constitute two clutching mechanisms 6, wherein one clutching mechanism 6 is composed of a first clutching surface on one of the contact supports 15 and a second clutching surface on one of the surfaces of the rotary plate 5, and the other clutching mechanism 6 is composed of a first clutching surface on the other contact support 35 and a second clutching surface on the other surface of the rotary plate 5. The elastic force of each overtravel spring 19 drives engaging of the clutching mechanisms 6, i.e., drives the first clutching surface to be in contact with the second clutching surface, and therefore, in the absence of an external force acting on the contact supports 15, 35, that is, the movable contacts 18, 38 are broken from the static contacts 22, 27, the first clutching surface is in contact with the second clutching surface, i.e., the clutching mechanisms are engaged. Such engaging limits relative rotation between the contact supports 15, 35 and the rotary plate 5, such that the positions of the contact supports 15, 35 relative to the rotary plate 5 are stable and realize linkage. When the movable contacts 18, 38 and the movable contacts 22, 27 are at a closed state, because the movable contacts 18, 38 are in contact with the static contacts 22, 27, a travel by which the rotary plate 5 rotates in a closing process is larger than a travel by which the contact supports 15, 35 rotate (it is equivalent to overtravel), and the elastic force of the energy storage spring overcomes the elastic force of the overtravel springs 9 to drive disengaging of the effective engaging 6, that is the first clutching surface is separated from the second clutching surface. It is not difficult to derive that the size of the contact pressure between the movable contacts 18, 38 and the static contacts 22, 27 depends on the elastic force of the overtravel springs 19 after the overtravel mechanisms are adopted. Because the two overtravel springs 19 act on the two contact supports 15, 35 respectively in the present invention, the consistency of the contact pressures of the two groups of contacts can be ensured.

**[0028]** The embodiments illustrated in the drawings are described with a combination way of one operation device and switching units of two poles as an example, however, the operation device of the multi-pole miniature circuit breaker of the present invention is limited to this way, and a combination way of a plurality of operation devices and switching units of more poles, for example, a combination way of two operation devices and switching units of four poles are also available. In order to make more than two operation devices be arranged compactly side by side and cooperatively work, an alternative scheme is as follows: the control element 40 and the actuating rod 16 are located in a space D between two contact supports 15, 35. Obviously, by means of such layout structure, the width of the operation device does

not exceed the width of two switching units arranged side by side, which is conductive to realizing uniform arrangement of a plurality of operation devices on the front surface of the multi-pole circuit breaker, and the linkage cooperation among various operation devices is reliable.

**[0029]** An operation process of the operation device of the multi-pole miniature circuit breaker of the present invention will be further illustrated as below referring to Figs. 2 to 4.

**[0030]** A normal closing process is as follows:

according to a broken or tripped state as shown in Fig. 2, when a manual or automatic device pushes the handle 1 to rotate about the rotating shaft 2 clockwise, the lock hook 42 of the tripping connecting rod 9 is engaged with the lock tooth 41 of the tripping rod 13 to make the mechanical interlock 10 be locked, and therefore, the handle 1 drives the U-shaped rod 4 and enables the U-shaped rod 4 to push the tripping connecting rod 9, the tripping rod 13 and the rotary plate 5 to rotate together about the mandrel 14 clockwise, the rotary plate 5 drives the two contact supports 15, 35 to rotate together through the engaging of the clutching mechanisms 6 of the overtravel mechanisms, the contact supports 15, 35 drive the two movable contacts 18, 38 to close synchronously toward the two static contacts 22, 27 till the two movable contacts 18, 38 are in contact with the two static contacts 22, 27 respectively, and the operation device enters a closed state as shown in Fig. 3; under this state, the two clutching mechanisms 6 are disengaged, the two overtravel springs 19 provide necessary contact pressure for two groups of contacts respectively, and meanwhile, the energy storage spring arranged on the rotary plate finishes compression and energy storage.

**[0031]** A normal breaking process is as follows:

according to the normal closed state as shown in Fig. 3, when the manual or automatic device pushes the handle 1 to rotate about the rotating shaft 2 anticlockwise, the lock hook 42 of the tripping connecting rod 9 is engaged with the lock tooth 41 of the tripping rod 13 to make the mechanical interlock 10 be locked, and therefore, the handle 1 drives the U-shaped rod 4 and enables the U-shaped rod 4 to push the tripping connecting rod 9, the tripping rod 13 and the rotary plate 5 to rotate together about the mandrel 14 anticlockwise, the rotation of the rotary plate 5 enables the clutching mechanisms 6 to be engaged first and then drives the two contact supports 15, 35 to rotate together through the engaged clutching mechanisms 6, the contact supports 15, 35 drive the two movable contacts 18, 38 to be synchronously separated apart from the two static contacts 22, 27 till the two movable contacts 18, 38 are separated from the two static contacts 22, 27 in place, and the operation device enters a broken state as shown in Fig. 2; under this state, the energy storage spring releases energy.

**[0032]** A short-circuit tripping process is as follows:

according to the normal closed state as shown in Fig. 3, if any one of electromagnetic tripping devices 23 connected in series to a control loop has a short-circuit current flowing by, the short-circuit current instantaneously excites the actuating ejection rod 24 of the electromagnetic tripping device 23 that the short-circuit current flows by to generate a transversely moving tripping action and subsequently triggers the motion of the short-circuit short column 31 or 32; this motion drives the tripping rod 13 to rotate anticlockwise about the second twisting shaft 12 and drives the lock tooth 41 of the tripping rod 13 and the lock hook 42 of the tripping connecting rod 9 to be separated to unlock the mechanical interlock 10; the energy storage spring releases energy, the elastic force of the energy storage spring drives the rotary plate 5 to rotate, and the rotation of the rotary plate 5 enables the clutching mechanisms 6 to be engaged first and then drive two contact supports 15, 35 to rotate together through the engaged clutching mechanisms 6; the contact supports 15, 35 drive two movable contacts 18, 38 to be synchronously separated apart from the two static contacts 22, 27 till the two movable contacts 18, 38 are separated from the two static contacts 22, 27 in place, and the operation device enters a broken state as shown in Fig. 2.

**[0033]** An overload tripping process is as follows:

according to the normal closed state as shown in Fig. 3, if any one of electromagnetic tripping devices connected in series to a control loop has an overload current flowing by, the overload current can drive, for example, the bimetal sheet 21 of the tripping device that the overload current flows by to be bent and deformed to generate a tripping action with free ends swinging, and the tripping action of the bimetal sheet 21 drives the motion of the overload short column 29 or 30; this motion drives the tripping rod 13 to rotate anticlockwise about the second twisting shaft 12 and drives the lock tooth 41 of the tripping rod 14 and the lock hook 42 of the tripping connecting rod 9 to be separated to unlock the mechanical interlock 10; the energy storage spring releases energy, the elastic force of the energy storage spring drives the rotary plate 5 to rotate, the rotation of the rotary plate 5 enables the clutching mechanisms to be engaged first and then drive two contact supports 15, 35 to rotate together through the engaged clutching mechanisms; the contact supports 15, 35 drive two movable contacts 18, 38 to be synchronously separated apart from the two static contacts 22, 27 till the two

movable contacts 18, 38 are separated from the two static contacts 22, 27 in place, and the operation device enters a tripped state as shown in Fig. 2.

**[0034]** The embodiments described above are just preferred embodiments of the present invention, and all the technical equivalent variations and modifications made according to claims of the present invention should be deemed to fall into the scope of the present invention.

## Claims

1. An operation device of a multi-pole miniature circuit breaker, comprising a handle (1) pivotally mounted on a circuit breaker housing through a rotating shaft (2), a rotary plate (5) pivotally mounted on the circuit breaker housing through a mandrel (14),two static contacts (22, 27) and two movable contacts (18, 38) capable of performing closing/breaking fit with the static contacts (22, 27) respectively, an energy storage spring acting on the rotary plate (5) and a resetting member configured to drive a tripping rod (13) to reset; and two electromagnetic tripping devices (23) arranged side by side, each electromagnetic tripping device comprising an actuating ejection rod (24) which is capable of providing a short-circuit tripping action when a short-circuit current appears; and two thermal tripping devices arranged side by side, each thermal tripping device comprising a bimetal sheet (21) which is capable of providing an overload tripping action when an overload current appears;
wherein, the operation device further comprises:

a tripping connecting rod (9) provided with a lock hook (42), which is pivotally mounted on the rotary plate (5) through a first twisting shaft (8);
a tripping rod (13) which is provided with a lock tooth (41), a control element (40) capable of being matched with electromagnetic tripping devices of circuit breakers of two adjacent poles, and an actuating rod (16) capable of being matched with bimetallic sheets of thermal tripping devices of the adjacent two-pole circuit breaker, the tripping rod (13) being pivotally mounted on the rotary plate (5) through a second twisting shaft (12) and being capable of doing a finite rotation about the second twisting shaft (12).
a U-shaped rod (4) of which the two ends are in joint connection with the handle (1) and the tripping connecting rod (9) respectively, and which can drive the tripping connecting rod (9) to move anticlockwise or clockwise about the first twisting shaft (8);
two short-circuit short columns (31, 32) arranged on the control element (40) of the tripping rod (13) side by side, the two short-circuit short columns (31, 32) being matched with actuating ejection rods (24, 24) of the two electromagnetic tripping devices (23) in a triggering manner respectively;
two overload short columns (29 and 30) arranged on the actuating rod (16) of the tripping rod (13) side by side, the two overload short columns (29 and 30) being matched with the bimetallic sheets (21,21) of the two thermal tripping devices in a triggering manner respectively.

2. The operation device of a multi-pole miniature circuit breaker according to claim 1, wherein the control element (40) is fixedly connected with the tripping rod (13); or the control element (40) and the tripping rod (13) are integrally formed.

3. The operation device of a multi-pole miniature circuit breaker according to claim 1, wherein the control element (40) or the tripping rod (13) is provided with an axle hole (33), and the actuating rod (16) is provided with a pillow block (34) which is inserted into the axle hole (33) to form installation connection; or the control element (40) or the tripping rod (13) is integrally formed with the actuating rod (16).

4. The operation device of a multi-pole miniature circuit breaker according to claim 1, wherein
two contact supports (15, 35) are pivotally mounted on the mandrel (14), and are connected with the rotary plate (5) respectively through two overtravel mechanisms;
the two movable contacts (18, 38) are arranged on corresponding contact arms (17, 39) respectively and are fixedly connected with the two contact supports (15, 35) respectively.

5. The operation device of a multi-pole miniature circuit breaker according to claim 4, wherein
each overtravel mechanism comprises an overtravel spring (19), a first stopper (11) arranged on the contact supports (15, 35), a second stopper (20) arranged on the rotary plate (5), and a first clutching surface and a second clutching surface which are arranged on the contact supports (15, 35) and the rotary plate (5) respectively to form a clutching mechanism (6), wherein one end of the overtravel spring (19) is connected with the first stopper (11), the other end of the overtravel spring (19) is connected with the second stopper (20), under a state in which the movable contacts (18, 38) are broken from the static contacts (22, 27), the clutching mechanisms (6) are engaged, and under a state in which the movable contacts (18, 38) and the static contacts (22, 27) are closed, the clutching mechanisms (6) are disengaged;
rotation centers of the two contact supports (15, 35) and the rotary plate (5) are concentric with an axis

of the mandrel (14) respectively.

**6.** The operation device of a multi-pole miniature circuit breaker according to claim 1, wherein a positional distance B between the overload short columns (29, 30) and the second twisting shaft (12) is larger than a positional distance A between the short-circuit short columns (31, 32) and the second twisting shaft (12).

**7.** The operation device of a multi-pole miniature circuit breaker according to claim 1 or 4, wherein the control element (40) and the actuating rod (16) are located in a space D between the two contact supports (15, 35).

**8.** The operation device of a multi-pole miniature circuit breaker according to claim 1, wherein the two short-circuit short columns (31, 32) are stretched respectively toward two lateral sides of the control element (40) respectively to form a T shape.

**9.** The operation device of a multi-pole miniature circuit breaker according to claim 1, wherein the two overload short columns (29, 30) are stretched respectively toward two lateral sides of the actuating rod (16) respectively to form a T shape.

**10.** The operation device of a multi-pole miniature circuit breaker according to claim 4, wherein the two contact supports (15, 35) are in contact fit with two surfaces of the rotary plate (5) respectively.

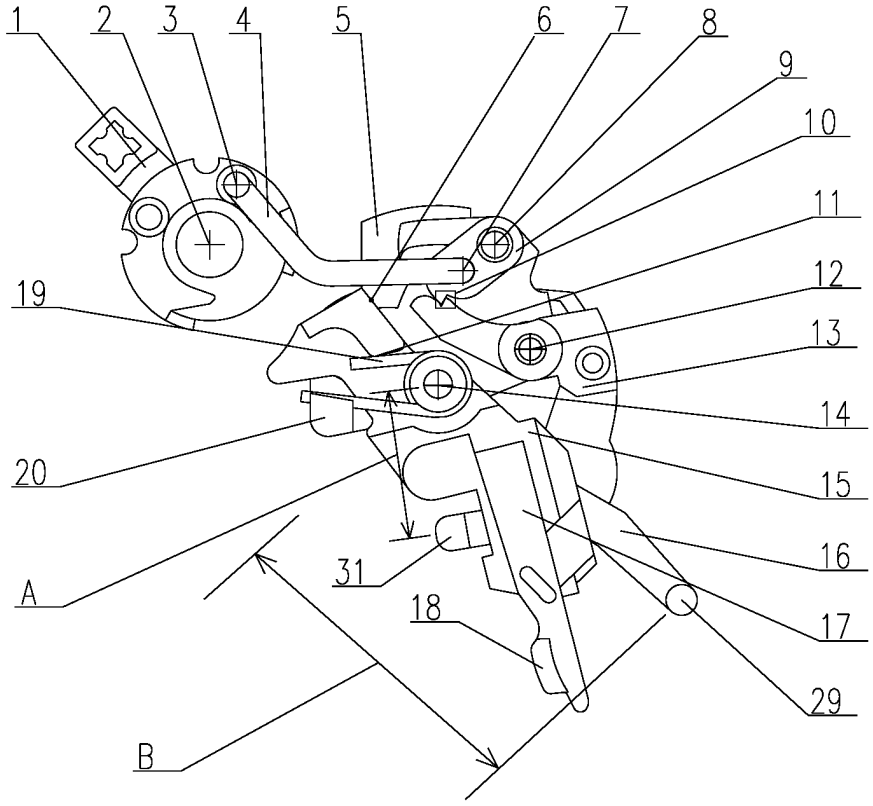
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Fig. 1

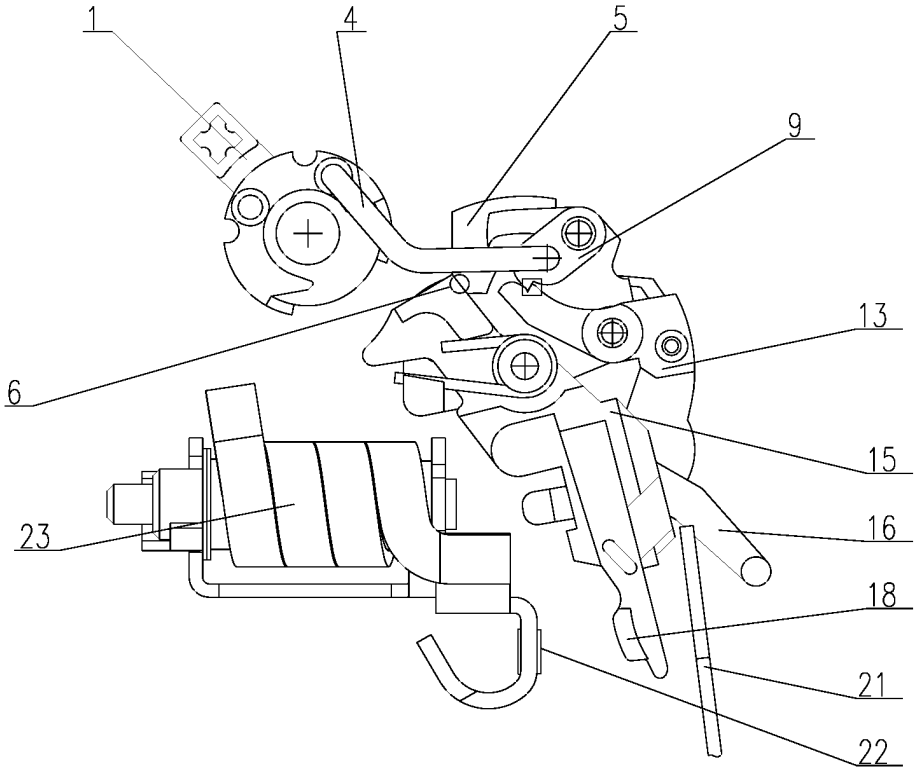
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Fig. 2

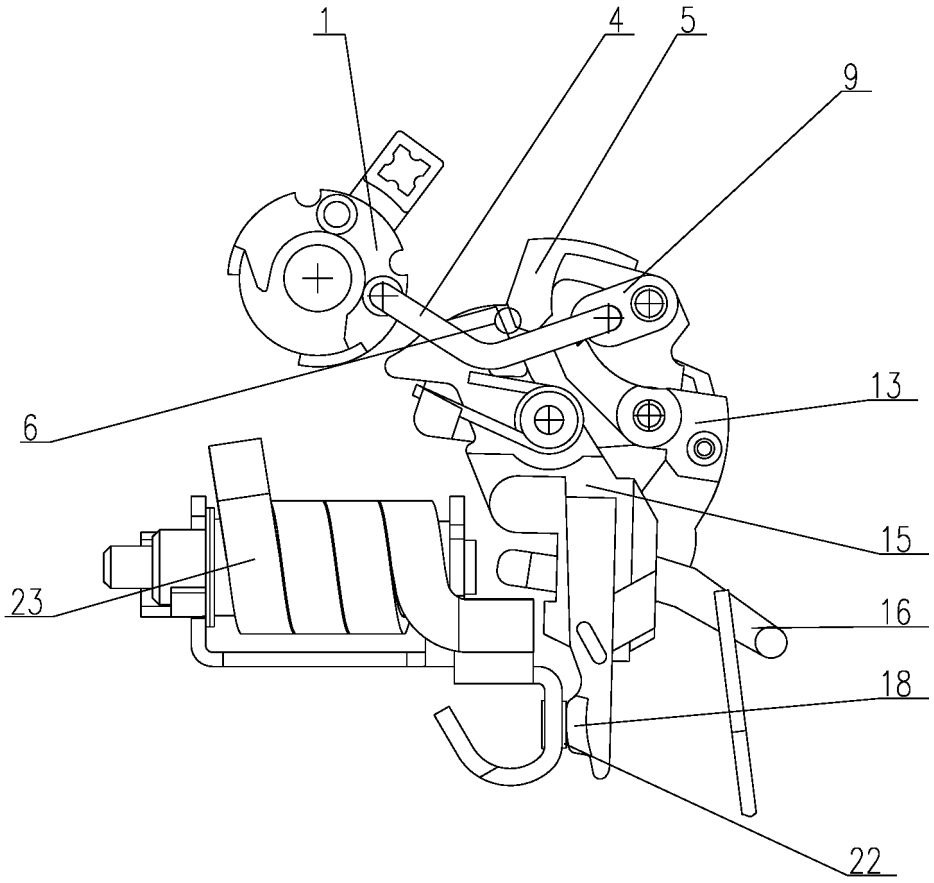


Fig. 3

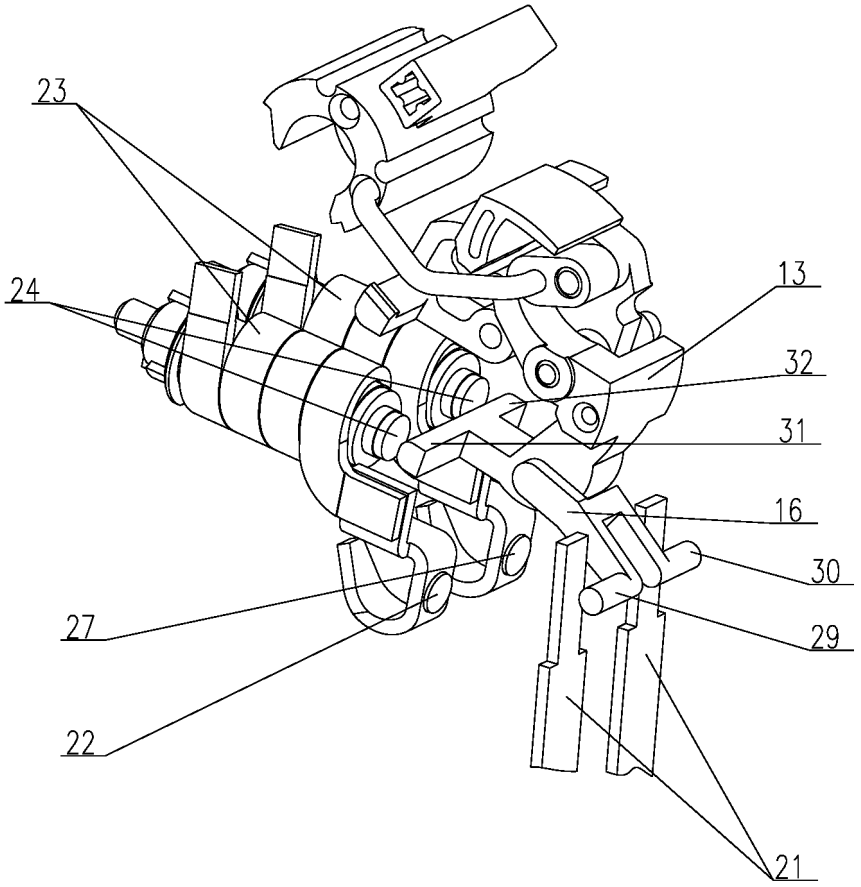


Fig. 4

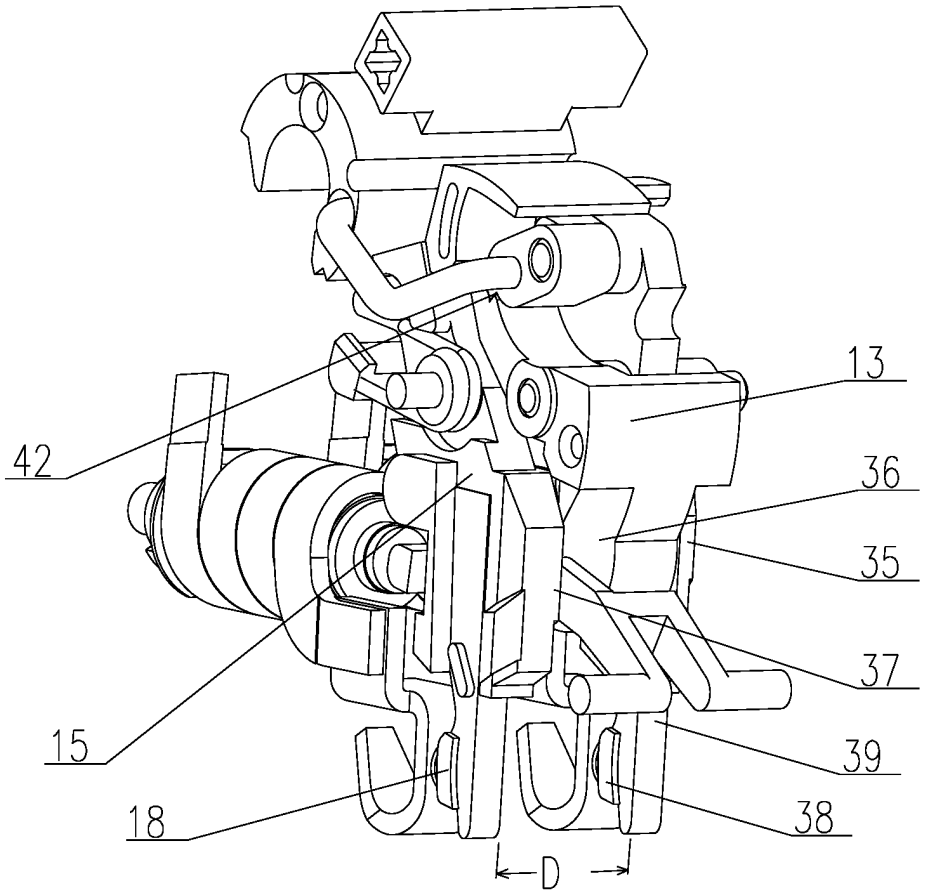


Fig. 5

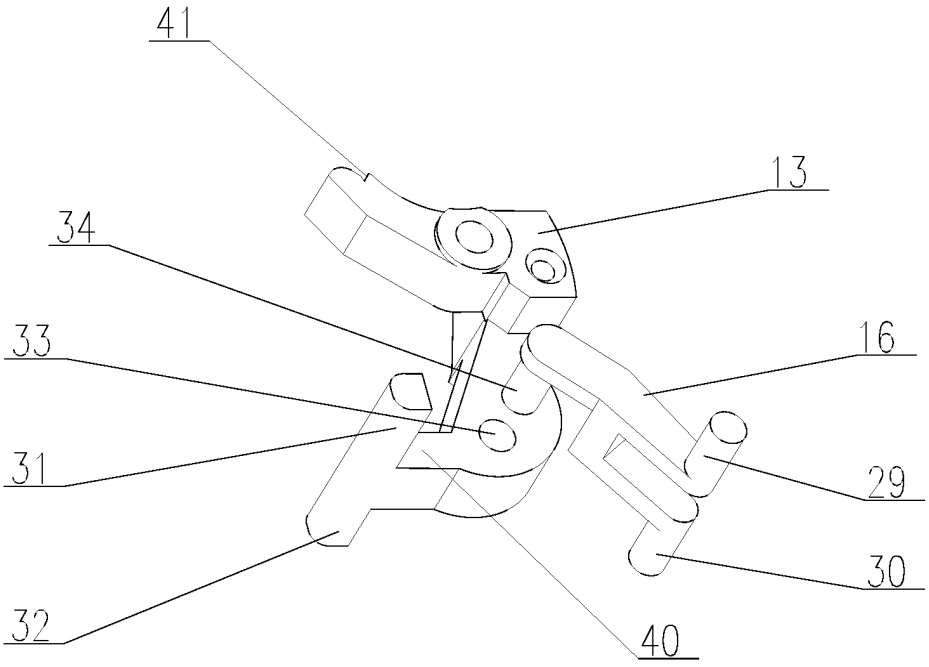


Fig. 6

# INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2015/071748

**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)

path press

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| PX | CN 204029740 U (ZHEJIANG CHINT ELECTRICS CO LTD et al.) 17 December 2014 (17.12.2014) claims 1-10 | 1-10 |
| PX | CN 104134588 A (ZHEJIANG CHINT ELECTRICS CO LTD et al.) 05 November 2014 (05.11.2014) claims 1-10 | 1-10 |
| A | CN 2777745 Y (ZHEJIANG DELIXI ELECTRICAL APP) 03 May 2006 (03.05.2003) the whole document | 1-10 |
| A | CN 2521745 Y (ZHENGTAI ELECTRIC APPLIANCES C) 20 November 2002 (20.11.2002) the whole document | 1-10 |
| A | CN 101388301 A (EATON IND NETHERLANDS BV) 18 March 2009 (18.03.2009) the whole document | 1-10 |

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

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| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 10 April2015 | 29 April 2015 |

| Name and mailing address of the ISA | Authorized officer |
|---|---|
| State Intellectual Property Office of the P. R. China<br>No. 6, Xitucheng Road, Jimenqiao<br>Haidian District, Beijing 100088, China<br>Facsimile No. (86-10) 62019451 | WANG, Xiaoyan<br>Telephone No. (86-10) 62411731 |

Form PCT/ISA /210 (second sheet) (July 2009)

**INTERNATIONAL SEARCH REPORT**
Information on patent family members

International application No.
PCT/CN2015/071748

| Patent Documents referred in the Report | Publication Date | Patent Family | Publication Date |
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| CN 104134588 A | 05 November 2014 | None | |
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Form PCT/ISA /210 (patent family annex) (July 2009)

## REFERENCES CITED IN THE DESCRIPTION

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