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(54) **CURRENT INTERRUPTION DEVICE**

(57) In a current interruption device comprising a main contact (12) and a group (14) of series-connected arc contacts including a first and a second arc contact, the main contact (12) and each arc contact comprises a first contact area (20, 30, 40) and a moveable contact element (24, 34, 44), where the moveable contact element (24, 34, 44) is moveable in relation to the first contact area (20, 30, 40) and each arc contact comprises a first group of arc plates (50, 52) placed adjacent a movement path of a first end (36, 46) of the moveable contact element (34, 44) in relation to the first contact area (30, 42) and the group of series-connected arc contacts (14) is electrically connected in parallel with the main contact (12).

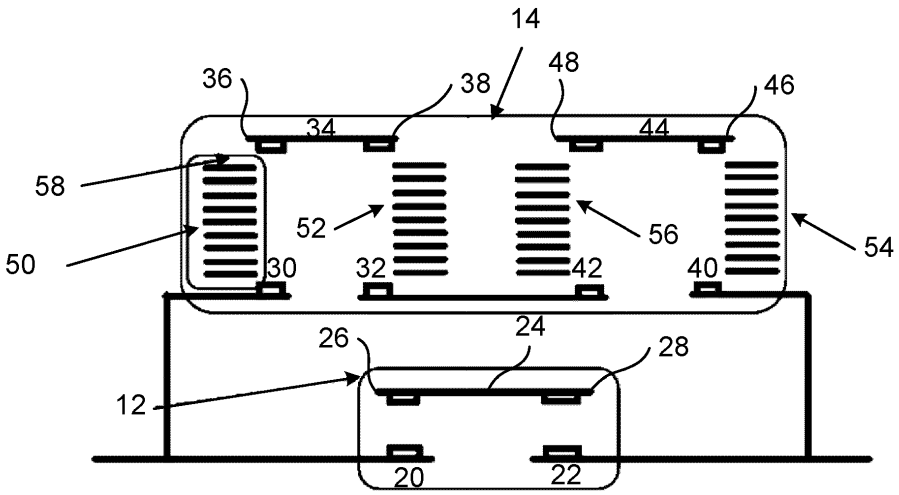

Fig. 2

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Description

FIELD OF INVENTION

[0001] The present invention relates to a current interruption device.

BACKGROUND

[0002] Current interruption devices, such as electric contactors, are important equipment in power transmission, distribution and supply systems

[0003] A current interruption device may then be provided with a main contact in parallel with which is connected an arc contact, where the arc contact comprises at least one group of arc plates for allowing an arc generated by the opening of the main contact to be extended via the arc contact and the arc plates for being interrupted.

[0004] One current interruption device having such a realization can be found in US 2009/0066939.

[0005] During the procedure of interrupting the current, the main contact is opened in advance of the arc contact. The current then commutates to the arc contact and an arc is ignited when the arc contact opens. The criteria to break the current is that the arc voltage created by the arc needs to be higher than the system voltage of the system in which the current interruption device is provided. To reach a sufficient arc voltage a number of arc plates are provided for the arc contact to divide the arc into sub arcs. To interrupt the current several arc plates is thus required, and these take up a lot of space. Especially if they are stacked on top of each other the current interruption device risks to be very high (deep). Furthermore, also the time it takes to interrupt the current depends on how far the arc contact has to be moved, which again is also dependent on the number of arc plates. A long distance gives a long arc time.

[0006] There is therefore a need to solve one or more of the above-mentioned problems.

SUMMARY OF THE INVENTION

[0007] One object of the present invention is to provide a current interruption device that addresses one or more of the above-mentioned problems.

[0008] This object is according to the present invention obtained through a current interruption device comprising a main contact and a group of series-connected arc contacts including a first and a second arc contact, wherein the main contact and each arc contact comprises a first contact area and a moveable contact element, where the moveable contact element is moveable in relation to the first contact area and each arc contact comprises a first group of arc plates placed adjacent a movement path of a first end of the moveable contact element in relation to the first contact area, where the group of series-connected arc contacts is electrically connected in parallel with the main contact.

[0009] The first contact area may be part of a stationary contact element.

[0010] The plates of a group of arc plates may be placed between a first position formed by the corresponding contact area and a second position being a maximum open position of the arc contact, which maximum open position may be the maximum open position of the corresponding moveable contact element. The second position may additionally be the location of the corresponding end of the moveable contact element, when the moveable contact element is in its maximum open position.

[0011] The current interruption device may comprise a gear mechanism configured to move the moveable contact element of the main contact with a first speed and the moveable contact elements of the arc contacts with a second speed that is higher than the first speed, where the second speed may be four times higher than the first speed.

[0012] The orientation of the moveable contact element of each arc contact may be angled to the orientation of the moveable contact element of the main contact with an angle, which angle may be an angle of ninety degrees.

[0013] The first arc contact may be placed at a first end of the moveable contact element of the main contact and the second arc contact may be placed at a second end of the moveable contact element of the main contact.

[0014] Furthermore, the moveable contact elements of the arc contacts may be moveable in a first plane and a second plane, respectively, while the moveable contact element of the main contact may be moveable in a third plane, where the first and second planes may be parallel with each other and perpendicular to the third plane. Both the first and the second planes may thus be perpendicular to the third plane. The first, second and third planes may also be vertical planes.

[0015] It is additionally possible that the first contact area of the main contact is placed in a fourth plane and the first contact area of the arc contacts are placed in a fifth plane that is parallel with the fourth plane, where the fourth and fifth planes are perpendicular to the first, second and third planes. The fourth and the fifth planes may in turn be horizontal planes.

[0016] The current interruption device may additionally comprise a number of arc chambers, each enclosing a corresponding group of arc plates and each equipped with a gas exhaust opening.

[0017] Each arc chamber may surround a corresponding end of the moveable contact element of a corresponding arc contact. A gas exhaust opening may additionally be provided in a wall of the arc chamber that is parallel to the third plane and perpendicular to the plane in which the corresponding moveable contact element is moveable.

[0018] It is additionally possible that each arc contact comprises a second contact area separated from the first contact area by a gap and a second group of arc plates placed adjacent a movement path of a second end of the

moveable contact element in relation to the second contact area. The second contact area of an arc contact may also be a part of the stationary contact element comprising the corresponding first contact area.

[0019] The first contact area of the first arc contact and the first contact area of the second arc contact may be placed on a first side of the third plane, while the second contact area of the first arc contact and the second contact area of the second arc contact may be placed on an opposite second side of the third plane, where the second contact areas of the first and second arc contacts may additionally be electrically interconnected via a conductor placed in the fifth plane, which conductor may be running in parallel with the third plane.

[0020] The main contact may likewise comprise a second contact area and the moveable contact element of the main contact may in this case also comprises a second end, which second end may be moveable in relation to the second contact area. The second contact area may also be a part of the stationary contact element comprising the first contact area.

[0021] Also, the second contact area of the main contact may be placed in the fourth plane, while the second contact areas of the arc contacts may be placed in the fifth plane.

[0022] It is additionally possible that the movement path of the first end of the moveable contact element of an arc contact is straight and the arc plates of the corresponding first group of arc plates may be placed in a stack that is parallel to this movement path.

[0023] It is likewise possible that the movement path of the second end of the moveable contact element of an arc contact is straight and the arc plates of the corresponding second group of arc plates are placed in a stack that is parallel to this movement path.

[0024] The current interruption device may be a contactor.

[0025] The present invention has a number of advantages. It provides a compact current interruption device with a short arc time.

BRIEF DESCRIPTION OF THE DRAWINGS

[0026] The present invention will in the following be described with reference being made to the accompanying drawings, where

fig. 1 schematically shows a current interruption device comprising a main contact connected in parallel with a group of arc contacts,

fig. 2 schematically shows a first embodiment of the current interruption device, where each arc contact is equipped with two groups of arc plates,

fig. 3 shows a first perspective view of the current interruption device with the arc plates being enclosed in arc chambers, and

fig. 4 schematically shows a second perspective view of the current interruption device where the arc chambers have been removed,

fig. 5 schematically shows a number of vertical and horizontal planes in which the contact areas of the main and arc contacts are provided and in which the moveable contact elements of the main and arc contacts move, and

fig. 6 schematically shows an alternative realization of an arc contact.

DETAILED DESCRIPTION OF THE INVENTION

[0027] The present invention concerns a current interruption device, which may be provided in various types of electric equipment such as circuit breakers, switchgear etc. The current interruption device may more particularly be a contactor. It may additionally be employed in low voltage applications in alternating current (ac) or direct current (dc) systems, where the use in dc systems may be preferred. In low voltage applications then for instance applications of 1000 V and above are contemplated, such as at 1200 or 1500 V dc.

[0028] Fig. 1 schematically shows such a current interruption device 10 connected between a first and a second conductor 16 and 18. The current interruption device 10 comprises a main contact 12 and a group 14 of series-connected arc contacts, where the group 14 of arc contacts is electrically connected in parallel with the main contact 12.

[0029] Fig. 2 schematically shows the current interruption device in some more detail. The main contact 12 comprises a first and a second contact area 20 and 22, where the first contact area 20 is attached to the first conductor 16 and the second contact area 22 is attached to the second conductor 18. The main contact 12 also comprises a moveable contact element 24, which moveable contact element 24 is longitudinal and has a longitudinal axis defined through its middle. The moveable contact element 24 also has a first end 26 and a second end 28. The first and second contact areas 20 and 22 are separated by a gap. The two contact areas and the gap may together form a stationary contact element. The moveable contact element 24 is moveable along a movement path in relation to the gap as well as in relation to the first and second contact areas 20 and 22. In the present example the path is a path that is the same for both contact areas 20 and 22. More particularly, in the present example the movement path is at right angles to the gap or at right angles to the contact areas 20 and 22. In the example the movement path is vertically towards or away from the contact areas 20 and 22. The first end 26 of the moveable contact element is intended to make contact with the first contact area 20, while the second end 28 is intended to make contact with the second contact area 22. As can be seen the first end 26 of the moveable contact element 24 may for this reason be equipped with a first contact pad for making contact with the first contact area 20 and the second end 28 may be equipped with a second contact pad for making contact with the

second contact area 22. It should be realized that the contact pads are optional.

[0030] As can also be seen in fig. 2 the group of arc contacts comprises a first arc contact connected in series with a second arc contact.

[0031] The first arc contact likewise comprises a first and a second contact area 30 and 32, where the first contact area 30 is connected to the first conductor 16 and the second contact area 20 is connected to the second arc contact. The first arc contact also comprises a moveable contact element 34, which moveable contact element 34 also is longitudinal and has a longitudinal axis defined through its middle. The moveable contact element 34 also has a first end 36 and a second end 38. The first and second contact areas 30 and 32 are separated by a gap and the first and second contact area 30 and 32 together with the gap forms a stationary contact element. The moveable contact element 34 is moveable along a movement path in relation to the gap as well as in relation to the first and second contact areas 30 and 32. In the present example the path is a path that is the same for both contact areas 30 and 32. More particularly, the movement path is at right angles to the gap between the contact areas 30 and 32. In this example the movement path is vertically towards or away from the contact areas 30 and 32. The first end 36 of the moveable contact element 34 is intended to make contact with the first contact area 30, while the second end 38 is intended to make contact with the second contact area 32. As can be seen the first end of the moveable contact element 34 may for this reason be equipped with a first contact pad for making contact with the first contact area 30 and the second end 38 may be equipped with a second contact pad for making contact with the second contact area 32. Also, these contact pads are optional.

[0032] The second arc contact also comprises a first and a second contact area 40 and 42, where the first contact area 40 is connected to the second conductor 18 and the second contact area 42 is connected to the first arc contact. The second contact area 42 of the second arc contact is in fact connected to the second contact area 32 of the first arc contact. The second arc contact also comprises a moveable contact element 44, which moveable contact element 44 also is longitudinal and has a longitudinal axis defined through its middle. The moveable contact element 44 also has a first end 46 and a second end 48. The first and second contact areas 40 and 42 are separated by a gap, where the first and second contact area 40 and 42 together with the gap forms a stationary contact element. The moveable contact element 44 is moveable along a movement path in relation to the gap as well as in relation to the first and second contact areas 40 and 42. In the present example the path is a path that is the same for both contact areas 40 and 42. More particularly, the movement path is at right angles to the gap between the contact areas 40 and 42. In this example the movement path is vertically towards or away from the contact areas 40 and 42. The first end 46 of the moveable contact element 44 is intended to make contact with the first contact area 40, while the second end 48 is intended to make contact with the second contact area 42. As can be seen the first end 40 of the moveable contact element 44 may for this reason be equipped with a first contact pad for making contact with the first contact area 40 and the second end 48 may be equipped with a second contact pad for making contact with the second contact area 32. Also, here the contact pads are optional.

[0033] It can thereby be seen that the main contact 12 and each arc contact comprises a first contact area 20, 30, 40 and a moveable contact element 24, 34, 44, where the moveable contact element 24, 34, 44 is moveable in relation to the first contact area 20, and where the first contact area may be a part of a stationary contact element. As can also be seen, each arc contact may additionally comprise a second contact area 32 and 42 separated from the first contact area 30 and 40 by a gap, which may also be a part of the stationary contact element. The moveable contact element 24, 34 and 44 is thereby also moveable in relation to the second contact area 22, 32, 42. The first end 26, 36, 46 of the moveable contact element 24, 34, 44 may more particularly be moveable in relation to the first contact area 20, 30, 40, while the second end 28, 38 and 48 of the moveable contact element 24, 34, 44 may be moveable in relation to the second contact area 22, 32, 42.

[0034] As can also be seen the first arc contact is also provided with a first and a second group of arc plates 50 and 52, where the plates of the first group 50 are placed adjacent the movement path of the first end 36 of the moveable contact element 34 and the plates of the second group 52 are placed adjacent the movement path of the second end 38 of the moveable contact element 34. In this case the plates are also placed along the movement paths. The plates of the first group 50 are more particularly placed between a first position formed by the first contact area 30 and a second position being a maximum open position of the arc contact, which may be the maximum open position of the arc contact. In fact, the maximum open position may be the maximum open position of the moveable contact element. The second position may more particularly be the location of the first end of the moveable contact element, when the moveable contact element is in its maximum open position. The plates of the second group 52 are in a similar manner placed between a first position formed by the second contact area 32 and a second position being a maximum open position of the arc contact, which in fact may be the maximum open position of the moveable contact element. The second position may more particularly be the location of the second end of the moveable contact element, when the moveable contact element is in its maximum open position.

[0035] The second arc contact is equipped with a first and a second group of arc plates 54 and 56 in the same way as the first arc contact.

[0036] As can be seen the plates of the first group 54 of arc plates are placed adjacent, here along, the movement path of the first end 46 of the moveable contact element 44 and the plates of the second group 56 are placed adjacent, here along, the movement path of the second end 48 of the moveable contact element 44. The plates of the first group 54 are more particularly placed between a first position formed by the first contact area 40 and a second position being a maximum open position of the arc contact. The plates of the second group 56 are in a similar manner placed between a first position formed by the second contact area 42 and a second position being a maximum open position of the arc contact.

[0037] Thereby it can also be seen that each arc contact comprises a first group 50 and 54 of arc plates placed adjacent a movement path of a first end 36 and 46 of the moveable contact element 34 and 44 in relation to the first contact area 36 and 46. Each arc contact may additionally comprise a second group 52 and 56 of arc plates placed adjacent a movement path of a second end 38 and 48 of the moveable contact element 34 and 44 in relation to the second contact area 32 and 42.

[0038] The movement path of the first end 36 and 46 of the moveable contact element 34 and 44 of an arc contact can also be straight and the arc plates of the corresponding first group 50 and 54 of arc plates may be placed in a stack that is parallel to this movement path. In a similar manner the movement path of the second end 38 and 48 of the moveable contact element 34 and 44 of an arc contact can also be straight and the arc plates of the corresponding second group 52 and 56 of arc plates may be placed in a stack that is parallel to this movement path.

[0039] The current interruption device additionally comprises a number of arc chambers, each enclosing a corresponding group of arc plates. Each group of arc plates is thus enclosed in an arc chamber, where only a first such arc chamber 58 enclosing the first group 50 of arc plates is indicated in fig. 2. It should here be realized that the contacts may have the opposite orientation. The second contact area 32 of the first arc contact may thus be connected to the first conductor 16 and the second contact area 42 of the second arc contact may be connected to the second conductor 18, with the first contact areas 30 and 42 of the two arc contacts being interconnected. As an alternative the first arc contact may have the orientation shown in fig. 2, while the second arc contact has the opposite orientation or vice versa. Also, the main contact 12 may have the opposite orientation where the first contact area 20 is connected to the second conductor 18 and the second contact area 22 is connected to the first conductor 16. In all the above-described situations the first end of a moveable contact element is to make contact with a first contact area, while there second end is to make contact with a second contact area.

[0040] Another possible variation is that the contacts may be realized through the second end of moveable contact element being rotatably joined to a joint that replaces the second contact area. In this case there is thus only one contact area in the contact, the first contact area with which the first end of the moveable contact element is to make contact. This contact area may then then form a stationary contact element. Naturally, an arc contact realized in this way will then only be equipped with one group of arc plates.

[0041] Further aspect of the current interruption device will now be discussed with reference also being made to fig. 3-5, where fig. 3 shows a first perspective view of the current interruption device with the arc plates being enclosed in arc chambers, fig. 4 schematically shows a second perspective view of the current interruption device, where the arc chambers have been removed and fig. 5 schematically shows a number of vertical and horizontal planes in which the contact areas of the main and arc contacts are provided and in which the moveable contact elements of the main and arc contacts move.

[0042] The current interruption device comprises a gear mechanism 70. This gear mechanism 70 moves the moveable contact element 24 of the main contact 12 with a first speed and the moveable contact elements 34, 44 of the arc contacts 14 with a second speed that is higher than the first speed, where the second speed may with advantage be four times higher. The gear mechanism 70 may additionally be operated by an electromagnet.

[0043] For this reason, the current interruption device may comprise an actuating unit that is vertically moveable for actuating the moveable contact elements 24, 34 and 44 of the main and arc contacts from an open position to a closed position or vice versa.

[0044] The gear mechanism 70 may include a first rack and a first gear arranged to be cooperated with the first gear. It may additionally comprise a second rack and a second gear arranged to be cooperated with the second rack. The moveable contact elements of the arc contacts may be attached to the first rack. The second rack may in turn be attached to the moveable contact element of the main contact that additionally may be connected to the actuating unit. The first and second gears may additionally be co-mounted on a shaft.

[0045] During an interrupting/switching off operation, the actuating unit actuates the moveable contact element of the main contact and the second rack. The second rack and second gear translate the liner movement of the actuation to a rotational movement of the second gear. Since the first gear and second gear are mounted on the same shaft, the rotation of the second gear is transferred to a rotation of the first gear. With the meshed first rack, the rotation of the first gear is translated to a liner movement of the first rack thus actuating the moveable contact elements 34 and 44 of the arc contacts. Due to the fact that the radius of the first gear is bigger than the radius of the second gear, the moveable contact elements of the arc contacts move with a higher speed than the moveable contact element of the main contact, where, as was mentioned earlier, the speed ratio may be 4:1.

[0046] How the gear mechanism 70 may be realized can also be seen in US 2009/0066939, which is herein incorporated by reference.

[0047] The moveable contact element 34 of the first arc contact is moveable in a first plane, the moveable contact element 44 of the second arc contact is moveable in a second plane and the moveable contact element 24 of the main contact is moveable in a third plane, where the first and second planes are parallel with each other and also perpendicular to the third plane. Both the first and the second planes are thus perpendicular to the third plane. In the present example, the first, second and third planes are also vertical planes. The first plane is thus a first vertical plane VP1, the second plane a second vertical plane VP2 and the third plane a third vertical plane VP3.

[0048] The first vertical plane VP1 is additionally placed at a first side of the main contact 12 facing the first end 26 of its moveable contact element 24. The second vertical plane VP2 is in turn placed at a second side of the main contact facing the second end 28 of its moveable contact 24. The first arc contact is thereby placed at the first end 26 of the moveable contact element 24 of the main contact 12 and the second arc contact is placed at the second end 28 of the moveable contact element 24 of the main contact 12,

[0049] Since the moveable contact elements 34 and 44 of the arc contacts move in the first and second vertical planes VP1 and VP2 and the moveable contact element 24 of the main contact moves in the third vertical plane VP3, where the first and second vertical planes VP1 and VP2 are parallel and perpendicular to the third vertical plane VP3, the orientation of the moveable contact element of each arc contact is angled to the orientation of the moveable contact element 24 of the main contact 12 with an angle, which angle with advantage is ninety degrees.

[0050] The moveable contact element 34 of the first arc contact is thus angled to the orientation of the moveable contact element 24 of the main contact 12 by an angle of ninety degrees. Thereby the longitudinal axis of the moveable contact elements 34 of the first arc contact is perpendicular to the longitudinal axis of the moveable contact element 24 of the main contact 12. In a similar manner the moveable contact element 44 of the second arc contact is angled to the orientation of the moveable contact element of the main contact 12 by an angle of ninety degrees. Thereby the longitudinal axis of the moveable contact elements 34 of the first arc contact is perpendicular to the longitudinal axis of the moveable contact element 24 of the main contact 12.

[0051] The first contact area 30 of the first arc contact is placed on one side of the thrid vertical plane VP3 in which the moveable contact element 24 of the main contact 12 moves and the first contact area 40 of the second arc contact is placed on the same first side of the thrid vertical plane VP3 in which the moveable contact element 24 of the main contact 12 moves.

[0052] The second contact area 32 of the first arc contact is in turn placed on an opposite second side of the moveable contact element 24 of the main contact 12 in relation to the thrid vertical plane VP3 and the second contact area 42 of the second arc contact is placed on the same second side of the third vertical plane VP3.

[0053] The first contact areas 30 and 40 of the first and second arc contacts are thus placed on a first side of the third vertical plane VP3, while the second contact areas 32 and 42 of the first and second arc contacts are placed on a second opposite side of the third vertical plane VP3.

[0054] The second contact areas 32, 42 of the first and second arc contacts are furthermore electrically interconnected by a conductor 72 running in parallel with the moveable contact element 24 of the main contact 12. The conductor 72 is thereby also placed on the second side of the third vertical plane.

[0055] The main contact may be a double contact comprising a second moveable element interacting with third and fourth contact areas, where the second moveable contact is placed in a further vertical plane that is parallel with the third vertical plane. In this case the gear mechanism may be placed between the two moveable contact elements. Furthermore, in this case the first contact areas of the first and second arc contacts would be placed on a first side of both the third and the further vertical plane, while the second contact areas of the first and second arc contacts would be placed on a second opposite side of both the third and the further vertical plane with the gear mechanism placed between first side of the further vertical plane and the second side of the third vertical plane.

[0056] Furthermore, the first and second contact areas 20 of the main contact 12 are placed in a fourth plane. The first and second contact areas 30 and 32 of the first arc contact and the first and second contact areas 40 and 42 of the second arc contact 14 are placed in a fifth plane that is parallel with the fourth plane. The contact areas 20 and 22 of the main contact 12 and the gap that separates them are thereby provided in the fourth plane, while the contact areas 30, 32, 40 and 42 of the arc contacts and the gaps that separate them are provided in the fifth plane. The previously mentioned interconnecting conductor 72 may also be placed in the fifth plane.

[0057] The fourth and fifth planes are furthermore perpendicular to the first, second and third vertical planes VP1, VP2 and VP3. In the given example the third and the fourth planes are horizontal. Thereby the fourth plane may be a first horizontal plane HP1 and the fifth plane may be a second horizontal plane HP2.

[0058] Moreover, it can be seen in fig. 3 that there is a first, second, third and fourth arc chamber 58, 62, 64 and 66. In this case the first arc chamber 58 encloses the first group of arc plates of the first arc contact and the second arc chamber 62 encloses the second group of arc plates of the first arc contact. The third arc chamber 64 in turn encloses the second group of arc plates of the second arc contact, while the fourth arc chamber 66 encloses

the first group of arc plates of the second arc contact. Each arc chamber is additionally equipped with a gas exhaust gas opening, where only the gas exhaust openings 60 and 68 of the first and the fourth arc chambers 58 and 66 are shown in fig. 3. Each arc chamber may additionally surround a corresponding end of the moveable contact element of a corresponding arc contact as it moves between the first position formed by the corresponding contact area and the second position formed by the maximum position of the moveable contact element. The first arc chamber 58 may surround the first end 36 of the moveable contact element 34 of the first arc contact, the second arc chamber 62 may surround the second end 38 of the moveable contact element 34 of the first arc contact, the third arc chamber 64 may surround the second end 48 of the moveable contact element 44 of the second arc contact and the fourth arc chamber 66 may surround the first end 46 of the moveable contact element 44 of the second arc contact.

[0059] The gas exhaust openings 60 and 68 are each provided in a wall of the corresponding arc chamber 58 and 66, which wall is perpendicular to the vertical plane in which the corresponding moveable contact element 34 and 44 of the corresponding arc contact moves. It is likewise vertical and also perpendicular to the vertical plane in which the corresponding moveable contact element moves. Furthermore, the wall is placed furthest away from the end of the moveable contact element. It is thus a wall that is at right angles to the vertical plane in which the moveable contact element moves as well as furthest away from the corresponding end of the moveable contact element. The wall with the gas exhaust opening is thereby also placed at an outer edge of the current interruption device 10. The wall is additionally parallel to the third plane VP3 in which the moveable contact element 24 of the main contact moves 12.

[0060] It can thus be seen that the gas exhaust opening 60 of the first arc chamber 58 is placed in a wall of the arc chamber 58 that is perpendicular to the first vertical plane VP1 in which the moveable contact element 34 of the first arc contact moves and furthest away from the first end 36 of this moveable contact element 36. The wall with the gas exhaust opening 60 is thereby also placed at a first outer edge of the current interruption device 10.

[0061] It can likewise be seen that the gas exhaust opening 68 of the fourth arc chamber 66 is placed in a wall of the arc chamber 66 that is perpendicular to the second vertical plane VP2 in which the moveable contact element 44 of the second arc contact moves and furthest away from the first end 46 of this moveable contact element 46. The wall with the gas exhaust opening 68 is thereby also placed at the first outer edge of the current interruption device 10.

[0062] Although it is not explicitly shown in fig. 3, it is understood that the gas exhaust openings in the second and third arc chambers 62 and 64 are realized in the same way.

[0063] The gas exhaust opening of the second arc chamber 62 is thus placed in a wall of the arc chamber 62 that is perpendicular to the first vertical plane VP1 in which the moveable contact element 34 of the first arc contact moves and furthest away from the second end 38 of this moveable contact element 36. The wall with the second gas exhaust opening is thereby also placed at a second outer edge of the current interruption device 10, which second edge is opposite to the first edge.

[0064] The gas exhaust opening of the third arc chamber 64 is placed in a wall of the arc chamber 64 that is perpendicular to the second vertical plane VP2 in which the moveable contact element 44 of the second arc contact moves and furthest away from the second end 48 of this moveable contact element 46. The wall with the gas exhaust opening is thereby also placed at the same second outer edge of the current interruption device 10 as the gas exhaust opening of the second arc chamber 62.

[0065] The current interruption device may be provided in a system having an operating voltage, for instance an operating voltage of 1500 V dc. For this voltage it may additionally be able to interrupt currents of up to 4000A.

[0066] In operation the main contact is opened, for instance using an electromagnet. During the procedure of interrupting the current, the main contact (carrying most of the current) is opened in advance of the arc contacts. The current then commutates to the series-connected arc contacts and an arc is ignited in each arc contact when these open. The main and arc contacts are connected to each other through the previously described gear mechanism 70, for instance at a ratio of 1 to 4. The arc contacts then have a stroke four times the main contact. Operation of the contacts is powered by an electromagnet.

[0067] For a current interruption device where there is one arc contact in parallel with a main contact, the arc voltage created by the arc needs to be sufficiently high, where in the dc case it needs to be higher than the system voltage in order to interrupt the current. In the ac case current interruption is achieved through the zero-crossing. To reach a sufficient arc voltage a number of arc plates are placed between a fixed contact area and an end of a corresponding moveable contact element in order to divide the arc in to sub arcs. As an example, each sub arc may create roughly 25V in arc voltage. To break 1500V d.c. requires several arc plates and takes up a lot of space. Especially if they are stacked on top of each other the finished product risks to be very high (deep). Another problem is that the time it takes to break the current is set by the time it takes for the moveable contact element of the arc contact to reach the maximum position at the top of the arc chamber. A long distance gives a long arc time.

[0068] Through instead providing two series-connected arc contacts the same type of current interruption can be achieved. Additionally, each arc chamber will include fewer arc plates. If two arc contacts are connected in parallel with the main contact instead of one, then the

number of arc plates in each arc chamber can be halved. Thereby the height of the arc chambers is reduced, and a more compact current interruption device is obtained. Therefore, the space usage in the current interruption device may be more efficient. Furthermore, through the number of arc plates being reduced also the arc time is reduced, which improves the robustness of the current interruption device. The wear of the current interruption device is thereby also lowered.

[0069] The use of the gear mechanism has the advantage of lowering the arc time even more.

[0070] Through angling the orientation of the moveable contact elements of the arc contacts to the orientation of the moveable contact element it is additionally possible to place all gas exhaust openings so that exhaust gases generated by an arc can efficiently exit the current interruption device. It may also simply the design considerations, in that it does not matter which contact area of the first arc contact that is connected to which contact area of the second arc contact while still obtaining effective exhaust gas exiting.

[0071] The used placing of the arc contacts in relation to the main contact furthermore provides further improvements of the compactness, of the current interruption device, for instance with regard to conductor path lengths, while at the same time ensuring that no conductor paths need to cross each other.

[0072] From the foregoing discussion it is evident that the present invention can be varied in a multitude of ways.

[0073] One obvious variation was the previously described contact realization, where the second end of moveable contact element is rotatably joined to a joint that replaces the second contact area so that there is only the first contact area with which the first end of the moveable contact element is to make contact. One arc contact according to this variation is schematically shown in fig. 6. As can be seen the arc contact only has one group 50 of arc plates and a moveable contact element 34 that only makes contact with a first contact area 30.

[0074] It shall consequently be realized that the present invention is only to be limited by the following claims.

Claims

1. A current interruption device (10) comprising a main contact (12) and a group (14) of series-connected arc contacts including a first and a second arc contact, wherein the main contact (12) and each arc contact comprises a first contact area (20, 30, 40) and a moveable contact element (24, 34, 44), where the moveable contact element (24, 34, 44) is moveable in relation to the first contact area (20, 30, 40) and each arc contact comprises a first group of arc plates (50, 52) placed adjacent a movement path of a first end (36, 46) of the moveable contact element (34, 44) in relation to the first contact area (30, 42), where the group of series-connected arc contacts (14) is electrically connected in parallel with the main contact (12).

2. The current interruption device (10) according to claim 1, further comprising a gear mechanism (70) configured to move the moveable contact element (24) of the main contact (12) with a first speed and the moveable contact elements (34, 44) of the arc contacts (14) with a second speed that is higher than the first speed.

3. The current interruption device (10) according to claim 2, wherein the second speed is four times higher than the first speed.

4. The current interruption device (10) according to any previous claim, wherein the orientation of the moveable contact element (34, 44) of each arc contact is angled to the orientation of the moveable contact element (24) of the main contact (12) with an angle.

5. The current interruption device (10) according to claim 5, wherein the angle is an angle of ninety degrees.

6. The current interruption device (10) according to any previous claim, wherein the first arc contact is placed at a first end (20) of the moveable contact element (24) of the main contact and the second arc contact is placed at a second end (22) of the moveable contact element of the main contact.

7. The current interruption device (10) according to any previous claim, wherein the moveable contact elements (24, 34) of the arc contacts (14) are moveable in a first plane (VP1) and a second plane (VP2), respectively, while the moveable contact element (24) of the main contact is moveable in a third plane (VP3), where the first and second planes (VP1, VP2) are parallel with each other and perpendicular to the third plane (VP3).

8. The current interruption device (10), according to claim 7, wherein the first contact element (20) of the main contact (12) is placed in a fourth plane (HPi) and the first contact elements (30, 40) of the arc contacts (14) are placed in a fifth plane (HP2) that is parallel with the fourth plane, where the fourth and fifth planes (HP1, HP2) are perpendicular to the first, second and third planes (VP1, VP2, VP3).

9. The current interruption device (10) according to any previous claim, further comprising a number of arc chambers (58, 62, 64, 68), each enclosing a corresponding group of arc plates (50, 52, 54, 56) and each equipped with a gas exhaust opening (60, 68).

10. The current interruption device (10) according to claim 9 when depending on claim 7, wherein each arc chamber surrounds a corresponding end (36, 38) of the moveable contact element (34, 44) of a corresponding arc contact and comprises a gas exhaust opening (60, 68) in a wall of the arc chamber (58, 66) that is parallel to the third plane (VP3) and perpendicular to the plane (VP1, VP2) in which the corresponding moveable contact element (34, 44) is moveable.

11. The current interruption device (10) according to any previous claim, wherein each arc contact comprises a second contact area (32, 42) separated from the first contact area (30, 40) by a gap and a second group of arc plates (54, 56) placed adjacent a movement path of a second end (38, 48) of the moveable contact element (34, 44) in relation to the second contact area.

12. The current interruption device (10) according to claim 11 when depending on claim 7, wherein the first contact area (30) of the first arc contact and the first contact area (40) of the second arc contact are placed on a first side of the third plane (VP3), while the second contact area (32) of the first arc contact and the second contact area (42) of the second arc contact are placed on an opposite second side of the third plane (VP3), said second contact areas (32, 42) of the first and second arc contacts being electrically interconnected via a conductor (72) running in parallel with the third plane (VP3).

13. The current interruption device (10) according to claim 11 or 12, wherein the main contact (12) comprises a second contact area (22) and the moveable contact element (24) thereof comprises a second end (28) moveable in relation to the second contact area (22) along a corresponding movement path.

14. The current interruption device (10) according to claim 13 when depending on claim 8, wherein also the second contact area (22) of the main contact (12) is placed in the fourth plane (HPi), and the second contact areas (32, 42) of the arc contacts (14) are placed in the fifth plane (HP2).

15. The current interruption device (10) according to any previous claim, wherein the movement path of the first end of the moveable contact element of an arc contact is straight and the arc plates of the corresponding first group of arc plates are placed in a stack that is parallel to this movement path.

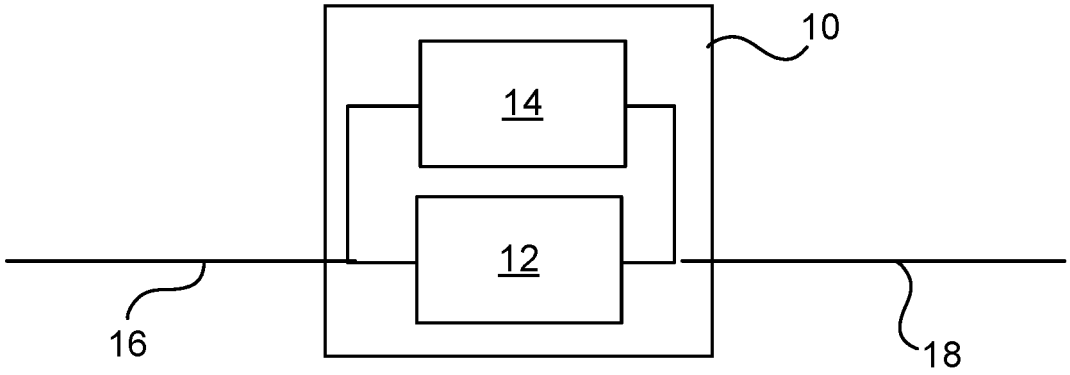
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Fig. 1

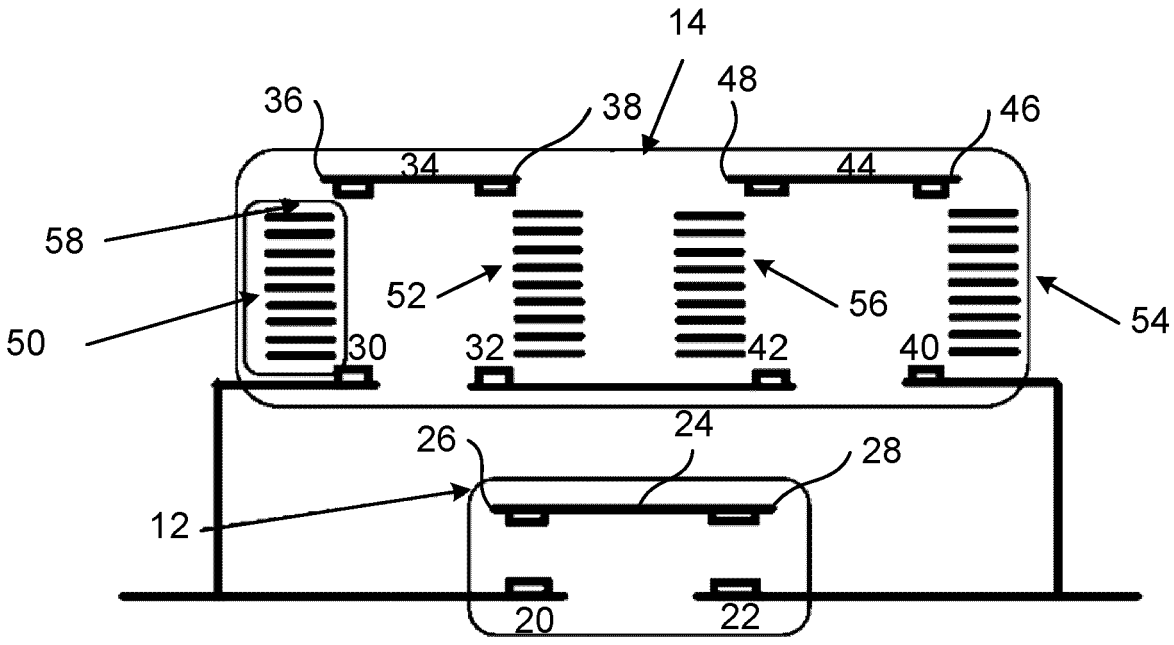
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Fig. 2

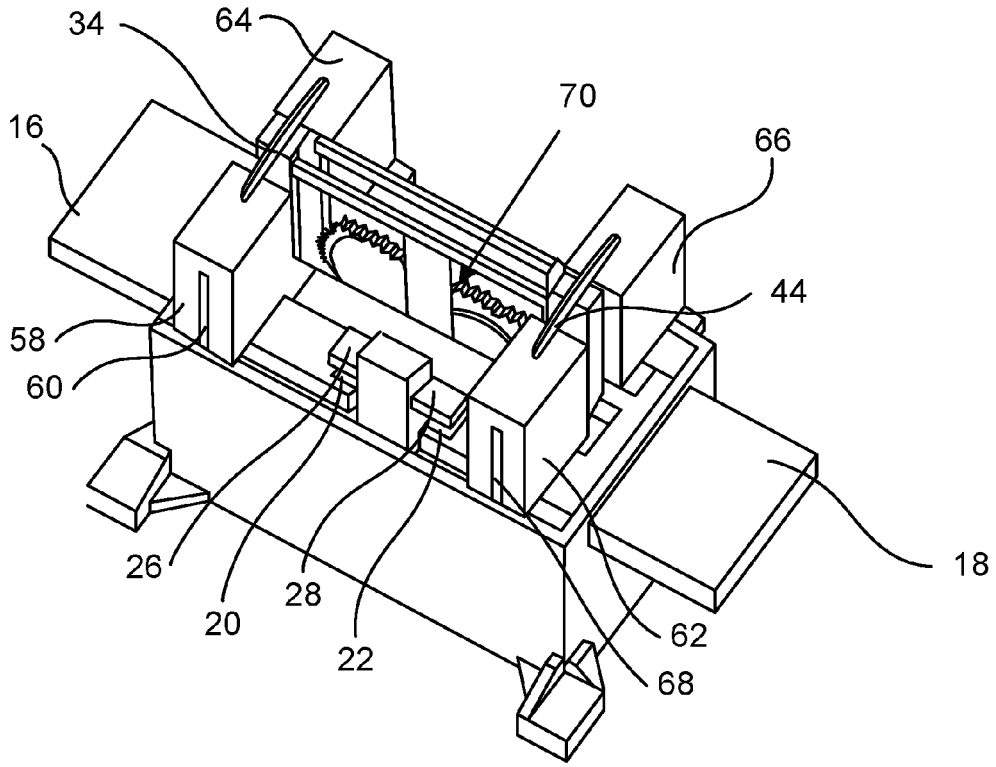
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Fig. 3

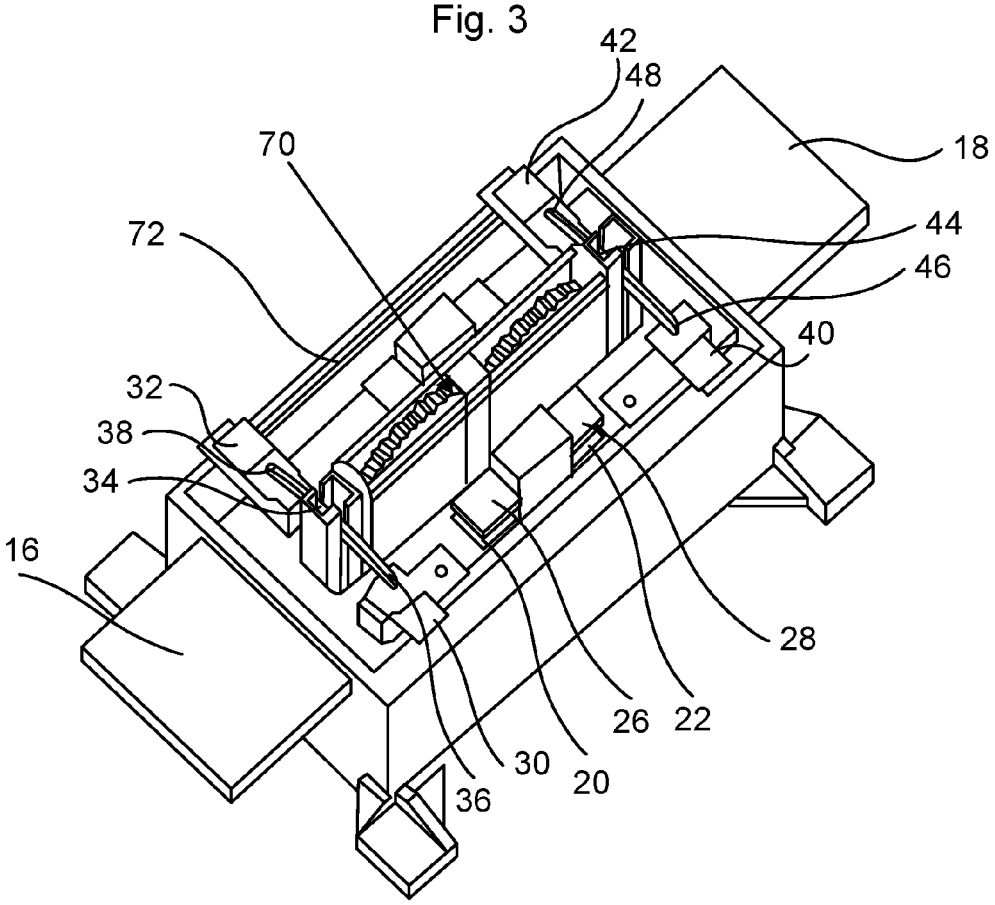
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Fig. 4

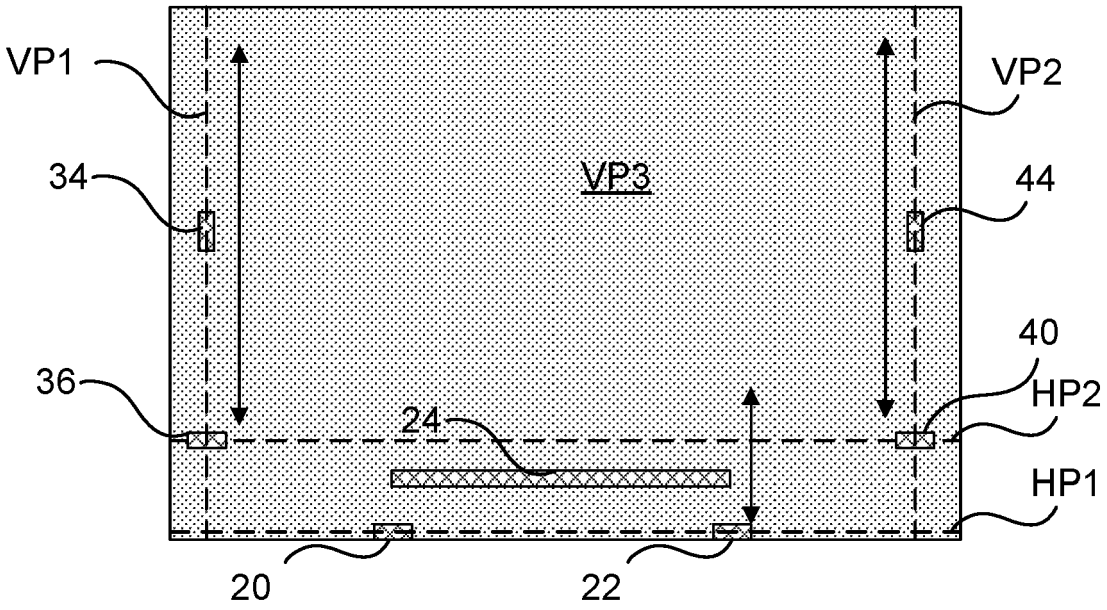

Fig. 5

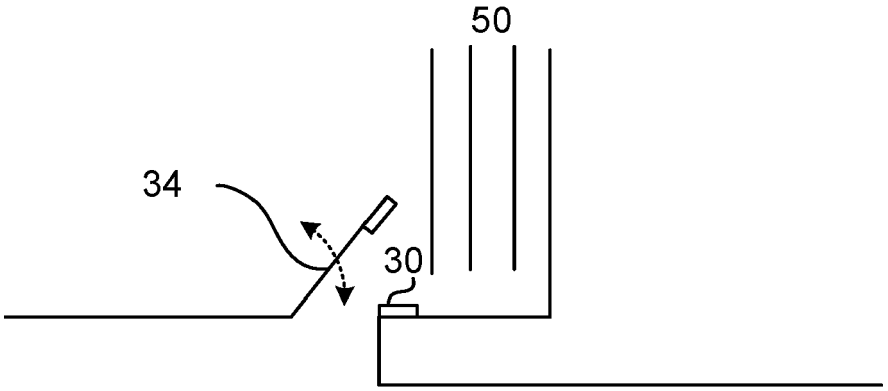

Fig. 6

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EUROPEAN SEARCH REPORT

Application Number
EP 21 17 0908

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X A	WO 2017/059910 A1 (ABB SCHWEIZ AG [CH]) 13 April 2017 (2017-04-13) * page 6, line 30 - page 10, line 21; figures 2,3a-3f * -----	1-3,6,9, 11,13,15 4,5,7,8, 10,12,14	INV. H01H9/38 H01H33/12 ADD.
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H01H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	22 September 2021	Pavlov, Valeri

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