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(54) Title: ELECTRIC CURRENT SWITCHING APPARATUS

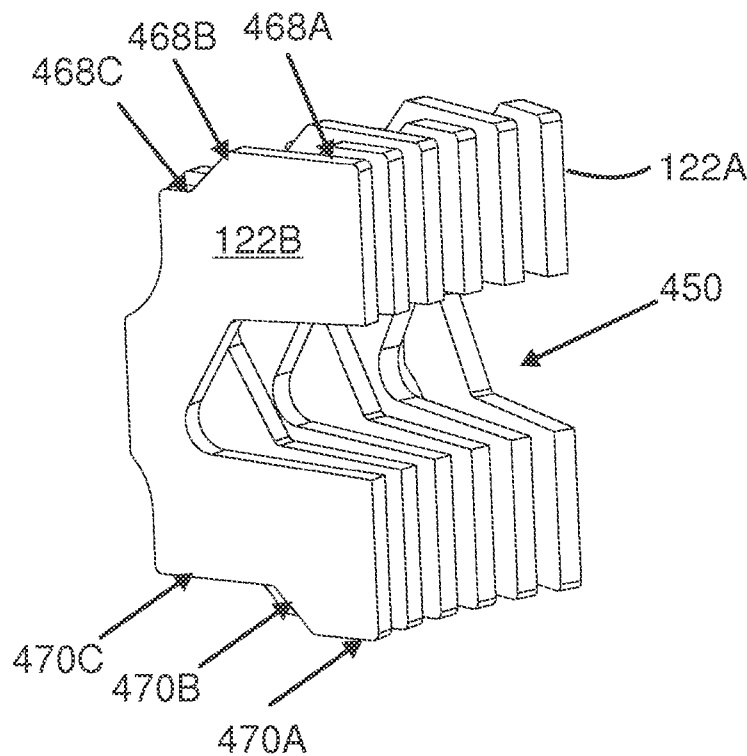


Fig. 4A

(57) Abstract: An arc quenching plate for an electric switch comprising a first mounting portion and a second mounting portion for mounting the quenching plate to respective recesses of the switch. The first mounting portion (468) and the second mounting portion (470) have a different form when compared to each other.

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ELECTRIC CURRENT SWITCHING APPARATUS

FIELD

The present invention relates to an electric current switching apparatus.

BACKGROUND

5 A known problem associated with opening a DC current is that an arc builds between the contacts of the switch when the contact are separated from each other. The arc is erosive and may thus damage nearby parts of the switch.

 There have been attempts to use a magnetic field, produced by permanent magnets or a coil placed in proximity of the contacts, to blow the arc away to
10 quenching plates. Often the case is that currents close to the nominal current are easier to switch than currents that are small compared to the nominal current. This is due to that an arc associated with a nominal current seeks to the quenching plates but an arc with low current more easily remains to burn between the contacts of the switch.

15 Current solutions quenching an arc in the switches are either complicated or do not fully meet the demand for durability of the switch.

SUMMARY

 An object of the present invention is to provide a switch so as to alleviate the above disadvantages. The object of the invention is achieved with a switch,
20 which is defined in the independent claim. Some embodiments are disclosed in the dependent claims.

 The invention relates to an electric switch for switching electric current. The application areas of the switch include electric motors and solar systems, for instance.

25 In the switch according to the invention there is provided an arc chamber for quenching an arc caused by separating the contacts of the switch. The arc chamber houses a plurality of quenching plates, and there is provided a permanent magnet for blowing the arc towards the plates.

 The quenching plates have a bottom portion and side portions extending
30 from the bottom portion. The permanent magnet is arranged such that the arc

is directed towards one of the side portions of the plates.

The present invention provides the important advantage in that the switch is easy to mount and is effective in quenching the arc caused by the separation of switch contacts.

5 DRAWINGS

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

- Figure 1 shows an embodiment of a switch;
- 10 Figure 2 shows the switch of Figure 1 from another viewing angle;
- Figure 3 highlights an arc chamber;
- Figure 4A shows a group of quenching plates; and
- Figure 4B shows one quenching plate from the side.

DETAILED DESCRIPTION

- 15 Figure 1 shows one embodiment of a single-pole electric switch 100 without a top cover. The switch has an electrically insulating module housing 102, and by stacking such modules together, multi-pole switches can be constructed.

- At the ends of the switch there are stationary contacts 104, 106 for connecting the switch to power terminals. A movable/rotary contact 108 comprises
20 contact arms 110, 112, between which a contact portion of the stationary contact 106 fits when the contact is made. The contact arms of the rotary contact may have a form of a lengthy knife, for instance.

- Figure 1 shows the switch in the open position, where the contact arms 110, 112 of the movable contact are not in contact with the stationary contact but
25 rest against a stoppage element 116.

- The switch also includes an arc chamber 120 for quenching an arc caused by separating the contacts from each other. The arc chamber houses a plurality of quenching plates 122 via which the contact arms 110, 112 of the movable contact move when the switch is opened. As the figure shows, the quenching
30 plates are arranged to the arc chamber next to each other such that they distance away from the contact area of the rotary contact and the stationary con-

tact. That is, the second quenching plate lies further away from the contact area than the first quenching plate.

There is also provided a permanent magnet 132, which is placed into a housing 130 for the magnet. The housing residing in the first switch module housing 100 comprises a wall portion that is provided between the magnet and the contact area and the plates. There may be provided also side portions extending perpendicularly from the wall portion. The purpose of the wall portion and the side portion is to keep the magnet in its place thereby resisting the traction between the magnet and the plates, and protecting the magnet from the erosive effects of the arc. A second switch module housing to be mounted to the first switch module housing 100 may comprise a support portion, which supports the magnet in housing 130 and further protects it from the arc.

The position of the housing is behind the quenching plates, and at the beginning of the arc chamber when seen from the stationary contact point of view. Preferably the permanent magnet is positioned such that it is behind one or more such plates that lie closest to the contact area. In the embodiment of Figure 1, the magnet lies behind substantially the first half of the quenching plates. In this way, sufficient blowing effect can be caused to the arc immediately when the arc builds up to push it towards one of the side portions of the plates. In Figure 1, the arc is thus blown towards the side of the plates that is arranged against the bottom of the housing, or towards the opposite side of the plates, depending on which way the current is arranged.

Figure 2 shows the switch 100 of Figure 1 seen from the top.

It can be seen that the stationary contact 106 has a plane-like contact portion 106A to be contacted by the contact arm 110 of the movable contact. When the movable contact arm 110 is in contact with the stationary contact 106A, the arm rests substantially against the stoppage element 118.

In the embodiment of Figure 2, there are six quenching plates placed to the arc chamber 120 such that there are small intervals between the plates. The first quenching plate 122A is in immediate proximity, or even in contact, of the stationary contact 106A and the last plate 122B may be arranged such that the arm 110 is not in the area of plates when the movable contact is in its open position.

The quenching plates have a base/bottom portion and two side portions extending from the base portion, that is, the base portion connects the side portions. The side portions may be arranged substantially parallel to each other. An example of such a form is a letter U form. In Figure 2, the base of the quenching plates 122A, 122B points towards the end of the switch having the stationary contact 106, that is, the base points substantially towards the magnet 132. The plate is thus arranged such that the base resides thus between the magnet 132 and the quenching area of the plate, which is the area between the side portions of the plate. In the viewing angle of Figure 2, mainly the top side portions of the plates are visible to the top.

The permanent magnet 132 may have a rectangular cross-section in the horizontal direction as Figure 2 shows. In vertical direction, the cross-section of the magnet may be a square or rectangle, for instance. The poles of the magnet are arranged such that magnetic field B of the magnet is directed in the horizontal plane, which is highlighted by the two-headed arrow. The direction of the magnetic field between the two alternatives depends on which way the permanent magnet is placed to the housing 130. In either direction, the magnetic field is substantially parallel to the principal directions of the side portions, and perpendicular to the base portion of the plates. The magnetic field is thus substantially parallel to the longitudinal direction of the rotary contact at the point of rotation of the rotary contact when it separates from the stationary contact, which is the point where the arc builds up.

The square cross-section form of the permanent magnet and the housing is advantageous as the magnet can be mounted to the housing in any position and the magnetic field B is directed in one of the directions shown in Figure 2. If the permanent magnet has a square form, there are eight available mounting positions for the magnet. The person doing the assembly can mount the magnet to the magnet housing in any of the eight positions, and the magnet field produced by the magnet is one of the alternatives shown in Figure 2.

The permanent magnet according to embodiments may be a small-sized magnet. In an example, the dimensions of the magnet are 1 cm * 1 cm * 2 mm. With such a small-sized magnet, special advantages are achieved when quenching small currents compared to the nominal current.

If the cross-section of the magnet on the side that faces the quenching plates is rectangular, there are four available mounting positions. There are also other forms that could be used, such as square or triangular. In the case of a triangular magnet there are six mounting positions and in the case of a square, there are two alternative mounting positions.

The form of the magnet housing and the magnet are such that the magnet housing forces the person doing the assembly to place the magnet into the housing in a position that is acceptable and results the magnetic field to be created in a desired way. Thus, any mounting position the user chooses is acceptable and allowable. The mounting direction of the magnet thereby need not be indicated in any way.

Figure 2 shows also the alternatives for the direction of the current I in the arc when the switch is opened. The direction of the current can thus vary between the two alternatives depending on which way the stationary contacts are mounted to the power supply.

According to the Lorentz force law, the force F acting on a point charge is directed in vertical direction in the situation of Figure 2 depending on the direction of the magnetic field B and the current I . That is, the force F acting on the arc blows the arc towards one of the side portions of the quenching plates.

Figure 3 further highlights the structure of the arc chamber 120. In the arc chamber, there are six slots/recesses 140, 142 for receiving respective quenching plates. The number of slots and plates is not limited to six but can vary depending on the size of the switch and other design factors.

In an embodiment, there are two types of slots. The odd numbered slots 140A, 140B, that is the first, third and fifth slots are similar. Correspondingly, the even numbered slots 142A, 142B, that is the second, fourth and sixth slots are mutually similar. The quenching plates are formed such that the outer edge of the first side portion, that is, the first mounting portion, of the plate is suitable to for mounting to the odd numbered slots, and the edge of the other side portion, that is the second mounting portion, is suitable for mounting to the even numbered slots. Thereby the form of the slots and the plates force that the plates are mounted to the slots in a correct way. If the plates are not mounted correctly to the slots, the

plates may prevent mounting of the first and second switch module housings together.

The embodiment is not limited to that there would only be two different types of recesses in the switch, but there can be a greater number of different types of recesses. However, also in such a case the form of the recess is such
5 that it forces the quenching plate to be assembled in a correct position to the switch.

Figure 3 shows the bottom housing module 120 of a switch module. There is also provided a top housing module for the switch module. The top housing
10 may have similar slots for receiving the quenching plates, however, they are in an inverse order compared to the slots in the bottom housing. That is, a slot of a first type in the bottom housing is opposite to a slot of second type in the top housing module. Thereby also the top housing ensures that the quenching plates are mounted to the switch in correct position.

Figure 4A illustrates further illustrates a group of quenching plates and Figure 4B shows one plate from the side.

In Figure 4A, all the plates are similar but they are arranged alternately such that each other plate is flipped 180 degrees. However, the plates are asymmetric in view of a middle line of the plate. The asymmetry shows inside of the
20 plate where a propagation channel 450 for the arc is formed. The asymmetry shows also on the outside of the plates, especially on the edges of the plates including a first mounting portion 468 and second mounting portion 470 for mounting the plate to respective recesses in the switch. When, in a group of plates, each other plate is flipped 180 degrees, the propagation channel 450 for the arc between the side portions of the plates becomes non-continuous or non-uniform. The
25 form of the channel changes between adjacent plates in the group of plates. Thereby the propagation path length can be increased, which effectively causes quenching of the arc.

As can be seen from Figure 4B, the quenching plate 122B is substantially U-shaped, having a base/bottom portion 464 and two side portions 460, 462
30 extending from the base portion. In the embodiment of Figure 4B, the base portion 464 comprises a vertical portion, and the side portions comprise horizontal portions, that is, they are arranged at least substantially perpendicularly to each other.

It can be seen that the two side portions 468, 470 are substantially parallel with respect to each other. Between the side portions, a propagation channel 450 is formed for the arc.

As the figure shows, the top and bottom halves of the plate are asymmetric in view of a horizontal middle line. The propagation channel of the plate is thus asymmetric in view of a horizontal middle line, which refers thus to a line, which is perpendicular to the longitudinal vertical direction of the base in the figure. The middle line is thus substantially parallel to the longitudinal direction of the side portions.

Within the propagation channel, a propagation bottom 466 may be provided in the lower half of the plate, which propagation bottom is closest to the base 464. The propagation bottom lies thus aside from the middle of the plate thereby causing the propagation channel to become non-uniform when similar plates are mounted alternately to the switch. The arc seeks the furthest point in the plate, and the purpose of the propagation bottom is to maximize the length and to give variety to the form of the arc propagation path. In the neighbouring plate, as the plate is 180 degrees flipped to plate 122B, the propagation bottom would be in the higher half of the plate.

It can also be seen that the mounting portions, that is the upper edge 468 and lower edge 470 of the respective side portions 460, 462 are mutually different from each other. As Figure 4A shows, the first mounting portion 468 comprises a first portion 468A, which may be substantially parallel the first portion 470A of the second mounting portion 470. The two first portions 468A, 470A are the most distant edges of the side portions 460, 462, and they may be parallel to the walls of the housing receiving the mounting portions. The first portions may be the most distant portions of the side portions when viewed from the base 464. It can be seen that the first portions may have different lengths when compared to each other. In the shown embodiment, the first portion 468A is longer than the first portion 470A. There may be provided second portions 468B, 470B, which are arranged to an angle with respect to the first portions and the third portions 468C, 470C, which may be substantially parallel to the first portions 468A, 470A. As the figures show, the propagation space between the sides 460, 462 of each plate is asymmetric when seen from the middle of the side portions.

The recesses in the module housings are arranged respectively, such that one of the housings is capable of receiving the first mounting portion of a quenching plate, and the opposite housing is capable of receiving the second mounting portion of the same quenching plate.

5 In this manner, the plate 122B can be mounted to either of the slots 140A or 142A depending on which mounting portion is used.

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

CLAIMS

1. An arc quenching plate (122) for an electric switch, comprising a base portion (464) and a first side portion (460) and a second side portion (462), the side portions (460, 462) extending from the base portion (464) and being substantially parallel to each other, the first and second side portions including a first (468) and a second (470) mounting portion, respectively, for mounting of the quenching plate to respective recesses of the switch, wherein a propagation channel (450) for the arc is formed between the side portions (460, 462) of the plate (122), which propagation channel is asymmetric, **characterized** in that the first mounting portion (468) and the second mounting portion (470) have a different form when compared to each other.

2. An arc quenching plate according to claim 1, **characterized** in that the first and second side portions (460, 462) comprise the respective first and second mounting portions (468, 470) on the outer edges of the side portions, and the first (468) and second (470) mounting portions comprise parallel wall portions, and the wall portion of the first mounting portion (468) is longer than the wall portion of the second mounting portion (470).

20

3. An arc quenching plate according to any preceding claim, **characterized** in that the quenching plate (122) has a form substantially of letter U.

25 4. An arc quenching plate according to any preceding claim, **characterized** in that at least one of the first mounting portion (468) and the second mounting portion (470) comprises a first wall section (470A) on an outer edge of the respective side portion (462), a second wall section (470B) arranged in angle to the first wall section (470A), and a third wall section (470C) being substantially parallel to the first wall section (470A).

30

5. An arc quenching plate according to any preceding claim, **char-**

acterized in that the quenching plate (122) comprises a first half having the first side portion (460) and a second half having the second side portion (462), and the first half and the second half have a different form between the first and second side portions (460, 462) where a propagation channel (450) for the arc is
5 formed.

6. An arc quenching plate according to any preceding claim, **characterized** in that the quenching plate (122) comprises a propagation bottom (466), which propagation bottom (466) is aside from the middle of the plate (122).
10

7. An electric switch module, comprising a first switch module (102) housing and a second switch module housing to be assembled together, the first and second switch module housings comprising recesses (140, 142) for receiving quenching plates (122), the electric switch module comprising quenching plates
15 (122) arranged between the first and second switch module housings when assembled together, which quenching plates form a propagation channel for an electric arc, wherein the propagation channel formed by the quenching plates is non-uniform, **characterized** in that a recess (140A) for receiving a quenching plate (122) in the first switch module (102) housing has a different form than a recess in the second switch module housing for receiving the same quenching plate
20 (122).

8. An electric switch according to claim 7, **characterized** in that each of the first switch module housing and the second switch module housing
25 comprise at least two recesses (140A, 142A) for receiving two quenching plates, wherein two neighbouring recesses (140A, 142A) in the at least two recesses have a different form when compared to each other.

9. An electric switch according to any preceding claim 7 or 8, **characterized** in that the switch module housings are arranged to receive a single
30 type of quenching plates (122), wherein each other plate is flipped 180 degrees.

10. An electric switch according to any preceding claim 7 to 9, **characterized**

acterized in that side portions are arranged perpendicularly to a propagation path of the arc.

11. An electric switch according to any preceding claim 7 to 10,
5 **characterized** in that the plates are arranged such that a non-uniform propagation channel is formed for the arc.

12. An electric switch according to any preceding claim 7 to 11,
characterized in that the switch comprises a permanent magnet (132) for
10 directing the arc, which is arranged to direct the arc towards one of the side portions (468, 470) of the quenching plates (122).

13. An electric switch according to any preceding claim 7 to 12,
characterized in that the switch comprises a magnet housing (130) for re-
15 ceiving the permanent magnet (132), and the magnet housing (130) allows mounting of the permanent magnet (132) only in a position where the arc is directed towards one of the side portions (460, 462) of the quenching plate (122).

14. An electric switch according to any preceding claim 7 to 13,
20 **characterized** in that when the permanent magnet (132) is mounted to the magnet housing (130) behind the quenching plates closest to the base (464) of the quenching plate, a magnetic field produced by the permanent magnet (132) directs from the magnet (132) towards the quenching plates (122) or from the quenching plates (122) towards the magnet (132).

25

15. An electric switch according to any preceding claim 7 to 14,
characterized in that the switch comprises a contact area for making a contact between a stationary contact (104, 106) and a movable contact (108, 110, 112), and the permanent magnet (132) is arranged in proximity to the contact area
30 of the movable contact (108, 110, 112) and stationary contact (104, 106) behind the quenching plate (122).

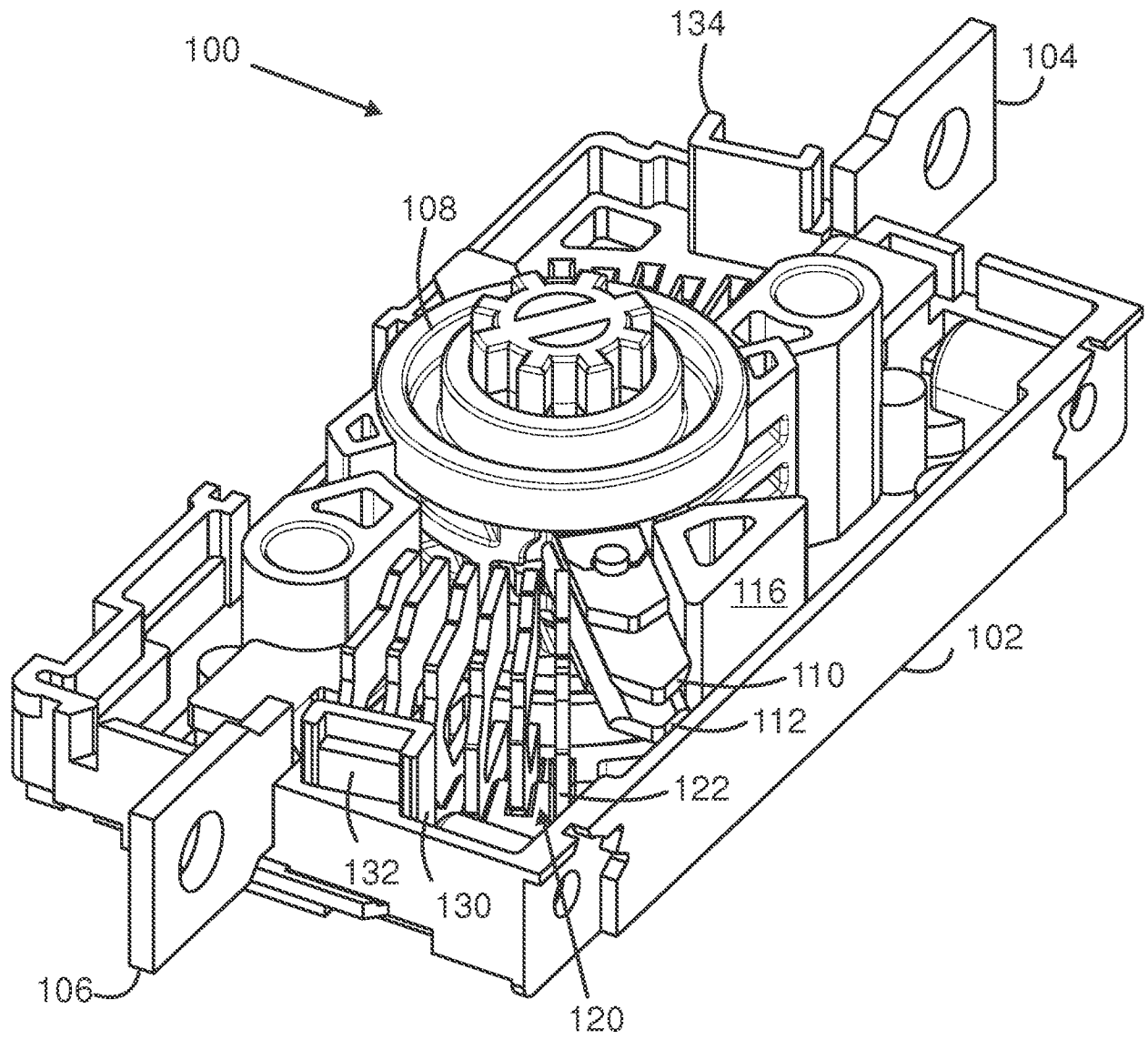


Fig. 1

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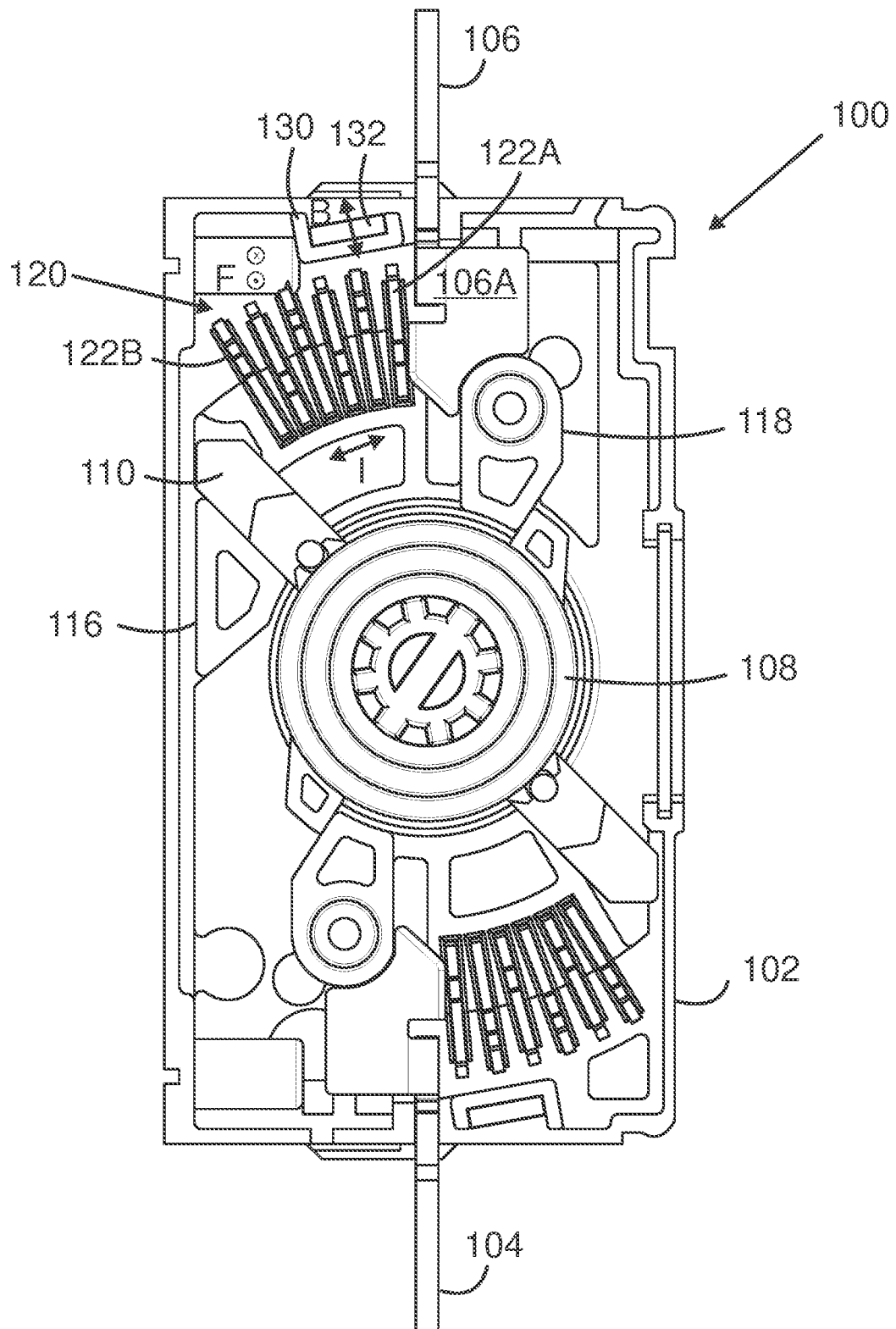


Fig. 2

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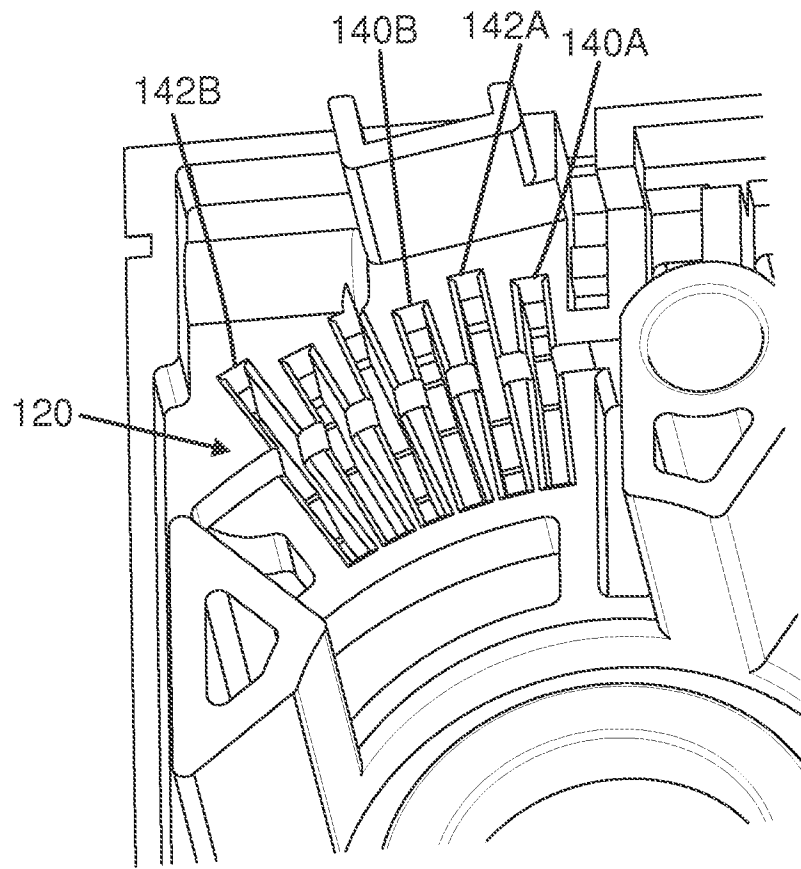


Fig. 3

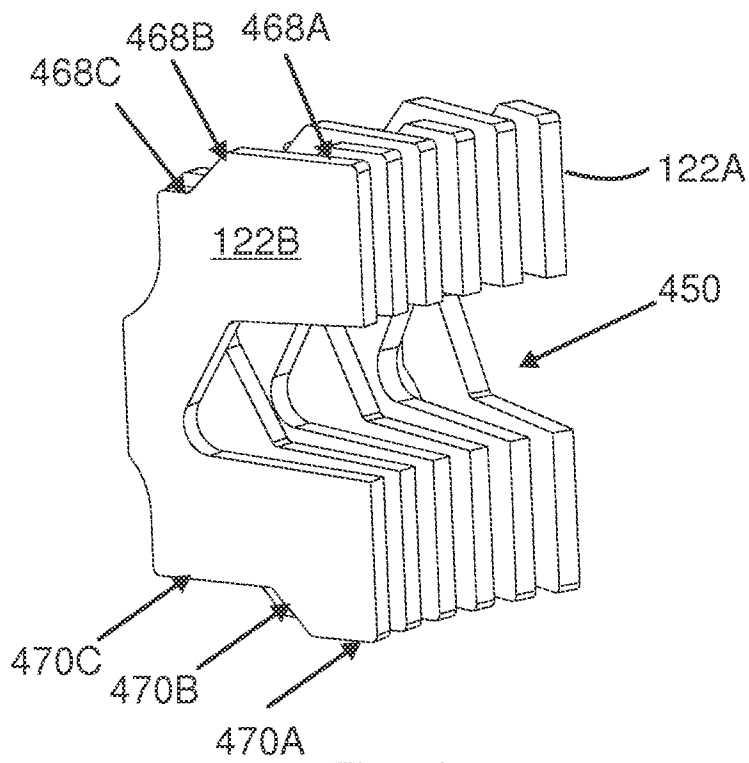


Fig. 4A

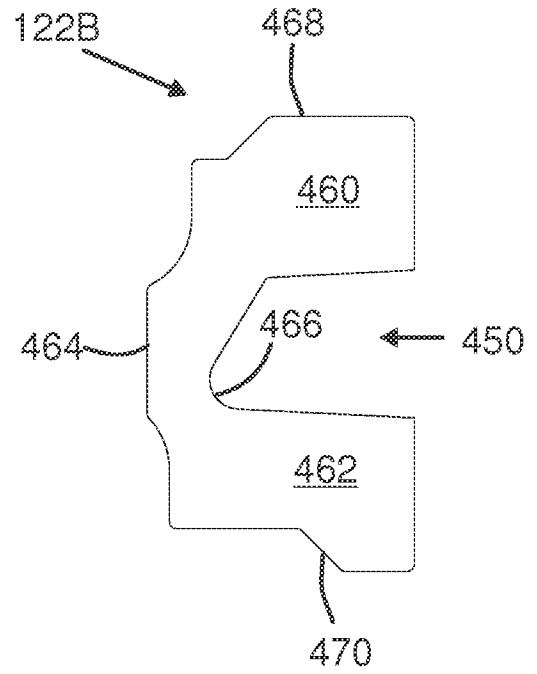


Fig. 4B

INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI2013/050384

A. CLASSIFICATION OF SUBJECT MATTER

See extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: H01H

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

FI, SE, NO, DK

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Y	US 2749410 A (WESTON DONALD E) 05 June 1956 (05.06.1956) column 5 line 72 – column 6 line 18, claims, and figures	1 - 9, 11, 14, 15
Y	US 2002056705 A1 (HEINS VOLKER [DE] et al.) 16 May 2002 (16.05.2002) abstract, paragraph 0019, claims, and figures	1 - 9, 11, 14, 15
A	EP 0061020 A1 (MITSUBISHI ELECTRIC CORP [JP]) 29 September 1982 (29.09.1982) abstract, page 15 lines 5 – 22, claims, and figures	1 - 15
A	EP 0874380 A1 (SOULE MATERIEL ELECTR [FR]) 28 October 1998 (28.10.1998) abstract, claims, and figures	1 - 15

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

* Special categories of cited documents:

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

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

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

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Date of mailing of the international search report

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
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