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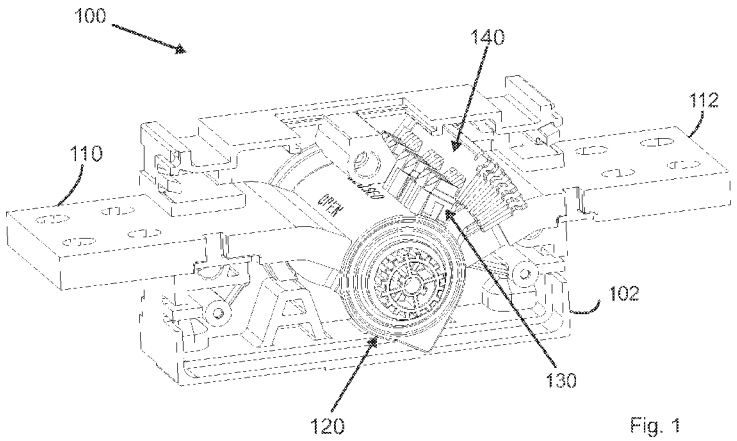

Fig. 1

(57) Abstract: A contact arrangement of an electric switch, comprising a first stationary contact (110), a second stationary contact (112) and a movable contact (130) for making an electrical connection between the first (110) and second (112) stationary contacts, wherein the movable contact (130) is pivotally connected to the first stationary contact (110) by a pivotal connection for allowing the movable contact (130) to pivot with respect to the first stationary contact (110) about a pivoting axis (116, 135) such that in an open position of the switch, the movable contact (130) is disconnected from the second stationary contact (112), and in a closed position of the switch, the movable contact (130) is in contact with the second stationary contact (112).The movable contact (130) and the first stationary contact (110) are arranged in a first angle with respect to each other in the open position of the switch, and in a second angle with respect to each other in the closed position of the switch, and the second angle is greater than the first angle.

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ELECTRIC CURRENT SWITCHING APPARATUS

FIELD

The present invention relates to an electric current switching apparatus.

BACKGROUND

Many issues affect designing of an electric current switching apparatus. The design goals include, for instance, ease of assembly of the switch, possibility to assemble various switch types, security of use of the switch, fast connecting and disconnecting of the contacts and efficient quenching of an arc firing when the contacts are separated.

SUMMARY

An object of the present invention is to provide an improved electric current switch. The object is achieved with an invention, which is defined in the independent claim. Some embodiments are disclosed in the dependent claims.

DRAWINGS

In the following, the invention will be described in greater detail by means of some embodiments with reference to the accompanying drawings, in which

Figure 1 shows an embodiment of a switch module;

Figure 2 shows another view of the switch module;

Figure 3 shows an embodiment of a movable contact;

Figure 4 shows an embodiment of a contact assembly;

Figure 5 shows another view of the contact assembly;

Figure 6 shows another view of the contact assembly;

Figure 7 shows another view of the contact assembly;

Figure 8 shows an embodiment of a quenching plate assembly;

Figure 9 shows another view of the quenching plate assembly;

Figure 10 shows another view of the quenching plate assembly;

Figure 11 shows an embodiment of a module housing;

Figure 12 shows another view of the module housing;

Figure 13 shows another view of the module housing;

Figure 14 shows an embodiment of a stationary contact assembly arrangement;

Figure 15 shows an embodiment of two different stationary contacts;

Figure 16 shows another view of two different stationary contacts;

Figure 17 shows a display arrangement of a contact module; and

Figure 18 shows another view of a display arrangement of a contact module.

DETAILED DESCRIPTION

Electric switches typically comprise a few switch modules/poles, which are stacked together to build multi-pole switches. Each module may comprise an insulating housing, which houses the electrical components of the switch modules. Each module housing may comprise a first housing half and a second housing half made of plastic, for instance, to be assembled together to form a switch module. The housing modules may be substantially rectangular.

Figure 1 shows one embodiment of an electric switch module showing the first housing 102 equipped with the components of the module. The second housing of the switch module to be assembled against the first housing 102 for forming the module and covering the switch components is not shown.

Figure 1 shows two stationary contacts 110, 112 at the opposite ends of the module and movable contacts 130 that are to be moved between open and closed positions of the switch. To perform the rotary action of the movable contacts 130, the device comprises a rotary actuator 120.

The switch may also comprise a quenching chamber housing one or more quenching plates 140 used for quenching an arc that fires between the contacts when the movable contact is disconnected from the stationary contact(s).

Figure 2 shows the switch module of Figure 1, however in a different rotary position than in Figure 1. In Figure 1, the switch is in open position in which the movable contacts 130 are separated from the stationary contact 112. In Figure 2, the switch is in closed position, where the movable contact 130 is in contact with the stationary contact 112.

The stationary contact 110 comprises a connection portion 110A to be connected to an external conductor. The connection portion 110A is preferably arranged substantially perpendicularly to the wall of the housing 102. The stationary contact further comprises a contact portion 110B to be connected to the movable contact. It can be seen that the connection portion 110A and the contact portion 110B are arranged to an angle with respect to each other, that is they are not parallel with each other. Similarly in the stationary contact 112, the connection portion and the contact portion are arranged in an angle to each other, which tilting of the two is arranged inside the housing.

In the shown embodiment, the first stationary contact 110 is pivotally connected to the movable contact. The stationary contact remains stationary during the operation of the switch. The movable contact pivots between the two extreme positions shown in Figures 1 and 2. The pivotal connection between the first stationary contact 110 and the movable contact 130 is arranged inside the rotary actuator 120, that is, inside the perimeter of a cross section of the actuator. Preferably, the pivot axis of the pivotal connection coincides with the rotation axis of the rotary actuator 120.

In an embodiment, the connection portions of the stationary contacts 110, 112 are parallel and aligned with each other, that is they are at the same plane. Alternatively, they may be slightly misaligned, that is they may be parallel to each other but in different planes. As the contact portions of the stationary contacts point substantially towards the rotation axis of the rotary actuator, the rotation axis of the actuator 120 lies below the plane of the connection portions of the stationary contacts 110, 112. The rotation axis may be substantially in the geometrical centre of the housing module, whereby the connection portions of the stationary contacts lie slightly aside from the middle level of the vertical height of the housing.

As the bold arrows indicate in Figure 2, when the contact is closed, the current path forms substantially a letter V at the contact portion of the first stationary contact and the movable contact. Preferably, the V-form extends to the contact portion of the second stationary contact 112 such that the movable contact 130 and the contact portion of the second stationary 112 contact are substantially parallel with each other.

In the current path, the angle of the branches of the V is at its smallest when the movable contact barely touches the second stationary contact 112. At that point, the magnetic forces in the branches of V, that is, in the first stationary contact 110 and in the movable contact 130 oppose each other, and are at their greatest, causing the movable contact to turn away from the first stationary contact. Thereby the force alleviates the making of the contact of the movable contact and the second stationary contact. This phenomena is especially advantageous in closing the switch against great short-circuit currents. If we assume that the nominal current of the switch is 4 kA, the short-circuit current may be as high as 80 kA, for instance. At such great currents, the V-profiled current path greatly assists in closing the switch.

Thus, in the switch, the angle between the movable contact and the first stationary contact is greater when the switch is closed than the angle between the two when the switch is open. In the examples of Figures 1 and 2, the angle between the movable contact and the first stationary contact is thus about 80 degrees when the switch is open and about 150 degrees when the switch is closed.

Here the angle between the two refers to the smaller angle, which is below 180 degrees if the contacts are assumed to originate from the pivot point between the two. Preferably the angle between the two is less than 180 degrees, preferably less than 170 degrees when the switch is closed, and even more preferably between 110 to 160 degrees. The angle between the movable contact and stationary contact thus never exceeds 180 degrees, but even in the closed state the V-form of the current path is maintained. If the angle between the two would be 180 degrees, the contact portion of the stationary contact and the rotary contact would be parallel to each other such that the pivotal rotary contact would be an extension of the stationary contact. This state is thus not reached in any pivotal situation of the rotary contact.

Figure 2 shows also a receptacle 114 in the first stationary contact 110, and a receptacle 116 in the second stationary contact 112, which are used to fix the stationary contacts to the housing 102. The shown receptacles 114, 116 are to be set against a housing module that closes the housing module 102 shown in Figure 2. There are similar receptacles in the stationary contacts 110, 112 on the opposite side of the stationary contacts to be set against the module 102.

Figure 3 shows an exploded view of an embodiment of a movable contact 130. The parts of the movable contact are a first contact blade 131, a second contact blade 132, an assembly pin 138, a first cover 133, a second cover 134, and a spring element 136.

The movable contact 130 makes an electrical connection with the stationary contact by receiving the stationary contact between the first and second contact blades 131, 132. The side 132C of the contact blade 132 that receives the stationary contact may be slanted to assist in receiving the stationary contact between the blades. The contact blade also comprises an assembly hole 132A for receiving the assembly pin 138 when the movable contact is assembled, and an pivoting hole 132B for receiving a pivoting pin when the movable contact is arranged together with stationary contact.

The movable contact may comprise first and second cover portions 133, 134, where the first cover portion 133 is placed next to the first contact blade 131, and the second cover portion 134 is placed next to the second contact blade 132. The contact blades 133, 134 may be similar to each other and when the movable contact is assembled, the cover portions 133 and 134 come mutually in opposite rotation position to each other.

The cover portion 133 comprises a side portion 133C covering and protecting the contact blade from the side. The cover portion 133 may be symmetric such that there is a similar side portion on the other side of the cover portion. On the top side, the cover portion may comprise an assembly hole 133A for receiving the assembly pin 138, and a pivoting hole 133B for receiving the pivoting pin.

The movable contact also comprises a spring element 136 on one side of the movable contact. Alternatively, another spring element may also be provided on the other side of the movable contact. The spring element comprises an assembly hole 136A for receiving the assembly pin 138, and a receptacle 136B for receiving the pivoting pin. As can be seen, the assembly hole converges to the right, that is, the hole is at its greatest on the left in Figure 3, and smallest to the right. The spring element further comprises a top portion 136C, and two tilted portions 136D, 136E extending towards the first cover 133. At the ends of the spring element, there are

provided projections 136F, 136G that are tilted such that extend away from the first cover 133.

The assembly pin 138 comprises a separation portion 138A, which defines the distance between the contact blades 131, 132. That is, the diameter of the separation portion 138A is greater than the diameter of the assembly hole 132A of the contact blade 132, whereby the contact blades set against the ends of the separation portion 138A.

The assembly pin 138 further comprises a first contact blade portion 138B and a second contact blade portion 138C, which are to be placed into the assembly holes of the contact blades, that is, the diameter of the assembly hole 132A is greater than the diameter of the contact blade portion 138B, which in turn is greater than the assembly hole 133A of the cover. When assembled, the cover thus stops the contact blade portion 138B and sets against the end of it. In an embodiment, the thickness of the contact blade 131 is slightly greater than the length of the contact blade portion 138B. Thereby if the contact blade wears and becomes thinner, there is some clearance and the contact spring can still apply a pressing force for pressing the contact blade against the separation portion 138A of the pin 138.

As Figure 3 shows, the assembly hole 133A has a form of a keyhole having a first end with a greater diameter/aperture, and a second end with a smaller diameter/aperture. The assembly pin 138 has a cover portion 138D and an end portion 138F having a greater diameter than the cover portion 138D. It can be seen that the cover portion 138D in one end of the assembly pin is longer than the cover portion 138E at the other end of the pin 138. The reason is that the cover portion 138D is as long as the assembly hole 133A and the assembly hole 136A of the spring 138 together. In the other end of the pin 138, it is sufficient that the length of the cover portion 138E equals to the thickness of the cover portion 134.

When the movable contact is assembled, the connection pin is put through the assembly holes in the contact blade 131, cover portion 133 and the contact spring 136A. The cover portion 138B is locked to the contact pin by moving the cover portion to the right, whereby the cover portion sets into the small end of the assembly hole 133B of the cover portion. The spring element 136 is locked to the

contact pin by moving the contact pin to the left, whereby the cover portion of the pin enters the smaller end of the assembly hole 136A of the spring.

The contact blades may be made of the copper and be coated with silver, for instance. The cover portion, the spring element and the assembly pin may be made of steel to obtain more contact power due to magnetic forces.

The shown structure provides an important advantage in that the contact blades can be made straight, and there is no need for provision of projections on the surfaces of the contact blades to keep them separated.

Figures 4 and 5 show an embodiment of a contact arrangement from two viewing directions. The contact arrangement comprises a stationary contact 110, a movable contact 130 and a rotary actuator 120.

When the stationary contact 110 and the movable contact 130 are assembled together, the movable contacts are set in the proximity of the projections 114A, 114B and 114C. Each of the projections is provided for mounting one of the shown three contact blade structures to the stationary contact. The contact blades of each contact blade structure are set to opposite sides of the respective projection such that the pivoting holes of the contact blade structures coincide with the pivoting holes 116 in the projections 114A, 114B and 114C. When the holes are aligned with each other, a pivoting pin 135 is pushed through all the holes, whereby the contact blade structures become pivotally connected to the stationary contact 110.

Thereafter, the assembled structure of the stationary contact and the movable contact is assembled to the rotary actuator 120. This is carried out pushing the assembled structure partly through the actuator. The actuator 120 comprises two apertures, one on each side of the actuator. Shown in Figure 4, there is provided a first aperture 122 on one side of the actuator, and shown in Figure 5, there is provided a second aperture 127 on the opposite side of the actuator. In the embodiment of Figures 4 and 5, there are practically three second apertures 127A-127C corresponding to three contact blade assemblies. However, the embodiments are not restricted to exactly three contact blades and apertures, but the number of contact blades and apertures may vary from 1 to 5, for instance.

In the assembly of the stationary contact and the movable contact to the rotary actuator, the movable contacts are pushed in the actuator from the first aper-

ture 122 such that each of the contact blade assemblies sets to their respective spaces separated by walls 124. The contact blades are pushed further such that their ends exit the actuator from the apertures 127A to 127C. At that stage, the projections of the stationary contact have entered the interior of the actuator. When the assembly is ready, the pivoting pin 135 sets inside the actuator, preferably to the rotation axis of the actuator 120.

In use, the stationary contact is arranged stationary to the housing, but the rotary actuator may rotate within the housing. The rotation of the rotary actuator with respect to the stationary contact is defined by the upper wall 126 and the lower wall 128. In one extreme rotary position of the actuator 120, that is the open position, the top wall 126 of the actuator 120 sets against the top surface of the contact portion 110B of the stationary contact 110. In the other extreme rotary position of the actuator, that is the closed position of the switch, the lower wall 128 of the aperture sets against the bottom surface 110C of the stationary contact 110. The edges of the aperture 122 thus define the rotary angle of the rotary actuator 120. On the other side of the rotary actuator, the second apertures 127A to 127C are dimensioned such that the movable contacts, or the contact blade assemblies, are substantially fixed/immovable with respect to the rotary actuator 120, that there is tight fitting between the two. The movement of the movable contact(s) thus follows the rotation of the rotary actuator.

Figures 6 and 7 further highlight the contact arrangement. In Figure 6, the movable contacts 130 have been assembled to the stationary contact 110. The movable contact of Figure 6 comprises three contact blade arrangements. Each contact blade arrangement comprises two contact blades separates from each other to receive a stationary contact between the blades.

The assembly is completed by pushing the connection pin 135 through holes provides in the projections of the stationary contact, and the movable contacts. When the movable contacts are mounted to the stationary contact with the pin, the movable contacts are freely pivotable about the stationary contact. The amount of mutual pivoting of the movable contact and the stationary contact is, however, limited by the rotary actuator shown in Figure 7.

Figure 6 also shows mounting recesses 117 and 118 in the stationary contact. The purpose of the mounting recesses is to mount the stationary contact to the switch module housing. There may be provided similar recesses on both sides of the stationary contact. The first mounting recess 117 is provided for keeping the stationary contact in place in horizontal direction. The second mounting recess is provided for fitting a thick stationary contact to a housing module which can receive also thinner stationary contacts. The second mounting recess 118 may extend the whole width, from one side to the other side of the stationary contact.

Figure 7 shows two indications 123, 125 indicating the rotary position of the switch. The first indication 123 may indicate that the switch is in the open position, and the second indication 125 that the switch is in the closed position. The indications may comprises written words, such as “OPEN” and “CLOSED” or may include a colour indications using green and red, for instance.

The indications may be provided on a wall section of the actuator, which wall section is between the first and second apertures of the actuator. The indications may be provided on the wall by any known means, such as by writing, carving, or by attaching a sticker, for instance. The indications, such as text, symbol or colour indications, are preferably provided on the actuator perpendicularly to the rotation direction of the actuator.

Figure 8 shows an embodiment of a switch module housing 102 equipped with the components of the switch. The switch is shown in the closed position, where the movable contact is in contact with the second stationary contact 112. The housing comprises a second window 106, which shows the text CLOSED in this case. The housing also shows a support structure 108 to provide mechanical strength to the module when the housing halves are mounted together. In an embodiment, the support structure 108 comprises a receptacle for receiving a pin of a housing half that is to be mounted to the shown housing half 102.

The support structure is positioned inside the housing next to a wall of the housing and may be substantially aligned with the centre of the actuator in longitudinal direction of the module. The support structure may be positioned between the windows 104, 106 such that the base of the support structure forms at least part of a housing wall residing between the windows. The windows may be implemented as

apertures in the housing, to which housing a transparent plastic or glass window can be arranged.

During use, the support structure 108 hides the text OPEN behind it such that it is substantially invisible from the first window when the switch is in the closed position. When the switch is rotated to the open position, the text OPEN emerges from behind the support structure 108 and is shown in the first window 104, which is closer to the first stationary contact 110 than the second window 106. When the switch is in the OPEN position, the text CLOSED is situated behind the support structure 108 and is substantially invisible from the second window 106.

In this way the security of the device can be greatly improved and combined when providing sufficient mechanical support for the module. The support section covers the indication that is not relevant at the particular moment, and the rotation of the rotary actuator is utilized in providing the indication.

Figure 8 also shows a quenching chamber 140 of the housing, which houses one or more quenching plates for quenching an arc that fires when the movable contact is separated from the stationary contact 112. In the quenching chamber, the quenching plate 142 that lies closest to the stationary contact 112 touches the stationary contact. This has the important advantage that when the contacts are separated, the current is moved from the contact surface of the stationary contact to the point where the quenching plate touches the stationary contact. This saves the contact surface of the stationary contact 112 from the arc burning the contact.

In an embodiment, the quenching plate 142 and the other quenching plates are straight such that their both surfaces are direct plane surfaces. In another embodiment, the quenching plate(s), especially the first quenching plate 142 has a tilted portion 142A at the back of the plate. The tilted rear portion 142 is thus divergent from the general plane level of the plate. The first quenching plate 142 is mounted in such a way to the housing 102 that its protrusion 142A pointing towards the stationary contact 112 is in contact with the stationary contact.

The quenching plate 142 comprises a front portion located close to the contact area of the movable contact 130 and the stationary contact 112, and a rear portion that resides at a distance from the contact area, and the contact between the quenching plate 142 and the stationary contact is arranged at the rear portion of the

quenching plate 142. The contact area between the two can be as small as possible to ensure catching the arc at the rear portion of the plate. The principal plane of the quenching plate and the stationary contact may be mutually slightly divergent such as to ensure that the contact area is small. In this way, the burning arc is quickly moved away from the contact area. As Figure 8 shows, this area where the rear portion 142A is the extreme point of the quenching plate 142 when seen from the contact area.

It can be seen that the stationary contact 112 comprises a contact portion to be contacted by the movable contact 130, and a connection portion to be contacted by a conductor, wherein the contact portion is divergent from the connection portion. The contact between the quenching plate 142 and the stationary contact 112 is arranged at the contact portion close to the area where the contact portion turns to the connection portion. In this way, the quenching plates can keep their position such that their plane surface points substantially towards the rotation axis of the rotary actuator, whereby the quenching plates are always perpendicularly to the movable contact 130 when it moves away from the stationary contact 112.Figure 9 shows the tilting of the quenching plate 142A from another viewing angle. The tilting may extend substantially the whole width of the stationary contact and the quenching plate.

Figure 9 highlights also mounting of the stationary contact to the module housing. The shown embodiment is especially advantageous, since the housing is capable of receiving stationary contacts of different thicknesses. The manufacturing of a mould for the module housing is very expensive and it is therefore advantageous that the same housing module could be used for switches having different nominal currents.

The embodiment achieves this by having a projection 109 at an aperture of the housing where the stationary contact 112 is to be mounted. Figure 9 shows a thick stationary contact where the stationary contact comprises a recess 118 for receiving the projection 109. When the stationary contact is mounted to the housing, the projection 109 in the housing fills the recess 118 in the stationary contact.

If assumed that the switch to be equipped would have a smaller nominal current, the stationary contact could be made thinner. In such as case, the stationary

contact has no such recess 118 as the shown stationary contact. The stationary contact would then lie on the projection 109.

The housing may comprise another projection, which fills the recess 117 in the stationary contact. This joint prevents the stationary contact from moving in longitudinal direction of the stationary contact, that is, to the left and right in the shown embodiment. Such a recess 117 may be provided both in the thick and thin stationary contacts.

Figure 10 further highlights the structure of the quenching plates and the co-operation between the quenching plates and the movable contacts. In Figure 10, the shown quenching plate is the furthermost quenching plate from the stationary contact, but the quenching plate closest to the stationary contact may be assumed to be a similar plate. The plate may otherwise be planar, but it comprises a bent portion 142A, which points towards the stationary contact such that the quenching plate closest to the stationary contact touches the stationary contact when mounted to the switch. The quenching plate 142 may further comprise one or more projections 142B, 142C, which project towards the movable contacts. It may be arranged such that each contact blade assembly fits between a pair of projections whereby the projections are between the contact blade assemblies when the movable contact moves. The projections and the base there between form substantially a form a letter U. The projections provide an important advantage in that the arc is immediate caught away from burning with the movable contact. The quenching plate shown in Figure 10 has thus the advantage that is efficiently protects the stationary contact by catching the arc to the projection 142A, and it protects the movable contact by catching the other end of the arc to the projections 142B or 142C.

Figure 11 shows an embodiment of a module housing half 102. The housing comprises various projections and recesses for connecting to matching elements in the other housing half, thereby ensuring a mechanical strength of a module when the housing halves are mounted together. In the case of alternating current where the current changes often its direction, especially at high short circuit currents, the forces that shake and attempt to separate the modules/poles are very strong. It is thus important to have elements that provide the mechanical strength evenly distributed over the area of the housing.

In the situation of Figure 11, this has been achieved by providing a support element, such as a receptacle 108 at top of the housing above the recess for the actuator. In the shown embodiment, this support element is advantageously utilized by providing two windows 104, 106 on both sides of the support element 108. These windows are co-operatively coupled to the operation of the rotary actuator. The rotary actuator has printed, carved, or indicated some other way on its surface the open and closed positions of the switch. The indications are visible from either of the windows 104, 106 to the user of the device. This provides a great security advantage as a user can immediately ensure whether the switch is in a connected state or not. Direct indication of the rotation position of the roll is advantageous compared to the indication of the rotation position of the rotation mechanism, as the mechanism may give a faulty indication if some internal switch mechanism element is broken. By way of an example, if the rotary mechanism of a switch breaks, a rotary actuator may not rotate even if the rotation mechanism is rotated. It may then occur that the switch is closed even if the rotation mechanism indicates that the switch would be open. The shown solution avoids this disadvantage as the actual rotation position of the rotary actuator can always be verified.

Figure 11 also highlights the implementation of the apertures in the housing that receive the stationary contacts. There is a first aperture 103 at one end of the module, and a second aperture 105 at the opposite end of the substantially rectangular housing. The apertures are preferably at the same heights in the module. The dimensions of the apertures may, however be slightly different from each other. The opening for housing the actuator may be placed substantially in the middle of the module in the left-right direction in Figure 11. As the movable contact and the quenching chamber require some space, there is less space for the stationary contact on the right. The second stationary contact may be shorter than the first stationary contact and some space may also be saved in that the aperture 105 receiving the second stationary contact is shorter than the aperture 103 receiving the first stationary contact.

The aperture comprises a first projection 109 which allows mounting of stationary contacts of two different thicknesses to the aperture. Despite the different thicknesses, the stationary contacts have the same width. The width of the stationary

contacts is substantially double the width of the aperture 103 shown as half of the stationary contact sets into the aperture 103 and the other half to the other module housing to be assembled to the shown housing.

It can be seen that the projection is placed, in the embodiment of Figure 11, parallel to the longitudinal direction of the stationary contact. The projection is arranged such that it extends from the bottom wall of the aperture. Preferably, the projection residing at the edge of the aperture fills only a small part of the width of the bottom wall. The height of the projection corresponds to the thickness difference of the two stationary contacts.

In a thicker stationary contact, there is a recess corresponding to and receiving the projection 109, whereby the rest of the stationary contact sets against the bottom surface of the recess 103. The thinner stationary has no such recess, whereby the bottom of the thinner stationary contact sets against the top surface of the projection 109.

Both the thin and thick stationary contacts may comprise a vertical recess for receiving the projection 107. The vertical and horizontal projections 107, 109 form substantially a letter T. They may extend equally long away from the side wall surface of the aperture.

Figure 12 shows another view of the already discussed features. It can be seen that the middle of the aperture receiving the actuator lies lower than the apertures 103, 105 of the housing receiving the stationary contacts. This provides an important advantage in that the current path becomes a letter V at the position where the movable contact is to contact the stationary contact thereby alleviating the making of the connection.

There is also another important advantage obtained. In a switch having a high nominal current, there may be a need to connect the stationary contact outside the switch module to one or more additional current conducting rails, which may have thicknesses equal to the thickness of the stationary contact. The holes provided in the stationary contact shown in Figures 6 and 7 may be used for that purpose. Even in such a situation it should be ensured that the current conductors lie at a predetermined distance from the bottom of the housing in the viewing angle of Figure 12. Due to this, the positioning of the apertures higher than the middle line of the

housing module provides an important additional advantage that there is enough space available below the stationary contacts. This can be seen from Figure 13, where the stationary contacts 110, 112 exit the housing such that the top level of the stationary contact is substantially at the same level as the top edge of the rotary actuator 120.

Figure 12 shows how the first projection 109 extends from the bottom surface 103A and a side surface of the aperture. The term bottom refers to the surface of the aperture that is lowest in the usage position of the switch as shown in Figure 12. Alternatively, the projection could extend from the top surface of the aperture downwards.

Figure 12 shows also the top surface 109A of the first projection. The lower surface of the thinner stationary contact sets against the top surface of the projection. Also the bottom side of a recess of the thicker stationary contact sets against the top side of the projection 109A.

Figure 13 shows a situation, where a thinner stationary contact for a smaller nominal current, such as 3150 A, is introduced into the switch module having a principal nominal current of 4000 A. It can be seen that the lower surface 110C of the stationary contact 110 lies over the horizontal projection 109 in the aperture 103.

It is especially advantageous to arrange the horizontal projections 109 such that they are on the side of the aperture 103 that is closer to the middle line of the switch housing. In Figure 13, this side is the bottom side of the aperture. In this way, the stationary contact may be arranged as high as possible in the situation of Figure 13.

In Figure 13, the projection resides only at the edges of the aperture, whereby there is an open space under the thinner stationary contact 110, 112 between the shown projection 109 and a corresponding aperture in the housing module that is to be mounted to the shown module. This aperture has an advantage that it provides additional cooling for the thinner stationary contact.

Figure 13 shows that there are recesses in both windows 104 106 for receiving a transparent window element therein. The window element may be a plastic or glass window element. Preferably, the mounting of the window element is arranged such that one window element can cover both windows. The housing may

comprise a groove, which houses the window element between the windows 104, 106 such that the window element is not visible to the outside as shown in Figures 17 and 18. This solution provides the advantage that mounting of the window element is simple as there is need only for one window element. Furthermore, the mounting of the window element is mechanically very strong, as the window element is mechanically supported at the middle of the window.

Figures 14 and 15 highlight another embodiment for mounting of the stationary contacts to the housing. Figure 14 shows a housing 202, which comprises an aperture 203 for receiving a stationary contact. To the aperture, there is formed a first projection 209, which projects from the bottom of the aperture. Similarly as in the previously shown embodiments, such as Figure 13, the projection is formed integrally and non-detachably to the housing. Preferably, the projection is formed to the housing by injection moulding as in the embodiment of Figure 12. Instead of a single projection 209 as shown in Figure 14, the housing may also comprise two or more projections, such as studs, having spaces between the projections.

The projection 209 is formed within the interior of the aperture. The interior of the aperture refers here to the space at the aperture which is between the inner and outer walls of the housing. Similarly, a recess of the stationary contact that receives the projection is provided such that the recess resides within the interior of the aperture when the stationary contact is mounted to the housing.

The embodiment of Figure 14 differs from the embodiment of Figure 13 in that the projection extends transversely to the longitudinal direction of the stationary contact when mounted to the aperture. The projection extends thus along the width of the stationary contact. This has the effect that even in the case of a thinner stationary contact, the housing stays closed and there remains no void space under the thinner stationary contact when mounted to the aperture.

Figure 14 shows also a second projection 207 which may be provided for locking the stationary contact in longitudinal direction to the housing. The locking member 207 is arranged transversely/perpendicularly to the first projection 209.

Figure 15 highlights two different stationary contacts 210, 310. The thinner stationary contact is 15 mm thick, and the thicker stationary contact 310 is 20 mm

thick. In the shown embodiment, both of the stationary contacts have a second recess 217, 317 for receiving the locking member 207 of the housing.

The thicker stationary contact 310 has an additional first recess 318 for receiving the first projection 209 of the housing.

Thus, both stationary contacts of Figure 15 can be mounted to the housing 202 of Figure 14. The thinner stationary contact 210 sets against and above the first projection 209, whereas the first recess 318 of the thicker stationary contact 310 sets against the projection 209. The rest of the thicker stationary contact 310 thus sets against the bottom surface 203A of the recess 203.

Figure 16 shows the two different stationary contacts from another viewing angle. It can be seen that the stationary contact 210 for a smaller nominal current has a recess 217 only for the locking member of the housing. The stationary contact 310 for the higher nominal current has a recess 317 for the locking member and a recess 318 for the compensating means, that is, for the first projection 209. The two recesses in the stationary contact 310 are on different sides of the contact.

It is noted that both stationary contacts have the same width, which in Figure 16 is the direction of the recess 318.

In a further embodiment, stationary contacts may be mounted to the switch housing by providing compensation means on the stationary contact instead of the housing. In this embodiment, the housing comprises an aperture, which is sized for receiving, by a substantially tight fitting, the thicker stationary contact of the two stationary contacts. The thinner stationary contact may comprise one or more projections, whose length corresponds to the thickness difference of the two stationary contacts, that is may be 5 mm, for instance.

In a further embodiment, the aperture comprises recesses, and both the stationary contacts comprise projections. The difference between the length of the projections correspond to the thickness difference of the stationary contacts.

Figures 17 and 18 highlight the implementation of the switch status indication. There are provided two windows 104, 106 at the outer surface of the housing. The actuator 120 projects out from the housing on the right hand side. When the rotary actuator 120 is turned clockwise, the movable contact rotates towards the

closed position, and turning the actuator switches the switch to the open position. The open position is shown in Figure 17, and the closed position in Figure 18.

The indications CLOSED/OPEN and provided on the actuator. The “open” indication is in the actuator closer to the first stationary contact 110, whereby this indication is shown in the first window 104. The “closed” indication is closer to the second stationary contact 112, whereby this indication is shown in the second window 106.

It will be obvious to a person skilled in the art that, as the technology advances, the inventive concept can be implemented in various ways. The invention and its embodiments are not limited to the examples described above but may vary within the scope of the claims.

CLAIMS

1. A contact arrangement of an electric switch, comprising a first stationary contact (110), a second stationary contact (112) and a movable contact (130) for making an electrical connection between the first (110) and second (112) stationary contacts, wherein the movable contact (130) is pivotally connected to the first stationary contact (110) by a pivotal connection for allowing the movable contact (130) to pivot with respect to the first stationary contact (110) about a pivoting axis (116, 135) such that in an open position of the switch, the movable contact (130) is disconnected from the second stationary contact (112), and in a closed position of the switch, the movable contact (130) is in contact with the second stationary contact (112), wherein the movable contact (130) and the first stationary contact (110) are arranged in a first angle with respect to each other in the open position of the switch, and in a second angle with respect to each other in the closed position of the switch, and the second angle is greater than the first angle, **characterized** in that the second angle is less than 180 degrees.

2. A contact arrangement of an electric switch according to claim 1, **characterized** in that the second angle is less than 170 degrees.

3. A contact arrangement of an electric switch according to any preceding claim, **characterized** in that the movable contact (130) and the first stationary contact (112) form, in the closed position of the switch a current path having a form substantially of letter V.

4. A contact arrangement of an electric switch according to any preceding claim, **characterized** in that the movable contact (130) is substantially parallel with the second stationary contact (112) when the switch is in the closed position.

5. A contact arrangement of an electric switch according to any preceding claim, **characterized** in that the contact arrangement comprises a rotary actuator (120) for moving the movable contact (130) about a rotation axis of the

rotary actuator, and the pivoting axis of the pivotal connection between the first stationary contact (110) and the movable contact (130) is arranged within a perimeter of the rotary actuator (120).

6. A contact arrangement of an electric switch according to any preceding claim, **characterized** in that the pivoting axis of the pivotal connection between the first stationary contact (110) and the movable contact (130) is parallel to the rotation axis of the rotary actuator (120).

7. A contact arrangement of an electric switch according to any preceding claim, **characterized** in that the contact arrangement comprises a module housing (102) having a substantially rectangular form, and the first stationary contact (110) and/or the second stationary contact (112) comprises a connection portion (110A) arranged substantially perpendicularly to a wall of the module housing (102), and a contact portion (110B) to contact with the movable contact (130), which contact portion (110B) is arranged to an angle with respect to the connection portion (110A).

8. A contact arrangement of an electric switch according to any preceding claim, **characterized** in that the connection portions (110A) of the first (110) and second (112) stationary contacts exit the module housing (102) from opposite ends of the housing.

9. A contact arrangement of an electric switch according to any preceding claim, **characterized** in that the connection portions (110A) of both stationary contacts (110, 102) are arranged at the same plane to each other, and the rotation axis of the rotary actuator (120) is arranged away from the plane of the connection portions of the stationary contacts (110, 112).

10. A contact arrangement of an electric switch according to any preceding claim, **characterized** in that the first stationary contact (110) comprises one or more projections (114A, 114B, 114C), each projection comprising a through hole (116) for receiving a pivoting pin (135) for pivotal mounting of the

movable contact (130) to the stationary contact (110).

11. A contact arrangement of an electric switch according to any preceding claim, **characterized** in that the movable contact (130) comprises a hole (131B, 132B, 133B) for receiving a pivoting pin (135) for pivotal mounting of the movable contact (130) to the first stationary contact (110).

12. A contact arrangement of an electric switch according to any preceding claim, **characterized** in that the rotary actuator (120) comprises on its surface a first indication (123) indicating an open position of the switch, and a second indication (125) indicating a closed position of the switch, and the module housing (102) comprises a first window (104) showing the first indication and a second window (106) showing the second indication in respective rotary positions of the rotary actuator (130).

13. A rotary actuator for an electric switch, **characterized** in that the rotary actuator (130) comprises a first aperture (122) for housing a stationary contact (110), the first aperture (122) comprising a top wall (126) and a bottom wall (128), which limit the rotation of the rotary actuator (120) with respect to the stationary contact (110), the rotary actuator (120) comprising a second aperture (127A, 127B, 127C) for housing a movable contact (130), the second aperture (125A, 125B, 125C) having a top wall and a bottom wall which substantially prevent the movement of the movable contact (130) with respect to the rotary actuator (120) such that the movable contact (130) follows the rotation of the rotary actuator (120), and the first aperture (122) and the second aperture (127A, 127B, 127C) are arranged in the rotary actuator (120) such that there is an angle between the movable contact (130) and the stationary contact (110) is in all rotary positions of the rotary actuator (120).

14. A method of mounting a rotary assembly of an electric switch, **characterized by**

mounting a movable contact (130) to a stationary contact (110) by a pivotal connection such that the movable contact (130) can be pivoted with respect

to the stationary contact (110),

pushing the movable contact (130) to a first aperture (122) of a rotary actuator (120); and

pushing the movable contact (130) further such that the movable contact (130) comes out from a second aperture (125A, 125B, 125C) of the rotary actuator (120) and the stationary contact (110) enters the rotary actuator (120) via the first aperture (122), wherein the first aperture (122) and the second aperture (125A, 125B, 125C) are arranged such that the stationary contact (110) and the movable contact (130) form an angle with respect to each other.

15. A method of rotating a rotary assembly of an electric switch, the method comprising the step of rotating a rotary actuator (120) of the electric switch, **characterized by** rotating the actuator (120) between an open and a closed position of the switch, in which open position a top wall (126) of an aperture (122) of the actuator is in contact with a top side of a stationary contact (110), and in the closed position of the switch a bottom wall (128) of the aperture (122) is in contact with a bottom side of the stationary contact (110), and a movable contact (130) arranged to a second aperture (127A, 127B, 127C) of the actuator (120) follows the rotation of the rotary actuator (120).

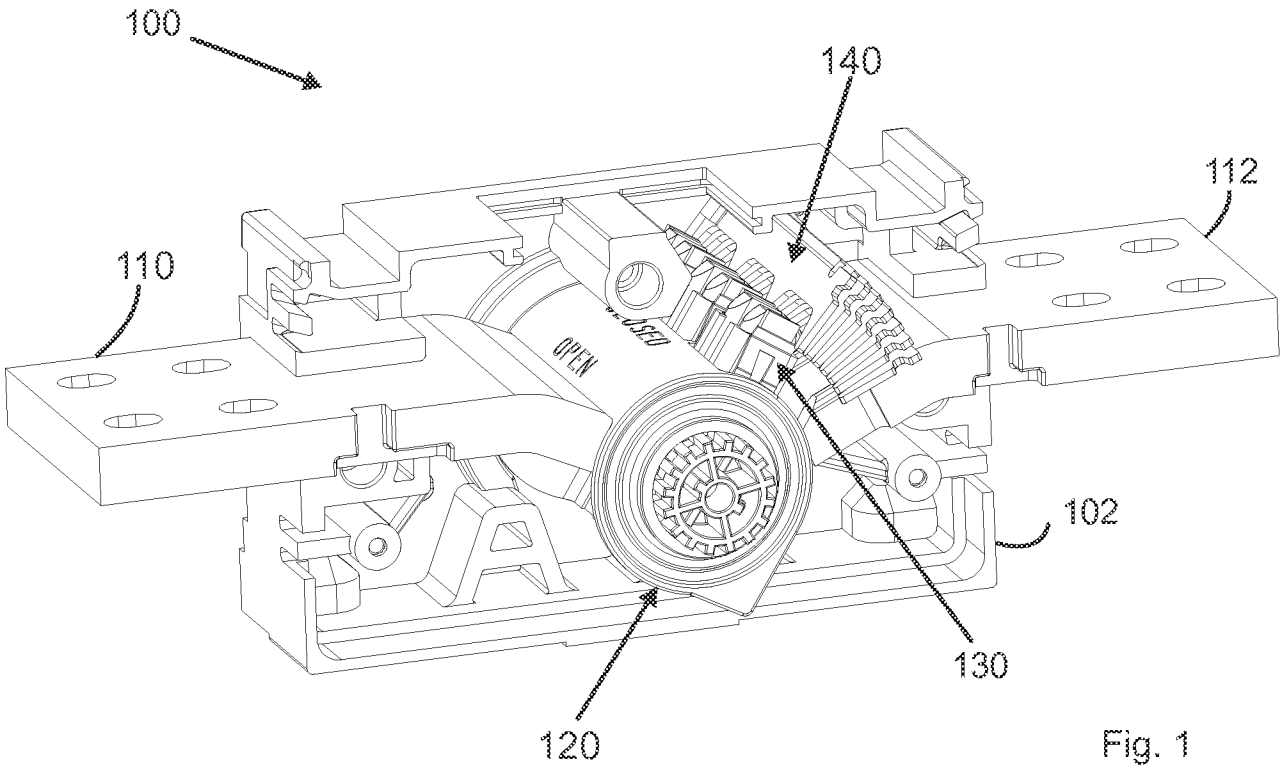
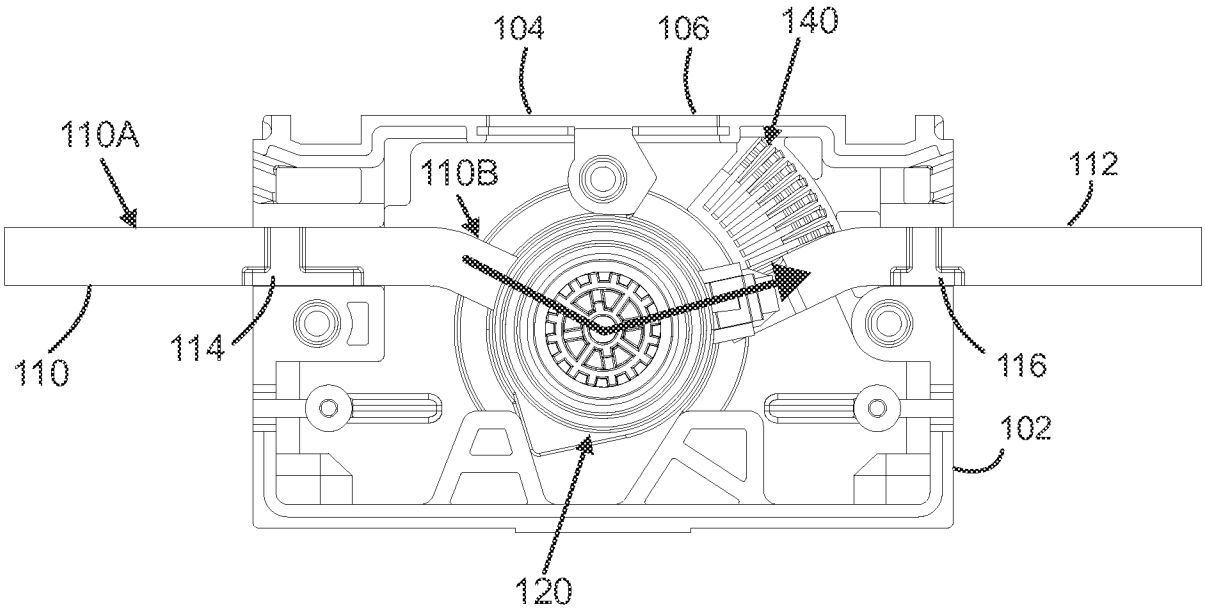

100
140
112
110
OPEN
102
130
120

Fig. 1


104
106
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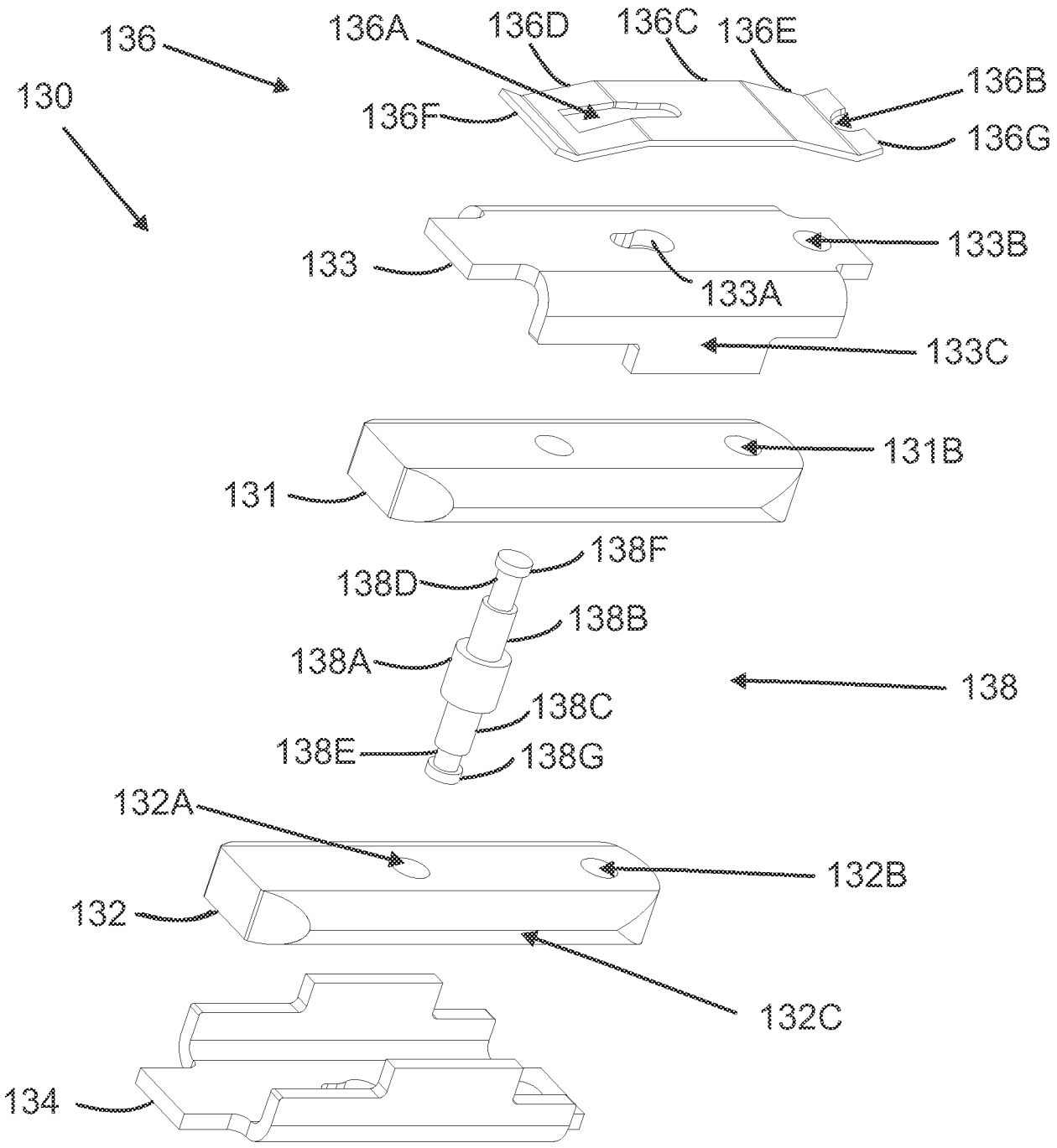
110A
110B
112
110
114
116
102
120

Fig. 2


136
136A
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136C
136E
136B
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136G
133
133B
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133C
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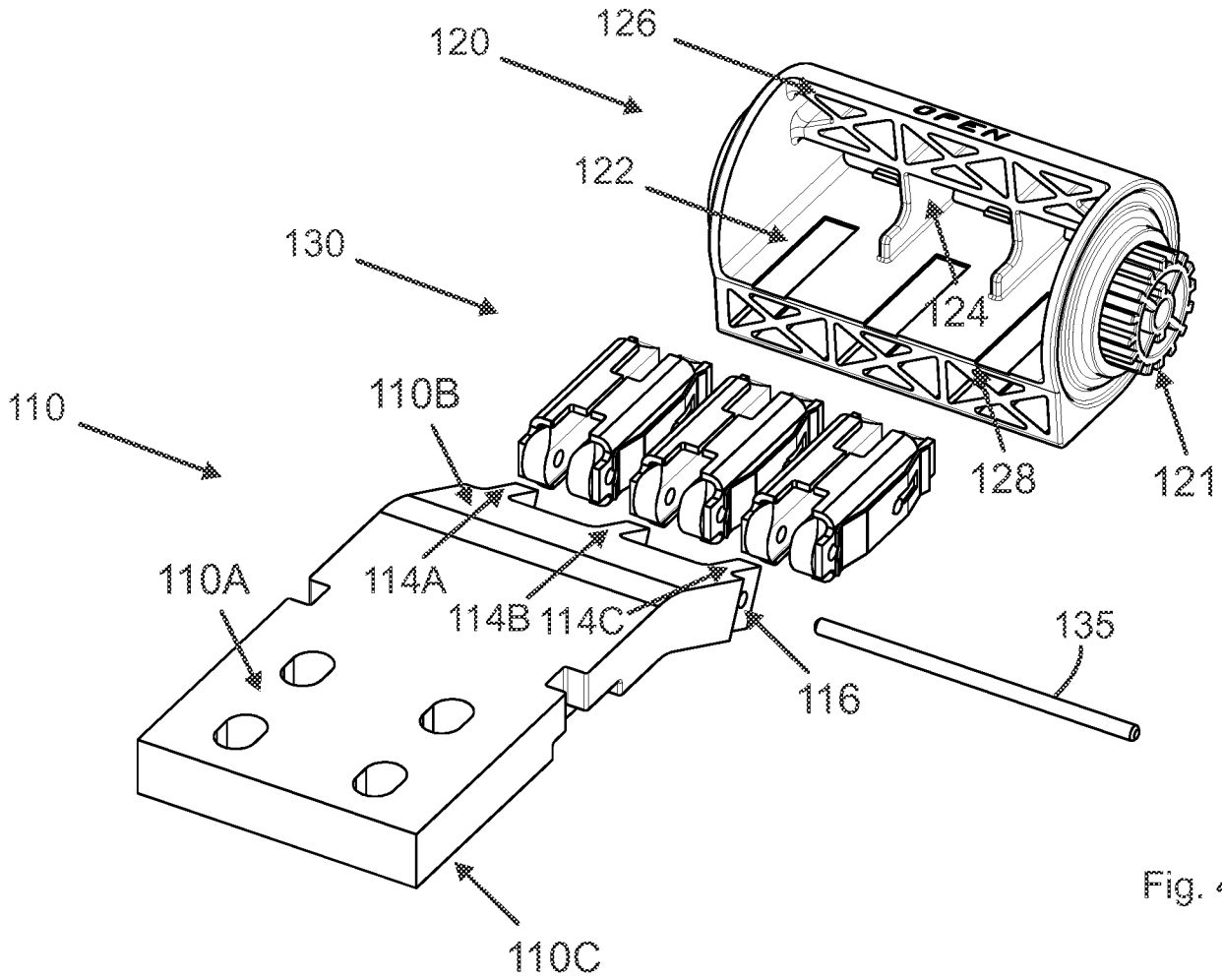
138G
132A
132B
132
132C
134

Fig. 3


120
126
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110
110B
124
128
121
110A
114A
114B
114C
116
135
110C
OPEN

Fig. 4

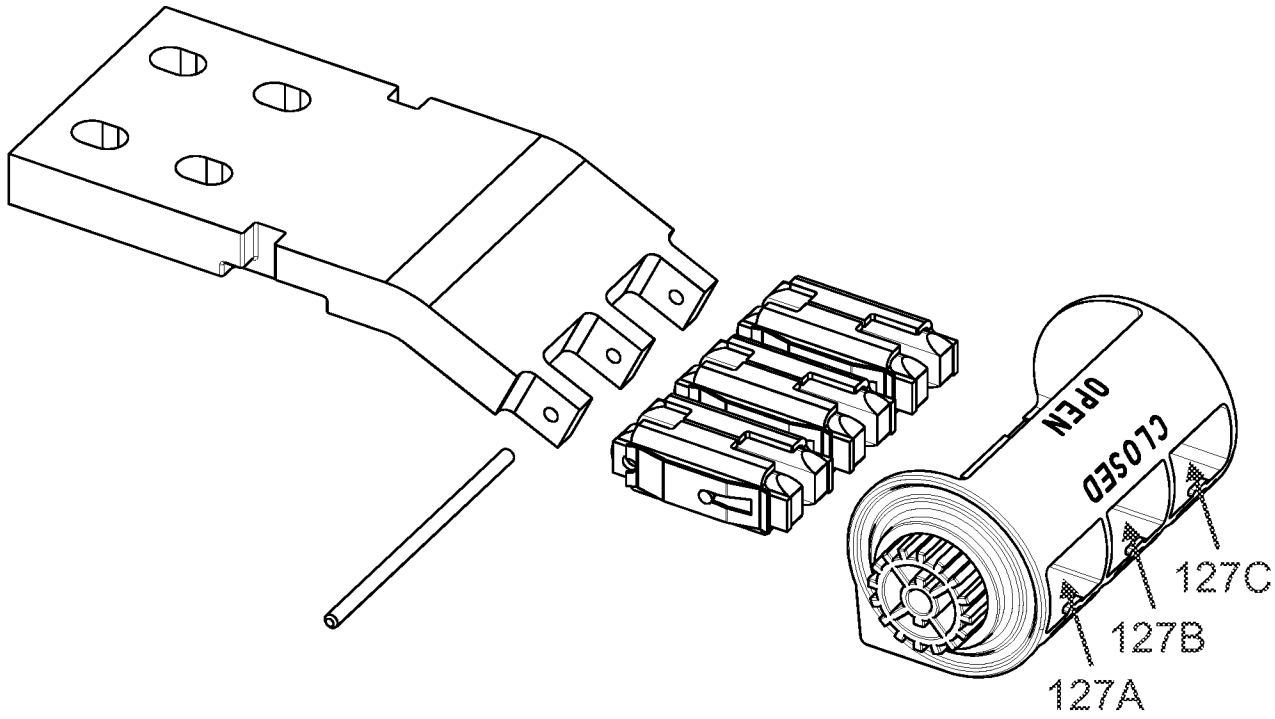
OPEN
CLOSED
127C
127B
127A

Fig. 5

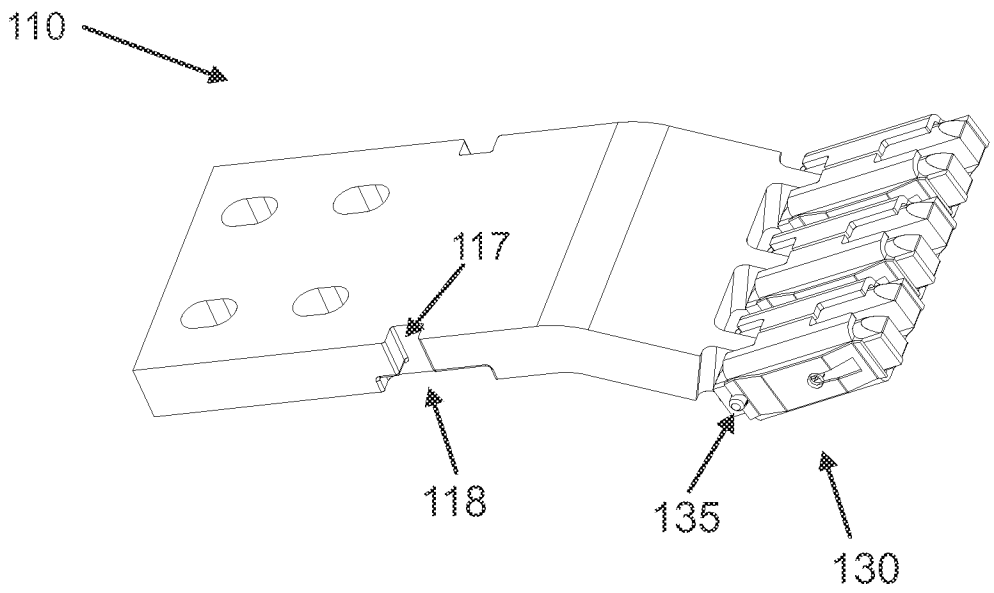

Fig. 6

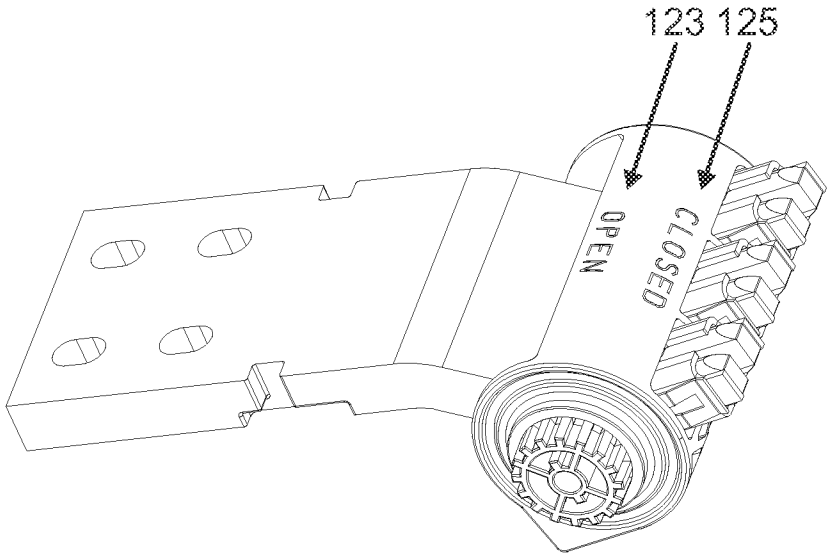

Fig. 7

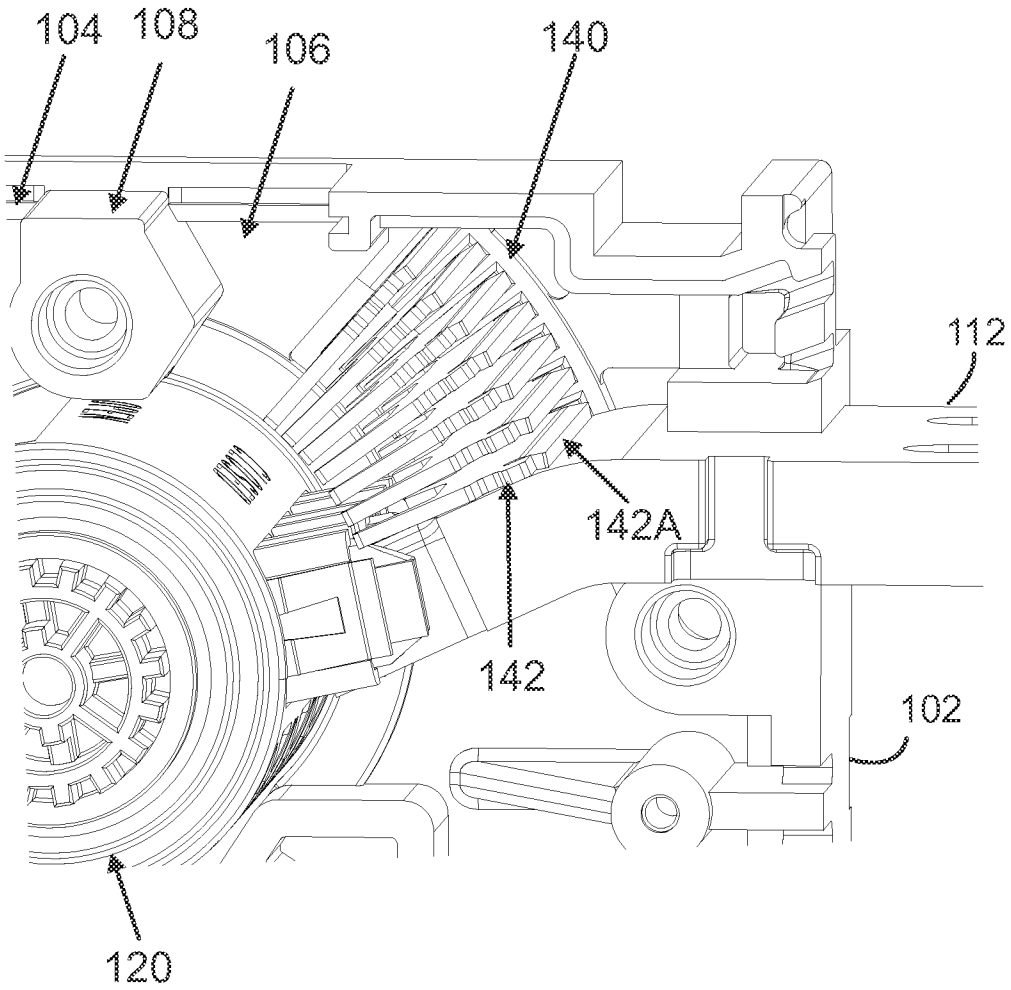

Fig. 8

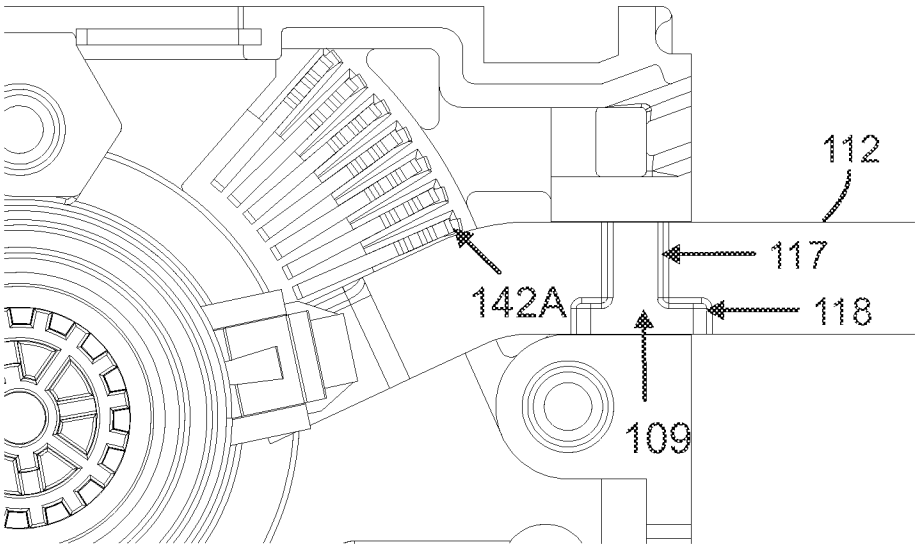

Fig. 9

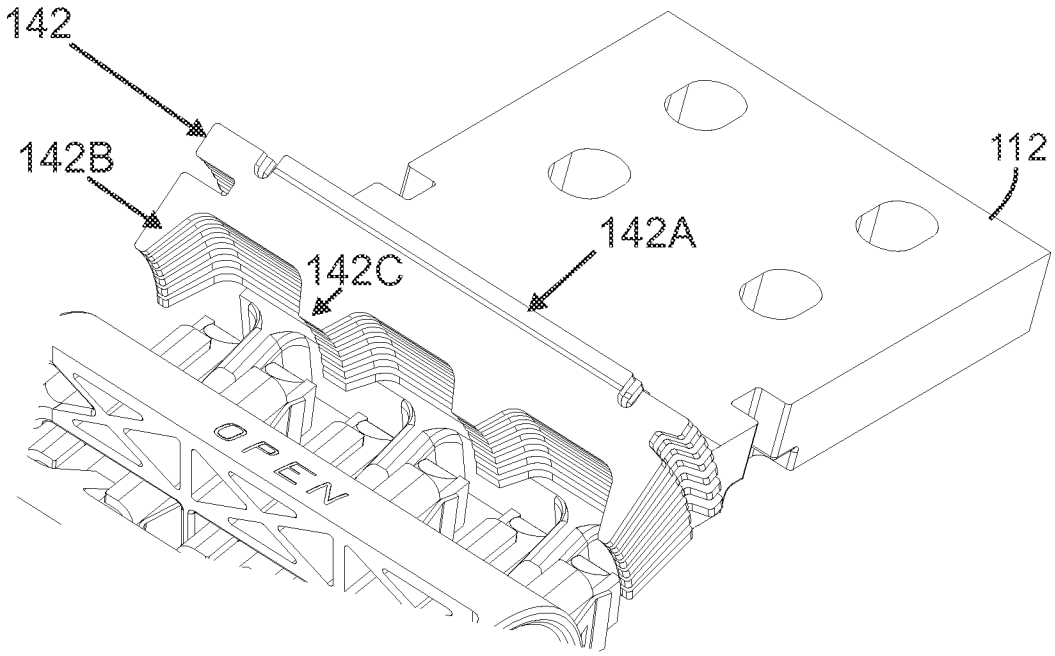

Fig. 10

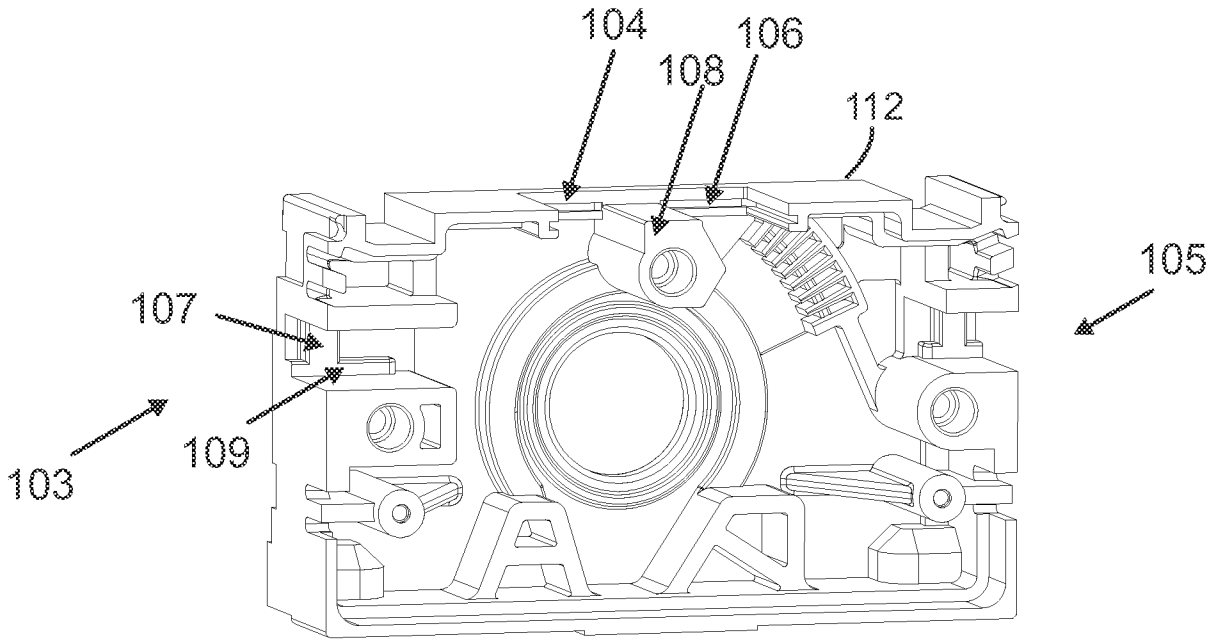

Fig. 11

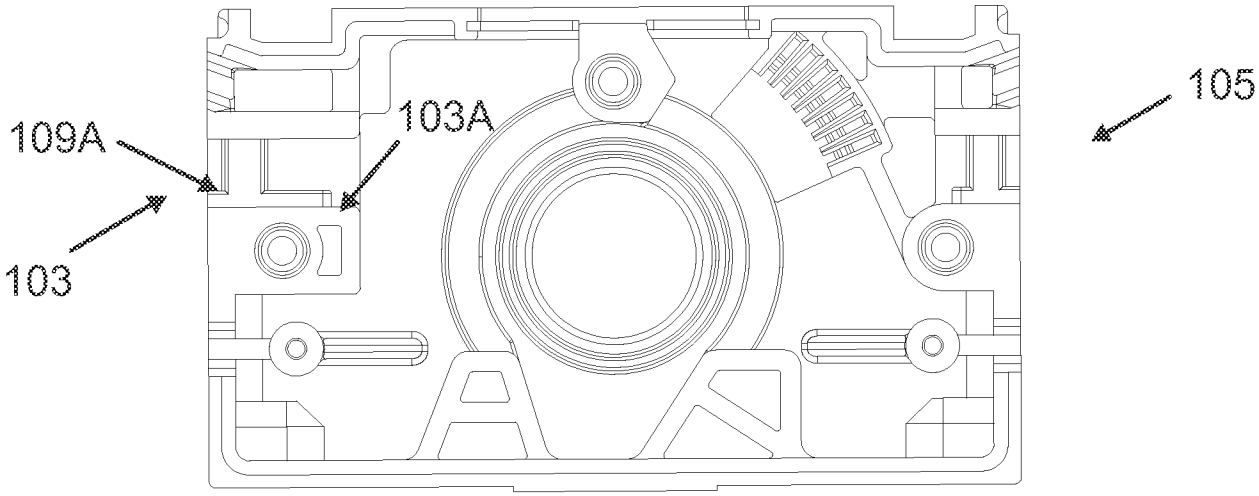

Fig. 12

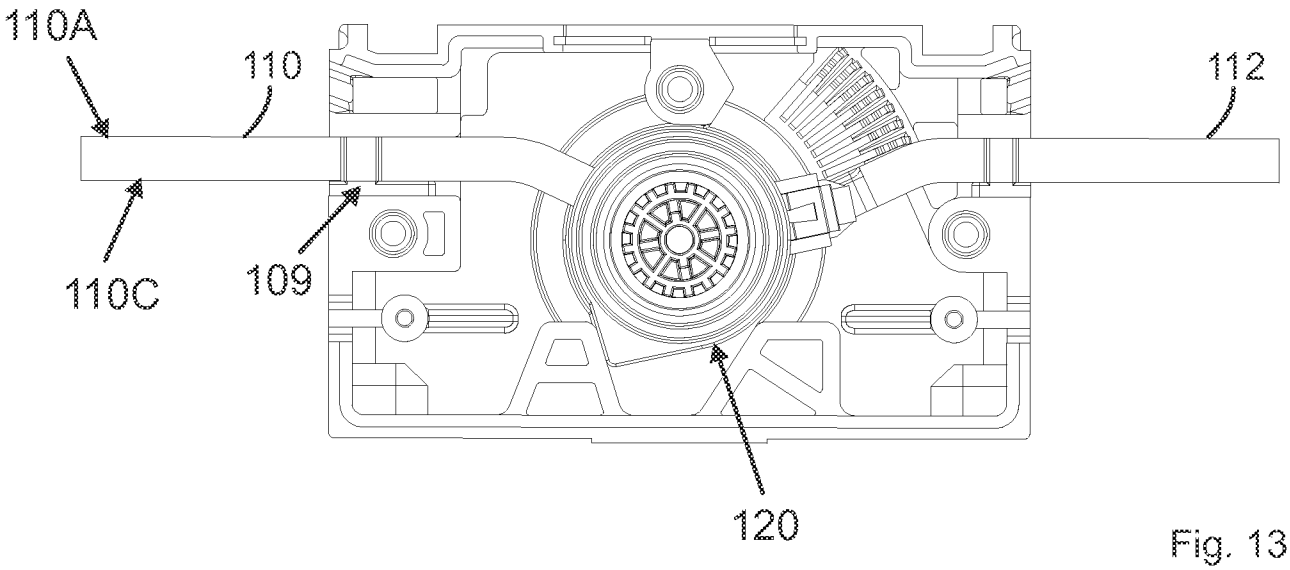

Fig. 13

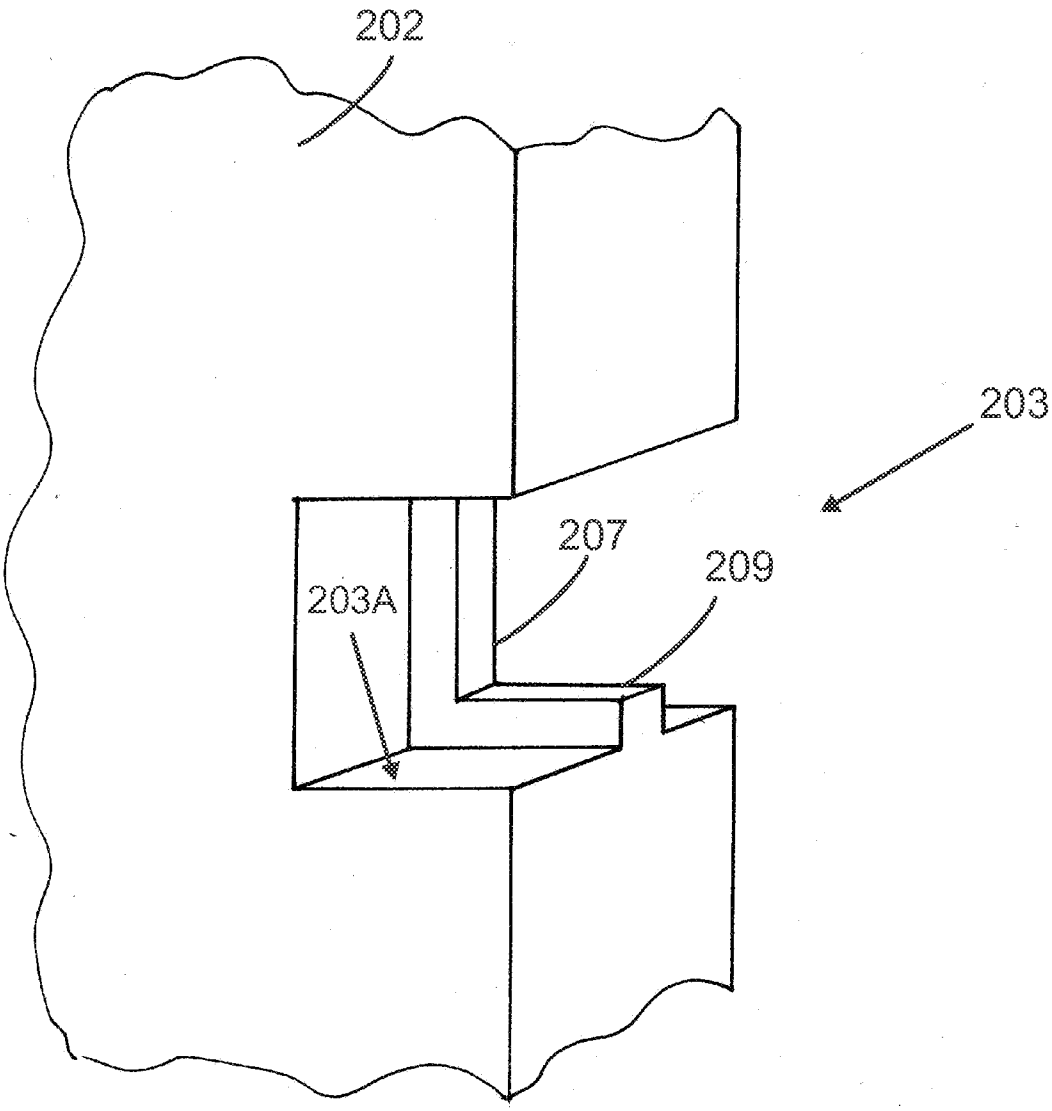

Fig. 14

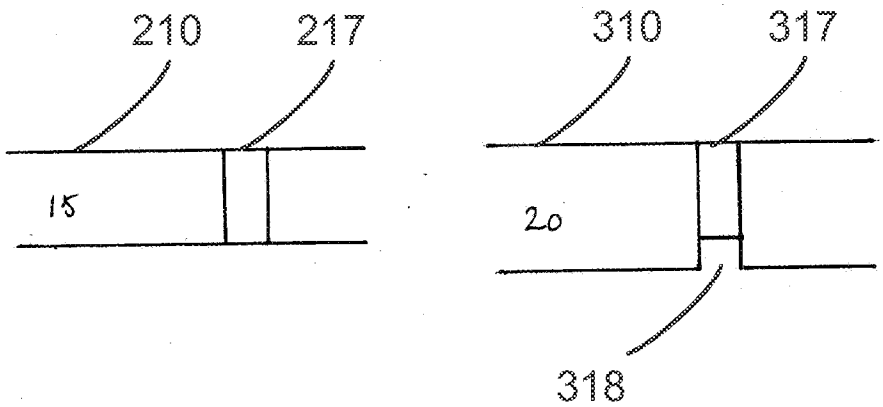

Fig. 15

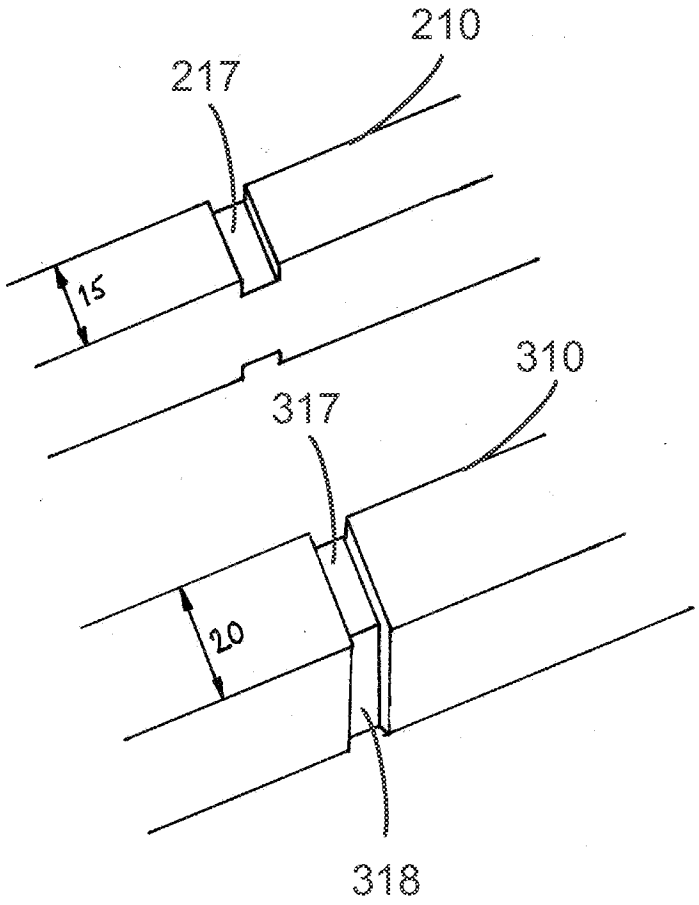

Fig. 16

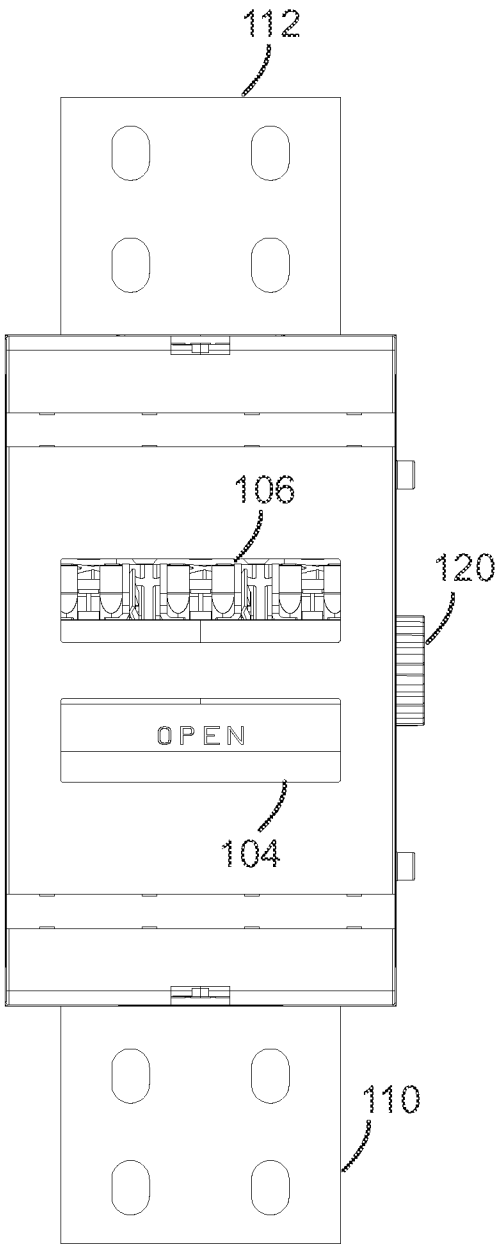

Fig. 17

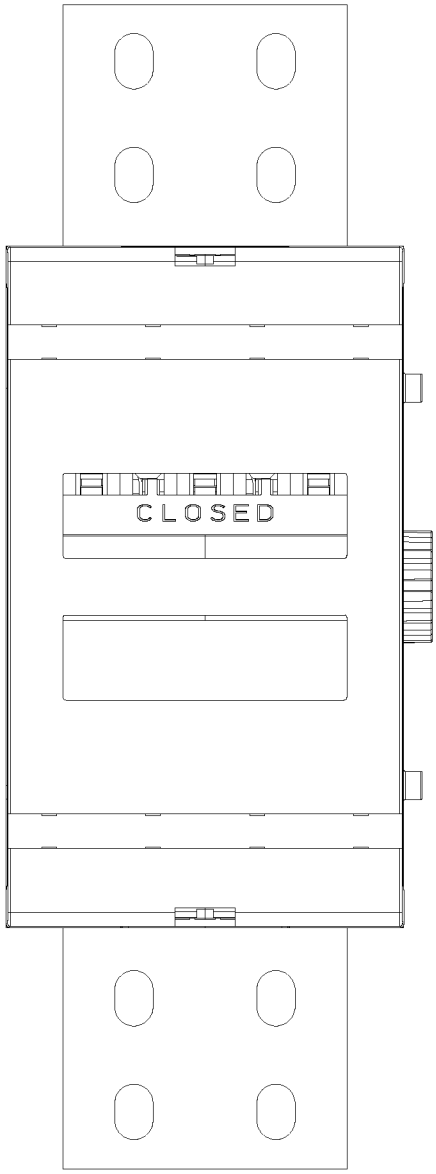

Fig. 18

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI2013/050575

A. CLASSIFICATION OF SUBJECT MATTER

See extra sheet

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)

IPC: H01H

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

FI, SE, NO, DK

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

EPO-Internal, WPI, COMPDX, EMBASE, INSPEC, TDB, NPL, XP3GPP, XPAIP, XPESP, XPESP2, XPETSI, XPI3E, XPIEE, XPIETF, XPIOP, XPMISC, XPOAC, XPRD

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4926016 A (LEONE DAVID A [US] et al.) 15 May 1990 (15.05.1990)	1 - 4, 7, 8, 10, 11, 13 - 15
Y	abstract, claims, and figures	5, 6, 9, 12
X	US 5184099 A (DIMARCO BERNARD [US] et al.) 02 February 1993 (02.02.1993)	1 - 4, 7, 8, 10, 11, 13 - 15
Y	abstract, claims, and figures	5, 6, 9, 12
X	EP 1912239 A1 (ABB SPA [IT]) 16 April 2008 (16.04.2008)	1 - 4, 7, 8, 10, 11, 13 - 15
Y	abstract, paragraph 0022, claims, and figures	5, 6, 9, 12

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

* Special categories of cited documents:
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"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"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
"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
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
06 September 2013 (06.09.2013)	10 September 2013 (10.09.2013)

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/FI2013/050575

Patent document cited in search report	Publication date	Patent family members(s)	Publication date
US 4926016 A	15/05/1990	CA 1330817 C	19/07/1994
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EP 1912239 A1	16/04/2008	CN 101162667 A	16/04/2008
		CN 101162667 B	28/11/2012
		EP 1912239 B1	08/08/2012
		ES 2392191 T3	05/12/2012
		IT BG20060054 A1	14/04/2008
		US 2008087536 A1	17/04/2008
		US 8110762 B2	07/02/2012

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI2013/050575

CLASSIFICATION OF SUBJECT MATTER

Int.Cl.
H01H 21/00 (2006.01)
H01H 1/22 (2006.01)
H01H 11/00 (2006.01)