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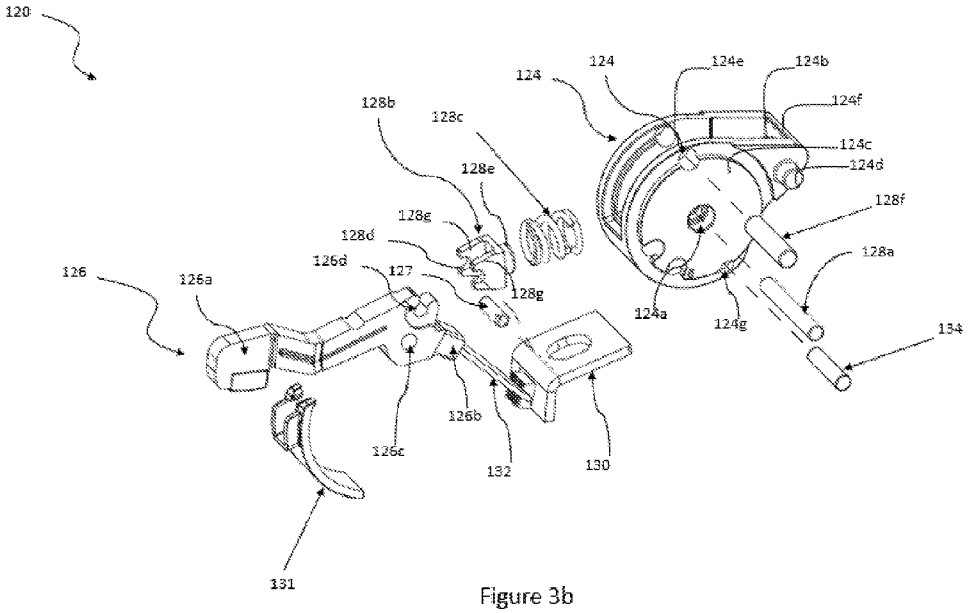

Figure 3b

(57) **Abstract:** Described herein is a rotary contact unit [120] for a moulded case circuit breaker (MCCB) [100], wherein the rotary contact unit [120] comprises a rotary member [124], an elongated rotating arm member [126] pivotally mounted on the rotary member [124], and a toggling mechanism [128]. Notably, the toggling mechanism [128] includes: a spring member [128c]; a support member [128b] defining a base portion [128e] positioned on the spring member [128c], and a pair of flanged portions [128g] extending therefrom, each of the pair of flanged portions [128g] defining a semi-circular attachment portion [128d]; and a pin member [127] passing through the semi-circular attachment portion [128d] of the pair of flanged portions [128g] of the support member [128b] and the spring connection portion [126d] of the elongated rotating arm member [126], for enabling toggling of the pin member [127] between the contact position and the non-contact position.

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A ROTARY CONTACT UNIT FOR A MOULDED CASE CIRCUIT BREAKER (MCCB)

FIELD OF THE INVENTION

The present disclosure relates to low voltage circuit breakers employed to protect electrical networks/circuits from over-load or short-circuit conditions, more particularly, the present disclosure employed to a rotary contact unit deployed in a pole assembly of the moulded case circuit breaker (MCCB).

BACKGROUND OF THE INVENTION

This section is intended to provide information relating to the field of the invention and thus, any approach or functionality described below should not be assumed to be qualified as prior art merely by its inclusion in this section.

Circuit Breakers are electro-mechanical switching devices capable of making, carrying and breaking currents and are also known as over current protective devices. Under normal circuit conditions, a circuit breaker closes the electrical circuit, carries current for a specified time and breaks the electrical circuit under specified abnormal circuit conditions. These over-current protective devices are also employed for current interruption. Accordingly, it is said that circuit breaker is an equipment which can open or close the circuit, under all conditions viz. no load, full load and fault conditions. Low voltage circuit breakers are commonly known to be deployed for low voltage applications, for example 1000 Volt or lower.

Various examples of low voltage circuit breakers are known, for example, a Miniature Circuit Breaker (MCB), a Moulded Case Circuit Breaker (MCCB), a Residual Current Circuit Breaker (RCCB), an Air Circuit Breaker (ACB), and the like. Notably, the MCB is used in applications of current rating under 125 Amperes and interrupting current rating of under 10KA, while MCCB is used in applications of current rating upto 1600 Amperes usually and interrupting current in a range of

10kA -150kA. Accordingly, it is submitted that MCCB is used for relatively high current rating applications.

Moulded case circuit breaker (MCCB) is commonly a multipolar circuit breaker, which protects the electrical network/circuit and equipment from overloading or short-circuiting. Specifically, the MCCB is capable of operating between an ON position, an OFF position, and a TRIP position. Conventionally, the MCCB includes at least a base assembly, a mid-cover assembly, a fascia plate assembly, at least one pole assembly, a trip assembly, and an actuator assembly. In one embodiment, the MCCB is a three-pole unit comprising of three (3) pole assemblies. In such embodiments, the base assembly, the mid-cover assembly, the fascia plate assembly, in combination with each other, forms a housing to house and support the three pole assemblies therein. Further, the actuator assembly is mounted on at least one of the three (3) pole assemblies, while the TRIP assembly is mounted on at least one of the three (3) pole assemblies, such that the three (3) pole assemblies are connected together and operated together between the ON position, the OFF position, and the TRIP position. Particularly, the actuator assembly includes a lever switch that can be manually adjusted, to adjust the three (3) pole assemblies together between the ON position, the OFF position, and the TRIP position.

In light of the aforementioned, it is understood that each pole assembly operates between the ON position, the OFF position, and the TRIP position. Conventionally, each of the three pole assemblies includes a cassette casing unit, a rotary contact unit, a stationary contact unit, and an arc chute unit. The cassette casing unit is a left-right type casing which includes defined sections for positioning of each of the rotary contact unit, a stationary contact unit, and an arc chute unit, such that the cassette casing unit houses and supports each of these components therein. The stationary contact unit is a conducting plate positioned within the cassette casing unit, and mostly electrically connected to a line side of the electric circuit. The rotary contact unit is a rotary assembly rotatably positioned within the cassette

casing unit, and mostly electrically connected to a load side of the electric circuit. The rotary contact unit can be rotated in one direction to allow the rotary contact unit to contact with the stationary contact, and thus resulting in the ON position of the pole assembly, further, the rotary contact unit can be rotated in opposite direction to allow the rotary contact unit to release contact from the stationary contact, and thus resulting in the OFF position of the pole assembly.

Moreover, the rotary contact unit is a combination of a rotary member, a rotating arm member, a metal conducting plate electrically connected to the rotating arm member, and a toggling mechanism. The rotating arm member is connected to the rotary member, by way of the toggling mechanism. Notably, the rotary member, the rotating arm member, and the toggling mechanism, are rotated together, to adjust the pole assembly between the ON position and the OFF position. The toggling mechanism toggles the rotating arm member, to rotate in one direction, with respect to the rotating member, to adjust the pole assembly between the ON position and the BLOW OPEN position. Furthermore, after adjustment of the pole assembly to the BLOW open position, the TRIP assembly actuates the actuator assembly which operates to adjust the three pole assemblies to the TRIP position. Therefore, the rotary contact unit plays a vital role in determining the accuracy, speed, and effectiveness of the adjustment of the pole assembly, between the ON position, the OFF position, the BLOW OPEN position, and the TRIP position. However, conventionally known rotary contact unit of pole assemblies deployed in MCCB suffer from the problems of low response time, high in cost, and bulky structure, which makes it less reliable during over-current and short-circuiting conditions.

The conventionally known rotary contact units of the MCCB employ torsion and extension springs arrangement. Such springs generally end up with higher hook stresses due to space constraint in compact rotary contact unit and thereby limiting reliability. The rotating arm joint in the conventionally known rotary contact units also suffer from increased transmission losses between the spring and the rotating

arm. The conventionally known rotary contact unit have high number of parts which increases assembly process time and decreases reliability. The conventionally known rotary contact unit are not optimised to avoid any chances of reclosing.

Publication No. US6259048 relates to a circuit breaker rotary contact assembly employs a common pivot between the rotor assembly and the rotary contact arm. A pair of off-center expansion springs directly engage the rotor at one end and engage the rotary contact arm via a linkage arrangement at an opposite end thereof. An elongated pin interconnects the operating mechanism with the center, first and second rotary contact arm assemblies. A pair of off-center expansion springs directly engage the rotor at one end and engage the rotary contact arm via a linkage arrangement at an opposite end thereof. The movable contact is positioned at one end of the contact arm and the pivot pin attaches the contact arm to the semi-rotor at the opposite end thereof. A contact braid is fixedly attached to the movable contact arm as indicated at one end, and to the load strap at the opposite end as indicated at. In a similar manner as described with respect to FIGS. 3-5, a link connects with the contact arm at one end by means of the pin and is positioned within the slot within the semi-rotor and is retained therein by means of the extended pin.

Publication No. US6262642 relates to a rotary contact arrangement for circuit breakers of the type including a pair of contact springs arranged on each side of a rotary contact arm, as the contact springs interconnect between the rotors and the contact arm via a pair of U-shaped levers. The provision of the U-shaped levers provides uniform contact pressure between both pairs of fixed and moveable contacts to prevent contact erosion.

Publication No. US6184761 relates to a circuit breaker rotary contact arrangement is disclosed in which the ends of the line and load straps supporting the fixed contacts are hook-shaped to control the angle of the repulsive force exhibited between the fixed contacts and the movable contacts arranged at the opposing ends of the rotary contact arm. The fixed contacts face outwardly away from the central

pivot of the contact arm such that a horizontal component of the popping force acts away from the center of rotation keeping the contact arm in tension for avoiding a buckling effect allowing contact arms with smaller cross-sectional area to be used to increase contact arm mobility and reduce the cost. The central pivot responds to the rotational movement of the rotor to affect the contact closing and opening function. The extended pin provides attachment of the rotor with the circuit breaker operating handle (not shown) to allow manual intervention for opening and closing the circuit breaker contacts.

Publication No. US9953789 relates to a single-pole breaking unit which includes a rotary contact bridge, a stationary contact operating with the contact bridge and connected to a current input, a rotary bar having radially extending axial end surfaces, and radial side surfaces with a transverse hole for the contact bridge which is salient through opposite radial side surfaces of the bar, an arc extinguishing chamber opening onto an opening volume for the contact bridge, two parallel side panels parallel to the axial end surfaces of the bar, with the rotary bar located between two sealing flanges between the axial end surfaces of the rotary bar and the side panels and movable axially toward the side panels to ensure tightness between the inside and the outside of the breaking unit, the sealing flanges each comprising a radially extending portion, and a cylindrical portion, both co-axial with the rotary bar, which cylindrical portion has an inside radius slightly less than the radial extent of the rotary bar, providing a space between the inside surface of the cylindrical portion and the rotary bar, the space permitting quenching gases to flow directly to push a sealing flange axially against a side panel to achieve tightness.

Publication No. US6310307 relates to a rotary contact arrangement for circuit breakers of the type including a pair of movable contacts, one arranged on each end of the rotary contact arm, utilizes a single pair of contact springs, one spring on each side of the rotary contact arm. The springs are aligned to intersect the axis of

rotation of the rotary contact arm for automatic uniform contact force adjustment throughout the operating life of the circuit breaker.

Publication No. EP2704172 relates to the rotor has rotor housing and a rotatably mounted contact bridge unit that with two movable contact portions. The movable contact portions are cooperated with fixed contact portions by rotation of main portion to open or close an electric circuit. The contact bridge unit is movably mounted in rotor housing in a direction perpendicular to direction of rotational axis in closed position.

Publication No. DE102008037967 relates to the system has a spring including a spring element i.e., compressed spring, and an end section at both ends of the spring. The spring is fixed to switching shaft segments in relation to rotational axis of the segments such that translational, radial spring balancing movement is enabled. The spring grips a molded inner contour of a recess in a spring-loaded condition such that contact arms are provided with slack point characteristic during rotational movement relative to the segments between two stable rotational latching positions (E1-E3). In this case, for additional radial fixation of the contact bridge, two guide pins are present on the contact bridge, which engage in a corresponding tangential groove in the switching shaft segment.

IN Publication No. 2591/MUM/2007 relates to a compact quad break mechanism for switching devices. The contact mechanism has a rotary contact which is coupled to a connecting link through a pivot. The connecting link is coupled to a knob through U -pin and to an operating lever which is lockably engaged to a locking lever. The operating lever is also connected to the knob through U-pin. The knob is moved to displace the connecting link to move the rotary contact to make and break electrical contacts at four locations to divide an arc into a series of arc of low intensities to quench the arc quickly. The mechanism is also used to obtain 2 normally closed and 2 normally open contacts simultaneously

Publication No. ES2267381 relates to the assembly has rotation shaft with holding groove surfaces for receiving slide pins on an outer circumferential surface of the shaft, such that motion of a movable contactor is delayed to return to fixed contactors. An elastic force is provided to the slide pins to accelerate a separation of the movable contactor from the fixed contactors at time of a current limiting operation.; Disclosed is a movable contactor assembly of a circuit breaker capable of enhancing a current limiting function by maintaining a contact state between a movable contactor and fixed contactors in a closed circuit state, by preventing the separated movable contactor from returning towards the fixed contactors at the time of a current limiting operation, by accelerating a separation operation of the movable contactor from the fixed contactors at the time of a current limiting operation, and by continuously maintaining a separated state of the movable contactor from the fixed contactors until a trip operation is performed by a trip mechanism.

IN Publication No. 609/MUM/2013 relates to a rotary contact arrangement for low voltage circuit breakers that comprises a contact shaft rotated to its own center by circuit breakers mechanism during normal ON, OFF and TRIP operation. The rotary contact arrangement further includes a moving contact, a first cylindrical pin, a fixed/ stationary cylindrical pin a second cylindrical pin, a connecting link, a pivotal pin and a contact spring. The rotary contact arrangement includes an arrangement of the contact spring and connecting links away from the center of rotation of the moving contact which helps to achieve higher contact pressure between moving contact button and fixed contact button with relatively less spring force. The rotary contact arrangement provides single break type flipping contact arrangement having least number of springs, a flexible conductor with a reduced effective length and drastically reduced effective width.

IN Publication No. 2439/CHENP/2012 relates to a single-pole breaking unit comprising: a rotary contact bridge, at least one stationary contact operating in conjunction with said contact bridge and connected to a current input conductor, a

rotary bar having an axis of rotation, radially extending end surfaces, and side surfaces extending longitudinally parallel to said axis, and having a transverse hole accommodating said contact bridge with clearance, which contact bridge is salient diametrically through opposite side surfaces of the bar, at least one arc extinguishing chamber opening onto an opening volume for the contact bridge, two side panels substantially parallel to one another and to the radially extending axial end surfaces of the bar, with the rotary bar located between said side panels, two sealing flanges, with the radially extending axial end surfaces of the rotary bar located between said two sealing flanges which are movable axially toward the side panels to provide a gas-tight seal between the flanges and side panels of the breaking unit, said sealing flanges each comprising a radially extending portion and a cylindrical portion which are co-axial with the rotary bar, and which cylindrical portion has an inside radius which is slightly more than the radial extent of the side surfaces of the rotary bar, thereby providing an interior space between the cylindrical portion of the flange and the side surfaces of the rotary bar, said space permitting quenching gases to flow directly to at least one sealing flange for pushing same axially against one of the side panels to achieve said tightness.

IN Publication No. 2471/CHENP/2012 relates to switchgear device having at least one single-pole breaking unit, said unit comprising a movable contact bridge, a pair of stationary contacts operating in conjunction with said movable contact bridge and respectively connected to a current input conductor, and two arc extinguishing chambers respectively opening onto an opening volume of the contact bridge, and comprising a stack of at least two deionizing fins separated from one another by a gas exchange space. Each extinguishing chamber is connected to at least one quenching gas exhaust channel, said exhaust channels opening onto a line-side panel of the case of the breaking unit, said line-side panel being positioned opposite another load-side panel designed to be placed in contact with trip means.

IN Publication No. 2104/MUM/2010 relates to a cam based contact mechanism of a low voltage molded circuit breaker to withstand/compensate the electrodynamic

forces generated and thereby maintaining contact stability. The mechanism comprising a housing means, an actuator means located inside housing means to perform ON-OFF-TRIP operations , biased cam arrangement for applying threshold value to withstand/compensate electrodynamic force generated thereby maintaining contact stability and an operating mechanism to provide energy to actuator means to achieve rotary motion of contact arms adapted to initiate ON and OFF operation.

Patent No. US6087913 relates to a rotary contact circuit breaker employs a crank to couple a switching mechanism to the rotary contact pole structure. The use of a crank allows for the mechanism and pole structure the individually optimized without effecting the performance of the other. In particular the crank allows for a mechanism that is able to achieve maximum torque delivery to the pole structure.

Patent No. US6326868 relates to a circuit breaker rotary contact arm is used within a plurality of single pole circuit breakers ganged together to form a single multi-pole circuit breaker. To provide uniform contact wear among the associated circuit breaker contacts, the rotor carrying the rotary contact arm pivot is slotted to automatically position the rotary contact arm to allow for changes in the contact geometry while maintaining constant contact compressive forces. The individual circuit breakers connect with the central operation mechanism by means of a single pin.

IN Publication No. 802/MUM/2010 relates to a contact locking mechanism for giving actuation to external mechanisms based on the contact position, at the same time have high repel open speed of moving contacts. The contact locking mechanism comprising drive shaft means, movable contact means, lock link means, plurality of spring means, plurality of pin means, and plurality of slot means. The movable contact means having a predetermined degree of freedom being pivoted by one of said pin means to said rotatable drive shaft means; one of said plurality of pin means travelling through said movable contact means such that said movable contact means being engaged with the said pin means in a manner to facilitate operative connection with said spring means at the ends of the pin means. The lock

link means being mounted on another pin means wherein said pin means being operatively disposed in said slot means such that predetermined lengths of said pin means project out of said slot means so as to engage with said spring means such that movement of said movable contact means co-operatively extends said spring means which correspondingly moves said lock link means whereby said movement of lock link means being guided by pin means disposed in the said slot means and being further guided by another set of slot means which allows and accommodate the movement of said lock link means such that during a fault condition movement of the movable contact means is restricted beyond a predetermined position by the said pin means disposed in the slots and the spring means extending to a predetermined deflected position whereby the movable contact means is brought back to its normal ON position by the said spring means when repulsion force on said movable contact means being not enough to move it beyond toggling position.

IN Publication No. 784/CHE/2010 relates to a rotary contact assembly for circuit breakers. The assembly comprising a contact shaft, at least one fixed contact, at least one moving contact, a cam profile, at least two extension springs, a copper braid, a plurality of fixed cylindrical pins and a plurality of moving cylindrical pins. The cam profile and the arrangement of at least two contact springs generate a contact pressure between at least one moving contact and at least one fixed contact to increase the contact opening velocity and to latch the moving contact in open position with minimum bouncing.

IN Publication No. 2640/CHENP/2007 relates to an automatic single- or multi-pole circuit breaker for use in low-voltage applications. The circuit breaker includes at least a first fixed contact that is coupled/uncoupled with a first moving contact. The latter is operatively connected to an operating mechanism that enables its displacement. The circuit breaker 1 according to the invention includes a kinematic tripping device driven by means of a first separating movement of the moving contact away from the fixed contact. The kinematic tripping device includes an operative member capable of tripping the operating mechanism, which in turn takes

effect on the moving contact, thus determining a second rapid separating movement until the circuit breaker tripped position is reached.

Publication No. US6924446 relates to a circuit breaker includes a housing and an operating mechanism having a cross bar supported by a first housing surface and moving in an arcuate path between open/tripped and closed positions, a pivotally mounted cradle including a latch, and pivotally mounted primary and secondary latches. The primary latch includes a pivot, an opening and a free end. The cradle latch rests within the opening when the contacts are not tripped open. The secondary latch includes a pivot and a surface. The latches are between a second housing surface and the cross bar in a first position. The cross bar is offset from the latches in a second position. The secondary latch surface and pivot are between the second housing surface and the primary latch pivot. The secondary latch surface engages the primary latch free end when the contacts are not tripped open and maintain the cradle latch within the opening.

Conventional electric rotary contact system is also based on the same principle i.e., repel/flip lock arrangement of rotating arm using dead center approach in which torque reversal happens after crossing the dead center axis during contact rotation because of blow open force. Some system has variable cross-section moving arm with extension spring type cam-based locking rotary mechanism. Hence there needed an improved reliable system providing better efficiency in contacts acceleration.

Accordingly in light of the aforementioned drawbacks and several other limitations inherent in the existing art, there is a well felt need to provide improved and cost effective rotary contact unit of each pole assembly deployed in MCCB, used for keeping the electrical network/circuits safe. Further there is a requirement of compact structure with lesser parts resulting in cost benefits, of the rotary contact unit of each pole assembly deployed in MCCBs.

SUMMARY OF THE INVENTION:

This section is intended to introduce certain objects of the disclosed system in a simplified form and is not intended to identify the key advantages or features of the present disclosure.

The present disclosure relates to a rotary contact unit for a pole assembly of a moulded case circuit breaker (MCCB). The rotary contact unit comprising a rotary member, an elongated rotating arm member, and a toggling mechanism. The rotary member has a predetermined structure, wherein the predetermined structure defines two parallelly positioned face plates at least partially connected together by an intermediate portion, the intermediate portion including a holding portion. The elongated rotating arm member is pivotally mounted on the rotary member, and defines a curved cut-out shaped spring connection portion. The toggling mechanism enables pivotal toggling of the elongated rotating arm member between a contact position and a non-contact position. The toggling mechanism includes a spring member, a support member, and a pin member. Notably, the spring member is positioned on the holding portion. While, the support member defines a base portion positioned on the spring member, and a pair of flanged portions extending therefrom, each of the pair of flanged portions defining a semi-circular attachment portion. Whereas, the pin member passes through the semi-circular attachment portion of the pair of flanged portions of the support member and the curved cut-out shaped spring connection portion of the elongated rotating arm member, for enabling toggling of the elongated rotating arm member between the contact position and the non-contact position.

According to one aspect of the present disclosure, the elongated rotating arm member defines a pivot connection through-hole.

According to another aspect of the present disclosure, the rotary member includes a coaxial pivot connection portion.

According to yet another aspect of the present disclosure, the rotary contact unit includes a pin means extending through the coaxial pivot connection portion of the rotary member and the pivot connection through-hole of the elongated rotating arm member, for pivotally mounting the elongated rotating arm member thereon, and for pivotally supporting the rotary contact unit on a cassette casing unit.

According to yet another aspect of the present disclosure, the elongated rotating arm member defines: a first end portion; and a second end portion electrically connected to a metal contact member through a braided wire, wherein, in the contact position and the non-contact position, the first end portion engages and disengages relative to a stationary contact unit of the pole assembly of the MCCB, respectively.

According to yet another aspect of the present disclosure, the elongated rotating arm member further defines a profiled stopper region proximal to the second end portion, which abuts against the intermediate portion of the rotary member, in the non-contact position thereof.

According to yet another aspect of the present disclosure, the toggling mechanism comprises a stopper pin installed between two parallelly positioned face plates of the rotary member, such that the elongated rotating arm member abuts against the stopper pin in the non-contact position thereof.

According to yet another aspect of the present disclosure, the elongated rotating arm member includes a variable cross-section that varies between the first end portion and the second end portion thereof.

According to yet another aspect of the present disclosure, the rotary member defines a braid routing cavity, through which the braided wire is routed to be electrically connected to the metal contact member.

According to yet another aspect of the present disclosure, the metal contact member includes either of a Z-shaped profile or an L-shaped profile.

BRIEF DESCRIPTION OF DRAWINGS

In order to explain the technical solution in the embodiments of the present disclosure more clearly, the drawings used in the description of the embodiments will be briefly introduced below. It is obvious that the drawings in the following description are only some embodiments of the present disclosure. For those skilled in the art, without any creative work, other drawings can be obtained based on these drawings.

FIG. 1a shows an exploded view of a moulded case circuit breaker (MCCB), in accordance with the concepts of the present disclosure.

FIG. 1b shows an exploded view of an arrangement between the three pole assemblies, the actuator assembly, and the TRIP assembly of the moulded case circuit breaker (MCCB) of FIG. 1a, in accordance with the concepts of the present disclosure.

FIG. 2a shows an exploded view of one of the pole assemblies of the moulded case circuit breaker (MCCB) of Fig. 1, in accordance with the concepts of the present disclosure.

FIG. 2b shows is side view of the one of the pole assemblies of the moulded case circuit breaker (MCCB) of Fig. 2, illustrating internal components of the pole assembly, in accordance with the concepts of the present disclosure.

FIG. 3a shows an exploded view of a first embodiment of a coaxial rotary contact unit of the pole assembly of Figs. 2a and 2b, in accordance with the present disclosure.

FIG. 3b shows an exploded view of a second embodiment of a coaxial rotary contact unit of the pole assembly of Figs. 2a and 2b, in accordance with the present disclosure.

DETAILED DESCRIPTION OF THE INVENTION

In the following description, for the purposes of explanation, various specific details are set forth in order to provide a thorough understanding of embodiments of the present invention. It will be apparent, however, that embodiments of the present invention may be practiced without these specific details. Several features described hereafter can each be used independently of one another or with any combination of other features. An individual feature may not address any of the problems discussed above or might address only one of the problems discussed above. Some of the problems discussed above might not be fully addressed by any of the features described herein. Exemplified embodiments of the present invention are described below, as illustrated in various drawings in which like reference numerals refer to the same parts throughout the different drawings.

Figure 1a shows an exploded view of a moulded case circuit breaker (MCCB) [100], in accordance with the concepts of the present disclosure. FIG. 1b shows an exploded view of an arrangement between the three pole assemblies, the actuator assembly, and the TRIP assembly of the moulded case circuit breaker (MCCB) of FIG. 1a, in accordance with the concepts of the present disclosure. Figures 1a and 1b should be referred to in conjunction with each other, in order to clearly understand the concepts of the present disclosure. The Moulded case circuit breaker [100] is a low-voltage and high-current circuit breaker, employed to protect electrical networks/circuits from over-load or short-circuit conditions. The MCCB [100] is positioned between at least one load phase on a load side and at least one line phase on a line side, for providing protection during over-load or short-circuit conditions. The MCCB [100] operates between each of an ON position, an OFF position, and a TRIP position, wherein the MCCB [100] is manually adjusted between the ON position and the OFF position, whereas MCCB [100] is automatically adjusted to the BLOW OPEN position followed by TRIP position due to short-circuit fault at the line side or the load side of the MCCB [100]. In the 'ON' position, the MCCB [100] allows a flow of current therethrough. In the 'OFF' position, the MCCB [100] restricts the flow of current therethrough. In the each of

the 'BLOW OPEN' position and the 'TRIP' position, the MCCB [100] restricts the flow of current therethrough.

Commonly, the MCCB [100] is a multipolar circuit breaker. Although, in the present disclosure the MCCB [100] is described as a three-pole circuit breaker, it may be obvious to a person ordinarily skilled in the art that the MCCB [100] may also be a single-pole circuit breaker, a four-pole circuit breaker, or a circuit breaker with any number of poles. The MCCB [100] includes three (3) pole assemblies [102], a base assembly [104], a mid-cover assembly [106], a fascia plate assembly [108], an actuator assembly [112], and a TRIP assembly [114].

Each of the three pole assemblies [102] are independent units capable of protecting the electrical networks/circuits from over-load or short-circuit conditions. In particular, each of the three pole assemblies [102] transmits electric current from one of the line phases to one of the load phases, while providing protection from overcurrent or short-circuit. Each of the three pole assemblies [102] operate in each of the 'ON' position, the 'OFF' position, and the 'TRIP' position. Notably, the three pole assemblies [102] are connected together with one or more components of the actuator assembly, to adjust each of the three pole assemblies [102] together between the 'ON' position, the 'OFF' position, and the 'TRIP' position. A structure and arrangement of the three pole assemblies [102] will be described later in details.

The base assembly [104] is a lower structure that provides a mounting base and support structure for holding and supporting each of the three pole assemblies [102] therein. In particular, the base assembly [104] defines pole holding cavities to mount and support each of the three pole assemblies [102] therein. Notably, the three pole assemblies [102] are fixedly attached within the pole holding cavities defined by the base assembly [104]. An attachment means for attaching the three pole assemblies [102] within the pole holding cavities defined by the base assembly [104] includes, such as but not limited to, a bolt attachment means, a screw attachment means, a rivet attachment means, an adhesive attachment means, a fit attachment means, a weld attachment means, and the like.

The mid-cover assembly [106] is an upper structure that is engaged with the base assembly [104], to at least partially cover the three pole assemblies [102] and protect the same from external environment. The mid-cover assembly [106] is usually fittingly engaged with the base assembly [104], to at least partially cover the three pole assemblies [102] and protect the same from external environment. Although, the mid-cover assembly [106] is described to be attached to the base assembly [104] by way of a fit attachment means, it may be obvious to a person ordinarily skilled in the art that the any other known attachment means may also be envisioned.

The fascia plate assembly [108] is fittingly mounted on the mid-cover assembly [106], to cover the mid-cover assembly [106]. The fascia plate assembly [108] defines portions to define electrical parameters related to MCCB [100].

The actuator assembly [112] is a multi-part component mounted on one of the pole assemblies. The actuator assembly [112] connects together the three pole assemblies [102], such that the three pole assemblies [102] are adjusted together between the ON position, the OFF position, and the TRIP position. The actuator assembly [112] includes a manual lever that may be manually adjusted to adjust the three pole assemblies [102] together between the ON position, the OFF position. In particular, the manual lever of the actuator assembly [112] may be manipulated, to adjust the three pole assemblies [102] together from the ON position to the OFF position and vice versa. Moreover, one or more of the three pole assemblies [102] may be adjusted to the BLOW OPEN position, during short-circuit conditions. Additionally, TRIP assembly [114] is mounted and supported on one of the three pole assemblies [102] such that the TRIP assembly [114] triggers the actuator assembly [112] to adjust the three pole assemblies [102] together from the BLOW OPEN position to the TRIP position. Further, the manual lever of the actuator assembly [112] may be manipulated to reset the three pole assemblies [102] together from the TRIP position to the OFF position.

A structure and arrangement of one of the three (3) pole assemblies [102] will be described in details hereinafter. Similar structure and arrangement of the remaining pole assemblies [102] may be envisioned. Fig 2a shows an exploded view of the pole assembly [102] of the MCCB [100]. Fig. 2b shows a side view of the pole assembly of the MCCB [100]. Fig. 2a and 2b should be referred to in conjunction with each other, to clearly understand the scope of the present disclosure. Although, the present disclosure is described as applied to the pole assembly [102] of single break contact type assembly, it may be obvious to a person ordinarily skilled in the art that the concepts of the present disclosure may also extend to the pole assembly [102] of double/any number of break contact type assembly. The pole assembly [102] includes a cassette casing unit [116], a stationary contact unit [118], a rotary contact unit [120], and an arc chute unit [122].

The cassette casing unit [116] houses and supports the stationary contact unit [118], the rotary contact unit [120], and the arc chute unit [122] of the pole assembly [102]. In particular, the pole assembly [102] defines various dedicated sections for housing and supporting the stationary contact unit [118], the rotary contact unit [120], and the arc chute unit [122] of the pole assembly [102]. The cassette housing [116] is a two-part structure comprising of a left cassette member [116a] and a right cassette member [116b] each of which can be fittingly attached together, while housing the stationary contact unit [118], the rotary contact unit [120], and the arc chute unit [122] therein. Notably, each of the left cassette member [116a] and the right cassette member [116b] are structures to keep each of the stationary contact unit [118], the rotary contact unit [120], and the arc chute unit [122] of the pole assembly [102], in position therein.

The stationary contact unit [118] is an electric contact plate structure that may be positioned within a defined portion in the cassette casing unit [116]. In particular, in complete assembly of the MCCB [100], the electrical wires from the line side are usually connected to the stationary contact unit [118].

The rotary contact unit [120] is a moving structure that engages/disengages with the stationary contact unit [118], to allow/restrict the flow of electric current therethrough. The rotary contact unit [120] is rotatably positioned within a defined portion in the cassette casing unit [116], and is provided to connect to electrical wires from the load side. Further, the rotary contact unit [120] is rotatably adjusted while being positioned within the cassette casing unit [116], to make/release a contact relative to the stationary contact unit [118], in order to allow/restrict the flow of electric current therebetween. Notably, the rotary contact unit [120] makes a contact relative to the stationary contact unit [118] to allow the flow of electric current (the 'ON' position), the rotary contact unit [120] releases a contact relative to the stationary contact unit [118], to restrict the flow of electric current (the 'OFF' position). Additionally, the rotary contact unit [120] is adjusted without rotation, to release a contact relative to the stationary contact unit [118], to restrict the flow of electric current (the 'BLOW OPEN' position). A structure and arrangement of the rotary contact unit [120] will be discussed later in details.

The arc chute unit [122] is positioned within a defined portion in the cassette casing unit [116] and comprises of a two-wall shaped arc chute holder member and an arc chute member. The arc chute holder member and an arc chute member, are arranged together, to vent out gases generated by an arc caused due to engagement/disengagement of the rotary contact unit [120] relative to the stationary contact unit [118] through a vent channel.

A structure and arrangement of the rotary contact unit [120] will be described in details hereinafter. Fig. 3a shows an exploded view of the first embodiment of a coaxial rotary contact unit [120] of the pole assembly [102]. The rotary contact unit [120] includes a rotary member [124], an elongated rotating arm member [126], and a toggling mechanism [128]. A structure and arrangement of the aforementioned components will be described hereinafter in detail.

The rotary member [124] has a predetermined structure being a double-walled egg-shaped structure. However, it may be obvious to a person skilled in the art that the

rotary member [124] can also be a single walled structure and may have shapes other than egg-shape. In particular, the predetermined structure of the rotary member [124] defines two parallelly positioned face plates [124c, 124e] at least partially connected together by an intermediate portion [124f], wherein the intermediate portion [124f] includes a holding portion [124b]. Additionally, the rotary member [124] includes a coaxial pivot connection portion [124a]. The coaxial pivot connection portion [124a] is adapted for pivotally mounting the elongated rotating arm member [126] thereon, as well as for rotatably supporting the rotary member [124] on the cassette casing unit [116]. Additionally, the rotary member [124] defines a braid routing cavity [124g], wherein the braid routing cavity [124g] is adapted to receive a braid routing pin [134] for routing a braided wire [132] to be connected to a metal contact member [130]. Notably, the metal contact member [130] includes either a Z-shaped profile or an L-shaped profile. Furthermore, the rotary member [124] also includes two extension stopper portions [124d] extending sidewards from each of the face plates [124c, 124e]. The extension stopper portions [124d] are slidably positioned within the profiled depressed region in the cassette casing unit [116], such that the extension stopper portions [124d] abuts against the profiled depressed region in the cassette casing unit [116] in each of the ON position and the OFF position of the MCCB [100]. This enables a plastic-to-plastic contact between the rotary member [124] and the cassette casing unit [116], thereby, reducing frictional losses.

In addition to the above, a provision for mounting a rotary shield [131] may be provided as part of the coaxial rotary member [124]. The rotary shield [131] is attached to the elongated rotating arm member [126a], by means of snap fit attachment. The rotary shield [131] is installed on the elongated rotating arm member [126] proximal to the first end portion [126a] thereof. In an alternate embodiment, such provision for mounting the rotary shield [131] may be an extruded region proximal to the first end portion [126a] of the elongated rotating arm member [126]. Essentially, the rotary shield provision [131] provides for protection to each of the rotary member [124], braided wire [132], and spring member [128c] from the hot gases, which are generated in the event of short-circuit

and/or over-current conditions. Furthermore, such provision [131] results in improved reliability of spring member [128c] and reduced hardening effect on braided wire [132].

The elongated rotating arm member [126] is pivotally mounted on the rotary member [126]. In particular, the elongated rotating arm member [126] defines a first end portion [126a], a second end portion [126b], a pivot connection through-hole [126c], and a curved cut-out shaped spring connection portion [126d]. In a contact position of the elongated rotating arm member [126], the first end portion [126a] engages relative to the stationary contact unit [118] of the pole assembly [102] of the MCCB [100]. While, in a non-contact position thereof, the first end portion [126a] disengages relative to the stationary contact unit [118] of the pole assembly [102] of the MCCB [100]. Moreover, the second end portion [126b] is electrically connected to the metal contact member [130] through the braided wire [132]. Either ends of the braided wire [132] may be connected to each of the second end portion [126b] of the elongated rotating arm member [126] and the metal contact member [130], by means of a weld attachment. Notably, the elongated rotating arm member [126] includes a variable cross-section that varies between the first end portion [126a] and the second end portion [126b] thereof. The variation of the cross-section of the elongated rotating arm member [126] may be in any form known to a person skilled in the art. For example, in one embodiment, there may be a uniform variation of cross-section of the elongated rotating arm member [126]. In another embodiment, the elongated rotating arm member [126] may have different cross-section at different points between the first end portion [126a] and the second end portion [126b] of the elongated rotating arm member [126]. In yet another embodiment, the elongated rotating arm member [126] may have different portions between the first end portion [126a] and the second end portion [126b] of the elongated rotating arm member [126], which have different widths. All such embodiments are within a scope of the present disclosure. Notably, variable cross-section of the elongated rotating arm member provides for reduced current density, and thereby efficient current transmission therefrom.

In addition to the above, the rotary contact unit [120] further includes a pin means [128a]. The pin means [128a] extends through the coaxial pivot connection portion [124a] of the rotary member [124] and the pivot connection through-hole [126c] of the elongated rotating arm member [126], for pivotally mounting the elongated rotating arm member [126] thereon, and for pivotally supporting the rotary contact unit [120] on a cassette casing unit [116].

The toggling mechanism [128] enables pivotal toggling of the elongated rotating arm member [126] between the contact position and the non-contact position. The toggling mechanism [128] includes a spring member [128c], a support member [128b], and a pin member [127]. The spring member [128c] is positioned on the holding portion [124b] of the rotary member [124]. While, the support member [128b] defines a base portion [128e] positioned on the spring member [128c], and a pair of flanged portions [128g] extending therefrom, each of the pair of flanged portions [128g] defining a semi-circular attachment portion [128d]. In particular, the pin member [127] passes through the semi-circular attachment portion [128d] of the pair of flanged portions [128g] of the support member [128b] and the curved cut-out shaped spring connection portion [126d] of the elongated rotating arm member [126], for enabling toggling of the elongated rotating arm member [126] between the contact position and the non-contact position. Furthermore, the toggling mechanism [128] comprises a stopper pin [128f] installed between two parallelly positioned face plates [124c, 124e] of the rotary member [124], such that the elongated rotating arm member [126] abuts against the stopper pin [128f] in the non-contact position thereof.

With the aforementioned arrangement, the first embodiment of the toggling mechanism is able to switch the elongated rotating arm member [126] between a contact position and a non-contact position. In the contact position of the elongated rotating arm member [126], the first end portion [126a] engages relative to the stationary contact unit [118] of the pole assembly [102] of the MCCB [100]. While, in the non-contact position thereof, the first end portion [126a] disengages relative

to the stationary contact unit [118] of the pole assembly [102] of the MCCB [100]. Moreover, the second end portion [126b] is electrically connected to a metal contact member [130] through the braided wire [132]. Notably, the metal contact member [130] is electrically connected to a line side of the terminal to transmit electric current thereto. Either ends of the braided wire [132] may be connected to the profiled stopper region [126e] of the elongated rotating arm member [126] and the metal contact member [130], by means of a weld attachment. Notably, the contact position of the elongated rotating arm member [126] is observed, during ON position of the MCCB, while the non-contact position is observed during the BLOW OPEN position/ TRIP position of the MCCB [100].

Notably, in the first embodiment of the toggling mechanism, the profiled stopper region [126e] of the elongated rotating arm member [126] is suitably structured and arranged, to engage with and abut against the intermediate portion [124f] of the coaxial rotary member [124], in the non-contact position thereof. Thereby, the profiled stopper region [126e] assist in stopping/ stabilizing the elongated rotating arm member [126] in the non-contact position. Accordingly, the profiled stopper region [126e] of the elongated rotating arm member [126] assists in stopping/ stabilizing the elongated rotating arm member [126] in the BLOW OPEN position/ TRIP position of the MCCB [100].

FIG. 3b shows an exploded view of a second embodiment of the coaxial rotary contact unit [120] of the pole assembly. It may be noted that majority of the parts of the first embodiment can be envisioned in the second embodiment. Particularly, in the second embodiment, the coaxial rotary contact unit [120] includes the coaxial rotary member [124], the elongated rotating arm member [126], and the toggling mechanism [128]. However, a structure and arrangement of each of the coaxial rotary member [124], the elongated rotating arm member [126], and the toggling mechanism [128] may differ slightly.

In the second embodiment of the coaxial rotary contact unit [120], the coaxial rotary member [124] includes a structure and arrangement similar to that of the coaxial rotary member [124] of the first embodiment of the coaxial rotary contact unit

[120]. However, in such embodiments, the coaxial rotary member [124] additionally employs a stopper pin routing through-hole [124f]. Remaining features of the coaxial rotary member [124] is same as that described earlier in the description of the first embodiment of the coaxial rotary contact unit [120], and is not repeated herein for the sake of brevity.

In the second embodiment of the coaxial rotary contact unit [120], the elongated rotating arm member [126] includes a structure and arrangement similar to that of the elongated rotating arm member [126] of the first embodiment of the coaxial rotary contact unit [120]. However, in such embodiment, the elongated rotating arm member [126] does not impart the feature of the profiled stopper region [126e]. Remaining features of the elongated rotating arm member [126] is same as that described earlier in the description of the first embodiment of the coaxial rotary contact unit [120], and is not repeated herein for the sake of brevity.

Furthermore, in the second embodiment of the coaxial rotary contact unit [120] the toggling mechanism [128] includes a structure and arrangement similar to that of the toggling mechanism [128] of the first embodiment of the coaxial rotary contact unit [120]. In such embodiment, the toggling mechanism [128] additionally includes a stopper pin [128f] passing through the stopper pin routing through-hole [124f] of the coaxial rotary member [124] thereof. Remaining features of the toggling mechanism [128] is same as that described earlier in the description of the first embodiment of the coaxial rotary contact unit [120], and is not repeated herein for the sake of brevity. With such arrangement of the second embodiment of coaxial rotary contact unit [120], the stopper pin [128f] assist in stopping/ stabilizing the elongated rotating arm member [126] in the non-contact position. Particularly, the elongated rotating arm member [126] is stopped/ stabilized] in the BLOW OPEN position/ TRIP position of the MCCB [100], by abutting against the stopper pin [128f] of the toggling mechanism [128].

In assembly, initially, the pin member [127] passes through the semi-circular attachment portion [128d] of the toggling mechanism [128] and the spring

connection portion [126d] of the elongated rotating arm member [126]. Thereafter, the spring member [128c] is positioned on the holding portion [124b] of the rotary member [124], such that the base portion [128e] thereof is at least partially within the spring member [128c]. The other end of the spring member [128c] is then supported on the holding portion [124b] of the rotary member [124]. Finally, a pin means [128a] extends through the coaxial pivot connection portion [124a] of the rotary member [124] and the pivot connection through-hole [126c] of the elongated rotating arm member [126], for pivotally mounting the elongated rotating arm member [126] thereon, and for pivotally supporting the rotary contact unit [120] on a cassette casing unit [116].

Various advantages of the presently disclosed rotary contact unit [120] are disclosed. For example, as the toggling mechanism [128] is a three-component based toggling mechanism [128], it results in reduced number of total parts for connection of the elongated rotating arm member [126] to the rotary member [124], thereby reducing overall cost of the rotary contact unit [120]. Additionally, as the single pin means [128a] is used to pivotally connect the elongated rotating arm member [126] to the rotary member [124] as well as for rotatably supporting the rotary contact unit [120] to the cassette casing unit [116], which further results in reduced number of parts and further reducing overall cost of the rotary contact unit [120]. Moreover, as the axis of pivotal support of the elongated rotating arm member [126] is coaxial to the axis of rotatable support of the rotary contact unit [120], it causes relatively uniform structure of the rotary member [124], and thus is able to achieve improved sealing with cassette casing unit [116], resulting in improved arc gas exhaust characteristics, and improved overall speed of adjustment to and from the BLOW OPEN position and the TRIP position.

Additionally, uniform and coaxial arrangement of the axis of pivotal support of the elongated rotating arm member [124] relative to the axis of rotatable support of the rotary contact unit [120], prevents the escape of gases during short-circuiting from kidney-cavities in the cassette casing unit thereby protecting adjacent parts.

Moreover, the variable cross-section of the elongated rotating arm member [126] varying from the first end portion [126a] to the second end portion [126b] thereof, results in reduced current density, stabilizing the elongated rotating arm member [126] thereof, in events of the over-current and/or short-circuit conditions. Furthermore, the said variable cross-section reduces the temperature rise proximal to the first end portion [126a] of the elongated rotating arm member [126]. Additionally, the variable cross-section thereof, can be varied to increase the current rating of the breaker, without varying the overall size of the MCCB [100]. Apart from the above, the braid routing pin [134] avoids the interference of braided wire [132] with the spring member [128c] during operation.

While the preferred embodiments of the present invention have been described hereinabove, it should be understood that various changes, adaptations, and modifications may be made therein without departing from the spirit of the invention and the scope of the appended claims. It will be obvious to a person skilled in the art that the present invention may be embodied in other specific forms without departing from its spirit or essential characteristics. The described embodiments are to be considered in all respects only as illustrative and not restrictive.

LIST OF COMPONENTS:

100 – Moulded case circuit breaker (MCCB)
102 – Pole assembly
104 – Base assembly
106 – Mid-cover assembly
108 – Fascia plate assembly
112 – Actuator assembly
114 – Trip assembly
116 – Cassette casing unit
118 – Stationary contact unit
120 – Rotary contact unit

122 – Arc chute unit

124 – Rotary contact member

124a – Coaxial pivot connection portion

124b – Holding portion

124c, 124e – Face plates

124d – Extension stopper portion

124f – Intermediate portion

124g – Braid routing cavity

126 – Elongated rotating arm member

126a – First end portion

126b – Second end portion

126c – Pivot connection through-hole

126d – Curved cut-out shaped spring connection portion

126e – Profiled stopper region

127 – Pin member

128 – Toggling mechanism

128b – Support member

128c – Spring member

128d – Semi-circular attachment portion

128e – Base portion

128f – Stopper pin

128g – Flanged portions

130 – Metal contact member

132 – Braided wire

134 – Braid routing pin

I/We Claim:

1. A rotary contact unit [120] for a pole assembly [102] of a moulded case circuit breaker (MCCB) [100], comprising:

- a rotary member [124] having a predetermined structure, wherein the predetermined structure defines two parallelly positioned face plates [124c, 124e] at least partially connected together by an intermediate portion [124f], the intermediate portion [124f] including a holding portion [124b];

- an elongated rotating arm member [126] pivotally mounted on the rotary member [124], the elongated rotating arm member [126] defining a curved cut-out shaped spring connection portion [126d]; and

- a toggling mechanism [128], wherein the toggling mechanism [128] enables pivotal toggling of the elongated rotating arm member [126] between a contact position and a non-contact position, the toggling mechanism [128] including:

a spring member [128c] positioned on the holding portion [124b];

a support member [128b] defining a base portion [128e] positioned on the spring member [128c], and a pair of flanged portions [128g] extending therefrom, each of the pair of flanged portions [128g] defining a semi-circular attachment portion [128d]; and

a pin member [127] passing through the semi-circular attachment portion [128d] of the pair of flanged portions [128g] of the support member [128b] and the curved cut-out shaped spring connection portion [126d] of the elongated rotating arm member [126], for enabling toggling thereof, between the contact position and the non-contact position.

2. The rotary contact unit [120] as claimed in claim 1, wherein the elongated rotating arm member [126] defines a pivot connection through-hole [126c].

3. The rotary contact unit [120] as claimed in claim 1, wherein the rotary member [124] includes a coaxial pivot connection portion [124a].

4. The rotary contact unit [120] as claimed in claims 1-3, further includes a pin means [128a] extending through the coaxial pivot connection portion [124a] of the rotary member [124] and the pivot connection through-hole [126c] of the elongated rotating arm member [126], for pivotally mounting the elongated rotating arm member [126] thereon, and for pivotally supporting the rotary contact unit [120] on a cassette casing unit [116].

5. The rotary contact unit [120] as claimed in claim 1, wherein the elongated rotating arm member [126] defines:

- a first end portion [126a]; and

- a second end portion [126b] electrically connected to a metal contact member [130] through a braided wire [132],

wherein, in the contact position and the non-contact position, the first end portion [126a] engages and disengages relative to a stationary contact unit [118] of the pole assembly [102] of the MCCB [100], respectively.

6. The rotary contact unit [120] as claimed in claim 5, wherein the elongated rotating arm member [126] further defines a profiled stopper region [126e] proximal to the second end portion [126b], which abuts against the intermediate portion [124f] of the rotary member [124], in the non-contact position thereof.

7. The rotary contact unit [120] as claimed in claims 1 and 5, wherein the toggling mechanism [128] comprises a stopper pin [128f] installed between two parallelly positioned face plates [124c, 124e] of the rotary member [124], such

that the elongated rotating arm member [126] abuts against the stopper pin [128f] in the non-contact position thereof.

8. The rotary contact unit [120] as claimed in claim 1, wherein the elongated rotating arm member [126] includes a variable cross-section that varies between the first end portion [126a] and the second end portion [126b] thereof.

9. The rotary contact unit [120] as claimed in claim 1, wherein the rotary member [124] defines a braid routing cavity [124g] adapted to receive braid routing pin [134] through which the braided wire [132] is routed to be electrically connected to the metal contact member [130].

10. The rotary contact unit [120] as claimed in claim 9, wherein the metal contact member [130] includes either of a Z-shaped profile or an L-shaped profile.

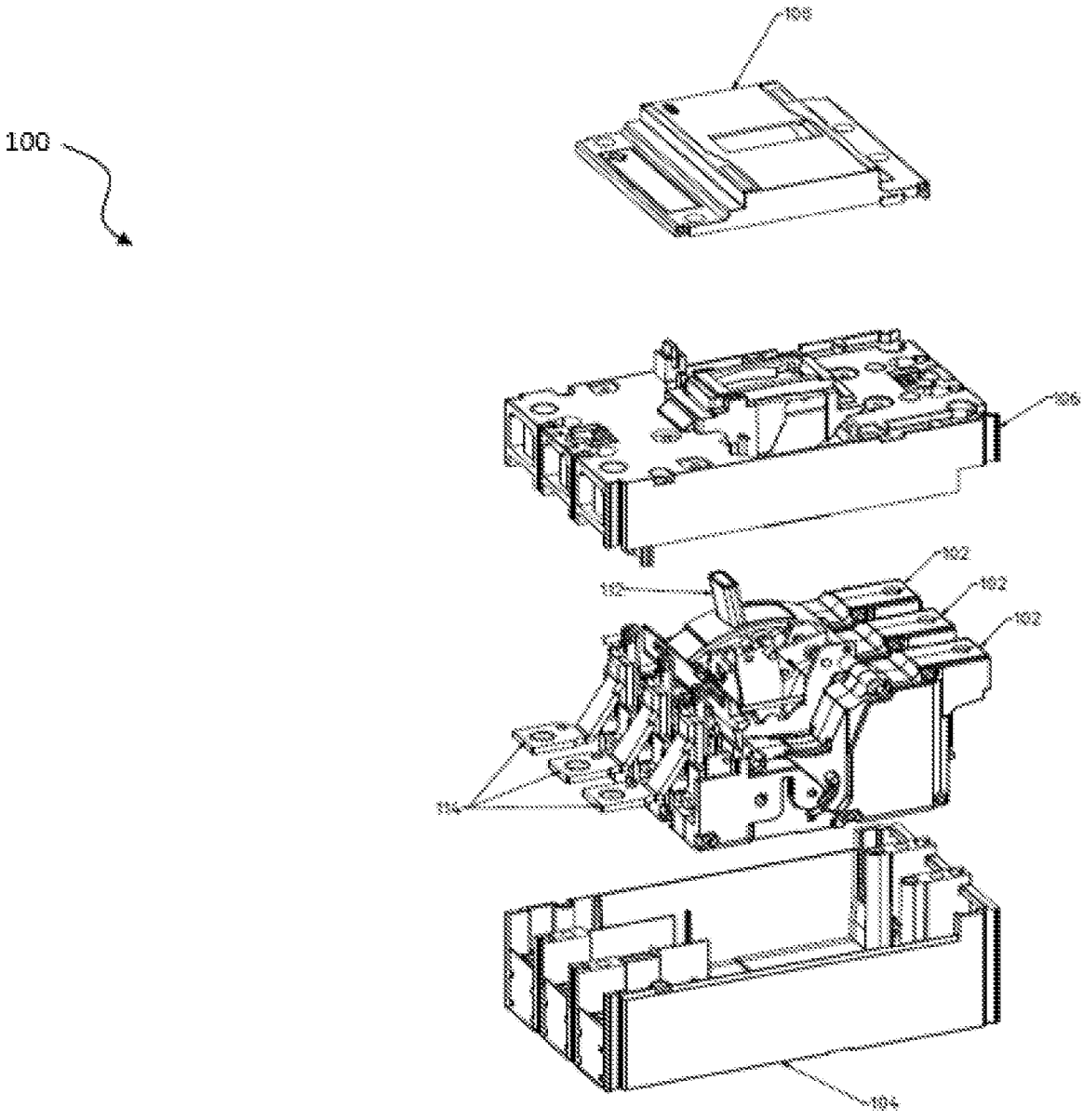

Figure 1a

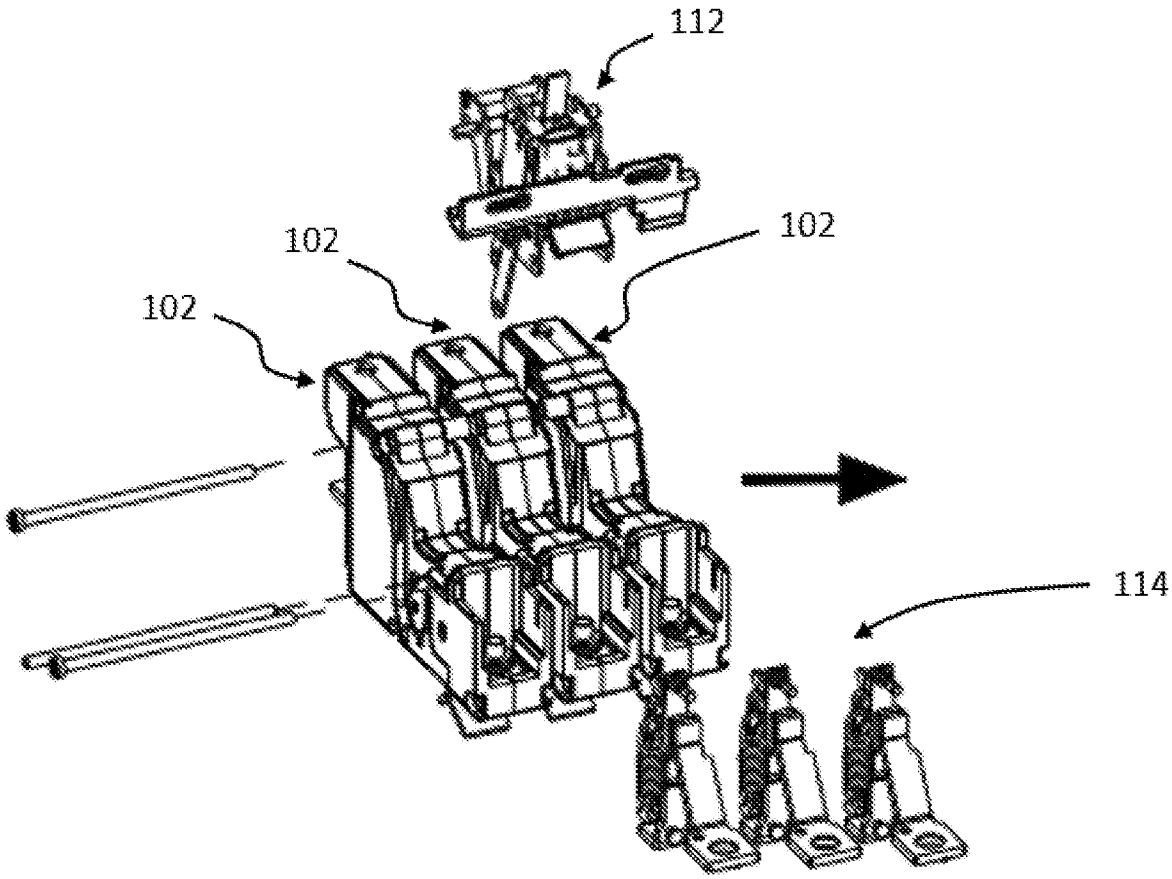

Figure 1b

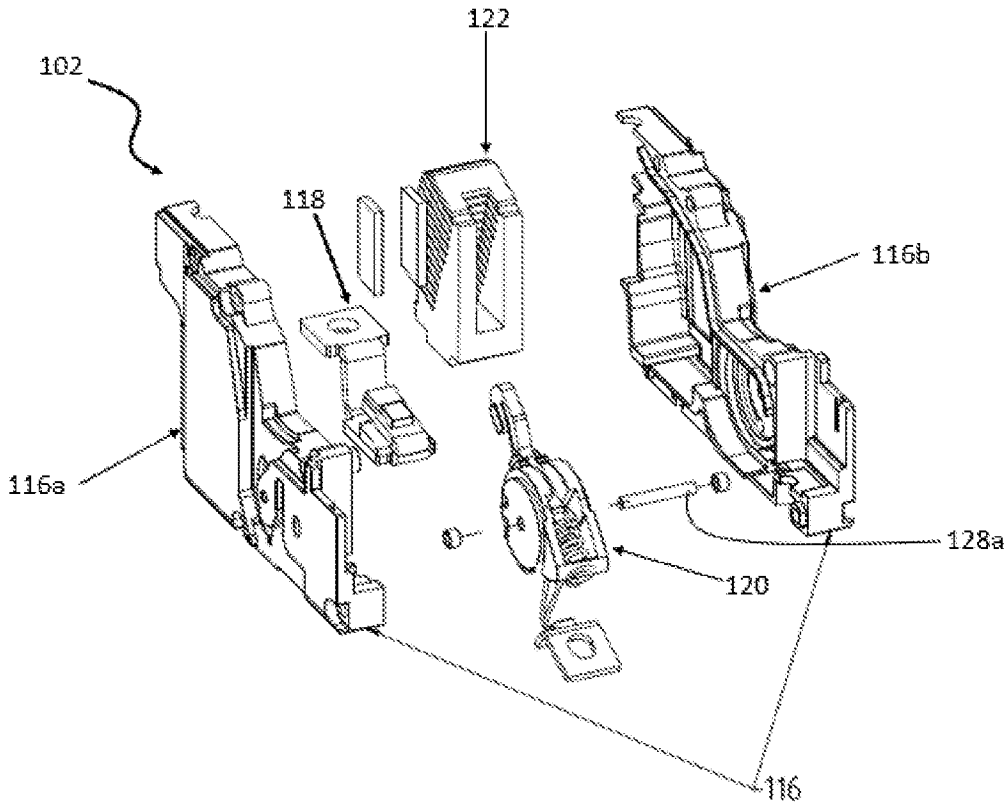

Figure 2a

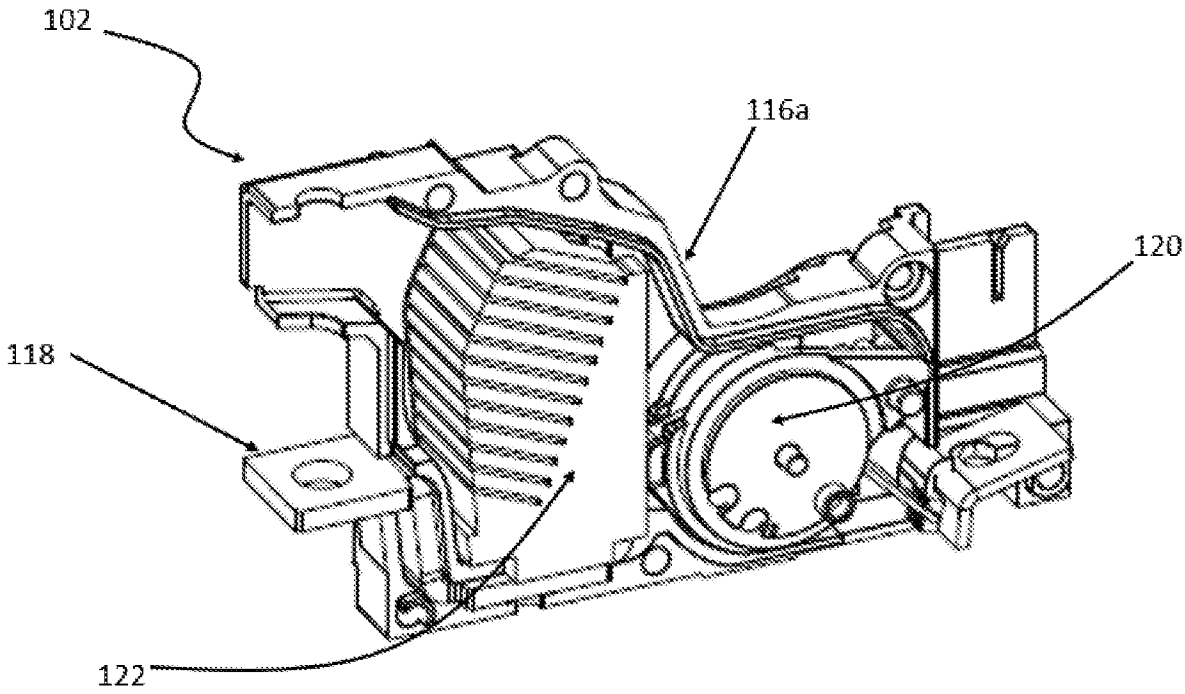

Figure 2b

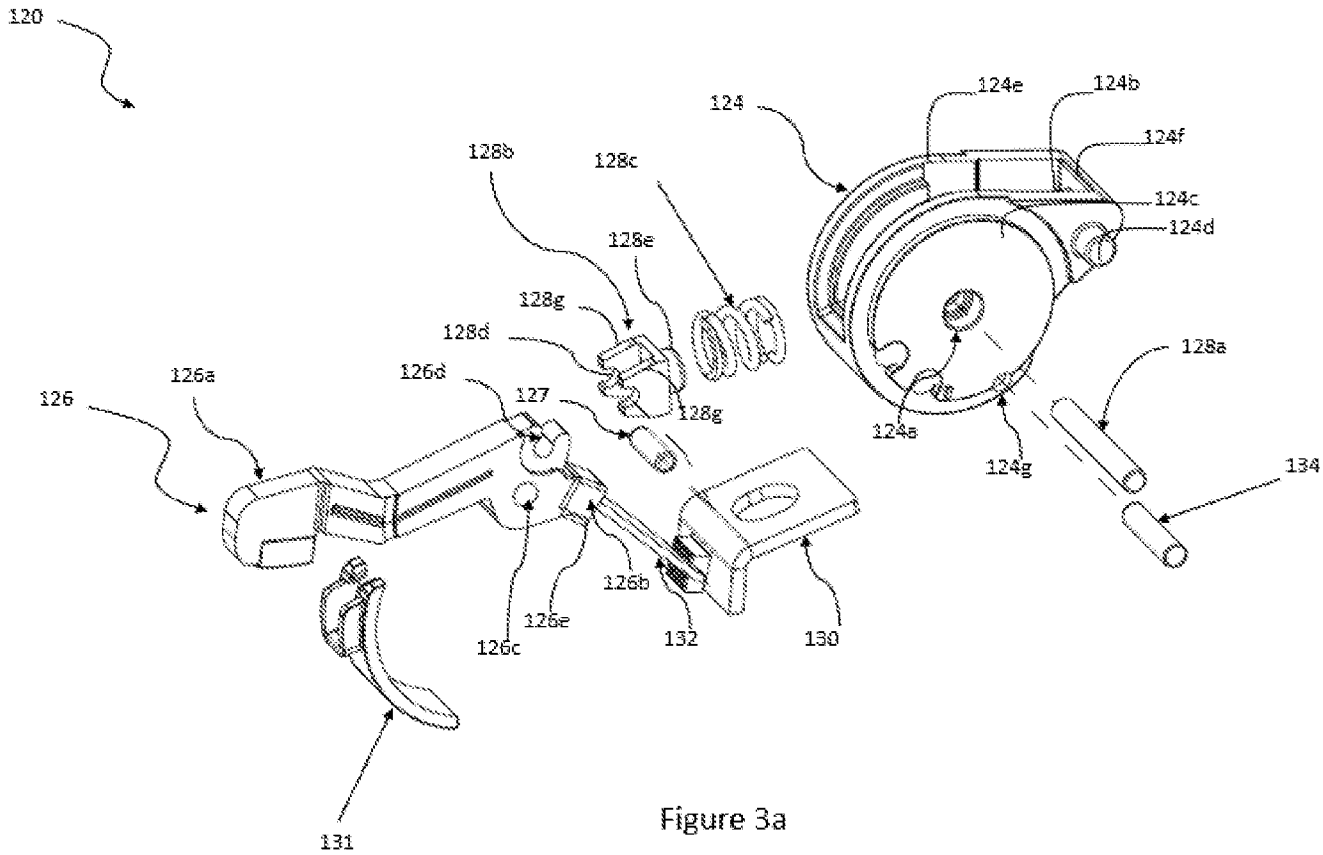
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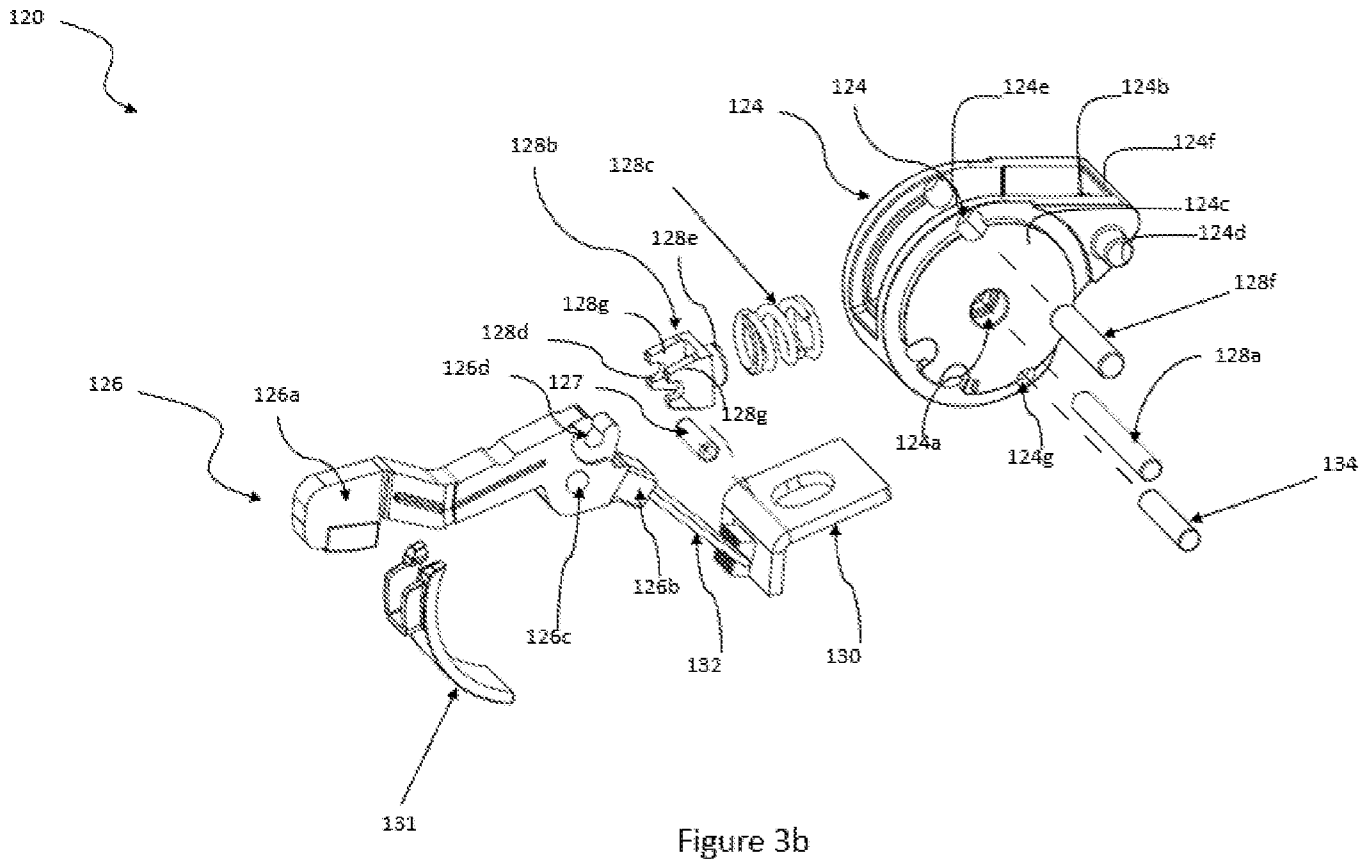
Figure 3a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128g
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126c
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Figure 3b

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IN2023/051156

A. CLASSIFICATION OF SUBJECT MATTER
H01H73/04,H01H1/20,H01H77/10 Version=2024.01

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 database consulted during the international search (name of database and, where practicable, search terms used)

PatSeer, IPO Internal Database

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	IN201721011296A [LARSEN & TOUBRO LIMITED] 05 October 2018 (05-10-2018) Paras. [0076] - [0080], Figures 5-6, 10-13	1 - 4, 10
Y	Paras. [0076] - [0080], Figures 5-6, 10-13	5, 8 - 9
A	Paras. [0076] - [0080], Figures 5-6, 10-13	6, 7
Y	EP0128676B1 [MITSUBISHI ELECTRIC CORP] 04 January 1989 (04-01-1989) Paras. [0019] - [0040], Fig 2	5, 8
Y	US20120298489A1 [SIEMENS AG] 29 November 2012 (29-11-2012) Paras. [0041] - [0064], Figs 5A-5B	9

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"D" document cited by the applicant in the international application

"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

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Date of the actual completion of the international search	Date of mailing of the international search report
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