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(54) **A QUENCHING CHAMBER FOR A CIRCUIT INTERRUPTER**

LOESCHKAMMER FÜR EINEN SCHUTZSCHALTER

CHAMBRE DE TREMPE POUR INTERRUPTEUR DE CIRCUIT

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Description

THE FIELD OF THE INVENTION

[0001] The present invention refers to a quenching chamber for a circuit interrupter according to the pre-characterised portion of claim 1 and a method for quenching an electrical arc according to the pre-characterised portion of claim 14.

BACKGROUND OF THE INVENTION AND PRIOR ART

[0002] Electrical current can be interrupted by devices such as switches or breakers. A circuit breaker is an example of a device used to interrupt a current upon occurrence of over-heating or overcurrent. Generally, the switch or breaker comprises a movable contact, which can be separated from a fixed contact to interrupt the current path. An electrical arc between the contacts may be formed during switching or breaking or a disconnecting operation. An arc voltage is developed across the contacts as the contacts move away from one another during the interruption event. Metal particles may be scattered from the contacts and gases may be released from the material surrounding the contacts during the formation of the arc. A pressure may build up inside the switch or breaker by the released gases. The arc event further increases the heat in the switch or breaker. These subsequent events such as pressure building and raises in temperature may result in re-ignition of the arc. Repeated interruption of the current in a switch or breaker is detrimental for the lifetime of the circuit interrupter and may decrement the operational reliability of the interrupter.

[0003] The developments for improving switched or breakers have been focused on extinguishing the electrical arc faster by e.g. lowering a peak let through current. Fig 1 shows a schematic plot of an arc event, wherein the current or arc voltage on the y-axis is plotted versus time on the x-axis. When the current exceeds a threshold level the contacts move from one another and an arc is formed between the contacts milliseconds after opening of the contacts. Then, the arc dissipates and the current decreases again.

[0004] The peak let through current (area B, time zone 2 in Fig 1) may be lowered, by providing dissipating structures such as arc chutes in the switch or breaker to assist in dissipation. US 5,589,672 describes a circuit breaker with an arc quenching device and a vent.

[0005] Another way to improve the circuit interrupters involves the use of arc quenching material disposed in the proximity of the contacts. This material may be aligned to the wall of a quenching chamber that surrounds the contacts. Quenching material ablates by the arc during an arc event. The ablation vapors interact with the arc to absorb the arcing energy, thereby cooling the arc temperature and dissipating the arc. Arc quenching materials may be used for lowering the peak let through energy and decreasing re-ignition probability. The material may be used for extending the life of the switch or breaker and improving operational reliability of the interrupter.

[0006] Different quenching materials have been used, whereby the different materials influence the arc in different ways. For example, some materials may be capable to ablate rapidly at the start of the arc event (area A, time zone 1 in Fig 1). Other materials may be capable of cooling the environment around the contacts and have more influence on lowering the peak let through current (area B, time zone 2 in Fig 1). Yet further materials may be capable to neutralise the particles present around the contacts after the arc event and have more influence on heat dissipation and neutralisation (area C, time zone 3 in Fig 1). Quenching materials may influence one specific area of the curve shown in Fig 1. However, quenching materials may at the same time also influence other areas of the curve.

[0007] Quenching material is mostly used to lower the peak let through energy. US 2008/0073326 describes a quenching chamber that includes a vent and quenching material aligned on part of the wall of the chamber to reduce the peak let through current.

[0008] US 5,841,088 describes a quenching chamber, whereby the walls of the chamber are aligned with two different quenching materials such that the area around the contacts in the chamber is symmetrically surrounded by a first quenching material, and whereby the first material is covered by a second quenching material on the surface that faces away from the contacts. The first quenching material is used to improve the quenching or extinguishing properties, the second material is used to improve the strength against pressure building in the chamber.

[0009] US2008/0061037 also describes a quenching chamber for a circuit interrupter comprising a space, and a wall surrounding the space. In the space a switch is present having a fixed contact and a movable contact between which contacts an arc can be generated. The wall of the quenching chamber comprises two or more levels of wall units, whereby the wall unit within one level symmetrically surround the space by extending over the width of the wall along a first axis and extending along a part of the length of the wall along a second axis being perpendicular to the first axis. Each wall unit comprises quenching material, whereby the quenching materials are different in two adjacent levels. One of the quenching materials used provides a relatively high ablation, generating large volumes of ablation vapors to lower the arc temperature and help quenching the arc. The other quenching material used provides a relative low ablation to limit the pressure increase and allowing arc quenching to proceed with less interference from an ablation vapor-induced pressure rise.

[0010] Operational conditions for switches and breakers vary significantly depending on design, voltage level, current and demands on circuit performances. Arc quenching materials are used to assist electrical interrupters under short circuit conditions. In some cases an interrupter is used to cut off current under normal load. Thus, the operational requirements may be different for circuit interrupters with regard to arc quenching.

[0011] There is a need for a quenching chamber, which can be adapted to specific conditions in which the chamber will be used. In other words there is a need for a quenching chamber comprising quenching material that can be easily varied and adapted to the specific operational needs of the interrupter. Further, there is still a need for an improved quenching chamber, wherein the electrical arc can be extinguished quicker and whereby the lifetime of the interrupter can be extended. Also, there is a need for improved quenching material.

SUMMARY OF THE INVENTION

[0012] The object of the invention is to provide a quenching chamber comprising arc quenching material that lowers the peak let through energy, and/or lowers the pressure build and/or decreases re-ignition probability. It is another object to extend the lifetime of the interrupter. It is a further object to improve the heat resistance in the quenching chamber. It is also an object to improve the operational reliability of the interrupter. It is furthermore an object to provide a quenching chamber, which can easily be adapted to different operational requirement.

[0013] The objects are achieved by the quenching chamber initially defined according to the pre-characterised portion of claim 1, which is characterised in that the wall units (9) on opposite sides of the space (6) within the same level (a) comprise quenching material having different quenching capabilities.

[0014] The inventors have surprisingly found that the asymmetric alignment of at least two quenching materials that have different quenching capabilities, on opposite walls improves the performances of the quenching chamber. Firstly, when the rapid ablative material ablates, the vapor gases from this material will push the arc sidewards. Without wishing to be bound by any theories, it is believed that the sidewards bending of the arc inside the quenching chamber as illustrated by the arrow in Fig 2, increases the length of the arc such that more energy is needed to maintain the arc. Thereby, the peak let through energy decreases. The second (and subsequent) quenching material may ablate with reduced quantities of vapor gases such that the pressure build up in the chamber decreases compared to using only the rapid ablative material. Heat resistance is likewise improved because not only rapid ablative material is being used but even quenching material, which has excellent cooling and/or neutralisation qualities. As a consequence, the risk for re-ignition of the arc is substantially reduced. Because the extinction of the arc occurs faster, less damage will be caused by the arc, which in turn improved the lifetime of the circuit interrupter. Reduced damage also improves the reliability of the circuit interrupter.

[0015] Another advantage of the novel quenching chamber is that the quenching materials that have different quenching capabilities, can be easily substituted by other material and thus allow for combining different quenching materials in many different ways. The new chamber can thus be easily adapted for different operational requirements such as higher voltages, smaller circuits, etc. In small circuits for example, rapid ablation and cooling may be more important than neutralisation. For such an application the quenching chamber may comprise asymmetric levels comprising materials that rapidly ablate at the start or onset of the arc event and material which has good cooling capabilities (area A and B in Fig 1).

[0016] In one embodiment, the quenching material is selected from a first material having ablation capability at a start of a circuit interruption, a second material having cooling capabilities and a third material having neutralisation capabilities, or any mixtures thereof. In another embodiment the first material ablates faster than the second and third material, and the second material cools the space faster than the first and third material, and the third material neutralises faster than the first and second material.

[0017] Using different materials having capabilities within the different regions A, B or C as shown in figure 1 advantageously improves the performance of the quenching chamber. The quenching materials used may have effects in more than one region, but a particular material will perform better in one particular region, while another material performs better in a another region. By using the quenching materials that have different quenching capabilities, the quenching chamber is configured to be adapted to the diversity of operational conditions in which the quenching chambers may be used. The ablating sequence of the materials may likewise be varied by the use of different quenching materials on opposite sides of the quenching chamber. This may further improve the performance of the quenching chamber.

[0018] In another embodiment, the at least two walls comprise two levels of wall units. In a further embodiment, the at least two walls comprise three levels of wall units, whereby the quenching materials comprised in the middle level has different quenching capabilities from the quenching material comprised in at least one of the other levels of wall units. Using even more different quenching materials that have different quenching capabilities, in different levels may further increase the speed of ablation, reduce the peak let through energy, improve heat resistance or reduce the pressure build-up.

[0019] In one embodiment, at least three different walls are present in the chamber, whereby, within one level, the quenching material comprised in the third wall may have the same or different quenching capabilities as the quenching material comprised in one or in both of the two opposite walls. By using two or three different quenching materials that have different quenching capabilities, on three different sides of the chamber within one level, the quenching performance can be further optimised. The quenching chamber can be even more advanced be adapted to the diversity of operational conditions.

[0020] In a further embodiment, the first material is selected from the group comprising polyacetals, polyolefins, polyamides and polyacrylates, or copolymers or mixtures thereof, and optionally glass materials up to 35 wt% and/or mineral fillers up to 30 wt%.

[0021] In yet a further embodiment, the second material configured is selected from the group comprising ceramic and thermosetting materials selected from the group comprising epoxy and polyesters, or copolymers or mixtures thereof, and optionally including glass materials up to 40 wt% and/ or mineral fillers up to 50 wt%.

[0022] In yet another embodiment, the third material is selected from the group comprising polyolefins, polyamids, fluorinated polymers and thermosetting polymers, or copolymers or mixtures thereof, and optionally including glass materials up to 40 wt% and/ or mineral fillers up to 50 wt%.

[0023] In one embodiment, the filler is selected from the group
compounds of formula $M_m(OH)_n$, wherein M is a metal, m is 0, 1, 2 or 3, and n is 0, 1, 2, 3 or 4, and
compounds of formula $Q_pH_yCO_x$, wherein Q is selected from the group comprising Ca, Na, Mg, Ba and K and p is 0, 1, 2 or 3, y is 0, 1 or 2 and x is 1, 2 or 3, and
compound of formula T_tR_r, wherein T is selected from the group comprising Ca, Al, Si, Zr, Ba, Ti, W, Mo, V, Mg, Zn and B, and R is selected from the group comprising O, SO_4, C and N, wherein t is 1, 2 or 3, and r is 0, 1, 2, 3 or 4,
or hydrates or mixtures thereof.

[0024] In another embodiment, the filler is selected from the group comprising CaO, MgO, ZnO, BaO, ZrO_2, SiO_2, TiO_2, $ZrSiO_4$, $MgAl_2O4$, Al_2O_3, BN, AlN, CN, SiN, TiN, Si_3N_4, SiC, TiC, ZrC, WC, Mo_2C, VC, B_4C, WSi_2 and $MoSi_2$, TiB_2, ZrB_2, $CaSO_4$, $MgSO_4$, $Al_2(SO_4)_3$, $Ca(OH)_2$, $Mg(OH)_2$, $Zn(OH)_2$ and $Al(OH)_3$, $CaCO_3$, $NaHCO_3$, $KHCO_3$, $MgCO_3$, $BaCO_3$, $CaMg(CO_3)_2$, K_2CO_3 and Na_2CO_3, or hydrates or mixtures thereof.

[0025] The object of the invention is also achieved by a quenching chamber comprising at least two opposite walls whereby, within one level, one wall comprises polyoxymethylene and optionally glass materials up to 35 wt% and/or mineral fillers up to 30 wt% and the opposite wall comprises polymethylpentene or polyamide 6, 6,6, 11 or 12 and optionally glass materials up to 40 wt% and/or mineral fillers up to 50 wt%.

[0026] The objects are further achieved by a switch comprising the quenching chamber as described above.

[0027] The object of the present invention is also achieve by a method initially defined according to the pre-characterised portion of claim 14, characterised in that the wall units on opposite sides of the space within the same level comprise quenching material having different quenching capabilities.

[0028] In one embodiment of the method the quenching material comprises quenching capabilities selected from a first material having ablation capability at a start of a circuit interruption, a second material having cooling capabilities and a third material having neutralisation capabilities, or any mixtures thereof.

[0029] In another embodiment of the method the quenching chamber is defined as described in any one of the embodiments above.

BRIEF DESCRIPTION OF THE DRAWINGS

[0030]

Fig 1	shows a schematic plot of the current or voltage versus time.
Fig 2	shows a schematic view of the quenching chamber with one level of wall units surrounding the space and quenching materials that have two different quenching capabilities.
Fig 3a and 3b	shows a schematic view of the quenching chamber with two levels of wall units surrounding the space and quenching materials that have two different quenching capabilities.
Fig 4	shows a schematic view of the quenching chamber with one level of wall units surrounding the space and quenching materials that have three different quenching capabilities.
Fig 5	shows a schematic view of the quenching chamber with two levels of wall units surrounding the space and quenching materials that have four different quenching capabilities.
Fig 6	shows a schematic view of the quenching chamber with one level of wall units enclosing the space and quenching materials that have two different quenching capabilities.
Fig 7	shows the effect on arc voltage versus time of the novel combination of quenching materials.
Fig 8	shows the effect on arc gap conductance versus time of the novel combination of quenching materials.

DETAILED DESCRIPTION OF VARIOUS EMBODIMENTS OF THE INVENTION

[0031] Fig 2 shows a circuit interrupter 1 comprising a contact with a fixed contact 2 and a movable contact 3. The contact is surrounded at least partly by a quenching chamber 4. The chamber 4 may comprise one, two, three or four walls 5. Fig 2 shows a quenching chamber 4 with three walls 5, whereby the walls 5 define a space 6 and a contact area 7 within this space 6. An electrical arc 8 may be generated when the contacts 2, 3 separate from one another. The walls 5 are positioned such that the arc 8 is exposed to the wall 5. The walls 5 may comprise more than one level a, b of wall units 9. As shown in figs 3a and 3b, the wall unit 9 within one level a extend over a width w of the wall 5 along a first axis x and extend along a part or whole length l of the wall 5 along a second axis y being perpendicular to the first axis. The different levels a, b are adjacent to one another.

[0032] At least two of the walls 5a in the chamber 4 are positioned on opposite sides of the space 6, i.e. on opposite sides of the contact area 7. See fig 2 to 6.

[0033] Each wall 5 may comprise one or more wall units 9 at one or more levels a, b. Each wall 5 may be divided in two, three, four or five units 9. Fig 4 shows a chamber 4 with three walls 5, whereby each wall 5 comprises one unit 9 at one level a. Fig 5 shows a chamber 4 with three walls 5, whereby each wall 5 comprises two wall units 9 at two levels a, b.

[0034] The wall units 9 comprise quenching material. The wall units 9 within one wall 5 may comprise the same quenching material (fig 3a) or different units 9 within one wall 5 may comprise different quenching materials at different levels a, b (fig 3b).

[0035] The quenching material on opposite walls 5 or sides of the space 6 in the quenching chamber 4, within at least one level a, comprises quenching material having different quenching capabilities. For example, the chamber 4 may comprise two walls 5a with three levels a, b, c of wall units 9, whereby the quenching material comprised in the middle level b on one wall 5a has different quenching capabilities compared to the material comprised in the middle level b on other opposite wall 5a. The quenching material comprised in one of the other levels a, c of wall units 9 may be the same or different from the quenching materials comprised in middle level b on either one of the opposite walls 5a.

[0036] The quenching chamber 4 may comprise three different walls 5a, 5b, whereby, within one level a, the quenching material comprised in the third wall 5b may be the same as the quenching material comprised in one of the two opposite walls 5a. The quenching material comprised in the third wall 5b, within one level a, may also be the same as the quenching material comprised in both of the two opposite walls 5a. (Fig 3) The third wall 5b may thus be divided and comprise different quenching materials within one level a. The quenching material comprised in the third wall 5b, within one level a, may also be different from the quenching material comprised in both opposite walls 5a. (Fig 4, 5)

[0037] The walls 5 may be aligned with quenching material. The walls 5 may also be made of the quenching material. In some interrupters quenching chambers 4 may be used, whereby the walls 5 are partly made of quenching material and partly made of other material, which may be aligned with quenching material.

[0038] With reference to fig 1, the different quenching materials may ablate at different voltages, temperatures or time intervals. Quenching material can be made to ablate under certain conditions. For example, a first ablating or quenching material (area A in fig 1) may, quickly after opening of the contact, i.e. at the start of the circuit interruption, ablate a vapor gas in the chamber 4. A second material may ablate at increased temperature to cause a cooling effect (area B in fig 1). Yet further a third material may ablate at a later time interval to neutralise the environment in the space 6 of the chamber 4 (area C in fig 1). The vapor gas of the first quenching material will push the electrical arc aside as indicated by the arrow in fig 2. Increasing the length of the arc assists in quenching or extinguishing the arc. A second ablative material may cool the vapor particles in the chamber 4, while a third quenching material may be used to neutralise the vapor in the space 6 of the chamber 4.

[0039] Important is that the quenching chamber 4 is asymmetrically aligned with quenching material such that the quenching material in the walls 5a, which are positioned on opposite sides of the space 6, within at least one level a, have different quenching capabilities. Thus, within at least one level a of wall unit 9 on one wall 5a, the quenching material is selected from a first material having ablation capability at a start of a circuit interruption, i.e. material which rapidly ablates or a second material having cooling capabilities or a third material having neutralisation capabilities, while the quenching material on the opposite wall 5a, within the same level a is selected from the first or second or third material, but whereby the material on this opposite walls 5a have different quenching capabilities. In one embodiment, the quenching capabilities of the material on one wall 5a is a mixture of one or more of the first, second and/or third material and the material on the opposite wall 5a is selected from one of the first, second or third material, and has different quenching capabilities. In another embodiment, both walls 5a comprise mixtures of one or more of the first, second and/or third material, whereby the capabilities are different on the opposite walls 5a of the space 6.

[0040] The quenching capabilities of the material comprised in the other levels may be the same or different as the capabilities of the material on the one level having the different quenching capabilities on opposite walls 5a. The quenching materials comprised in the other levels may be different and have different quenching capabilities or the material may be different but have the same quenching capabilities.

[0041] The quenching material comprised in the third wall 5b may be the same or different as the quenching material on two opposite walls 5a. The different material may have different quenching capabilities or the material may be different but have the same quenching capabilities. For example, the quenching chamber 4 may comprises three walls 5a, 5b, whereby, within the same level a, each wall 5a, 5b comprises a quenching material having quenching capabilities different from the capabilities in the other two walls 5a, 5b. (Fig 4 and 5) All possible combinations are included in the scope of this patent application as long as the quenching materials on the opposite walls 5a, at least within one level a of wall units 9, comprise quenching materials having different quenching capabilities.

[0042] A first quenching material configured for rapid ablation at the start of the interruption may be selected depending on the operational conditions for the circuit interrupter and may be selected from the group comprising polyacetals, polyolefins, polyamides, polyacrylates or copolymers or mixtures thereof, and optionally glass materials up to 35 wt% and/or mineral fillers up to 30 wt%.

[0043] Polyacetals may be defined as alkanes comprising an oxy molecule in the main chain. Examples of polyacetals are polyoxymethylene and polyvinylacetal, or copolymers or mixtures thereof. Another example is ethylene vinyl acetate. In one embodiment the first material is polyoxymethylene. In another embodiment the first material is polyvinylacetal. In a further embodiment the material is a copolymer of polyoxymethylene. Examples of polyolefines are polyethylene, polypropylene, polymethylpentene, cycloolefine and polybutylene, or copolymers or mixtures thereof. In one embodiment the first material is polyethylene. In another embodiment the first material is polymethylpentene. In a further embodiment the material is polypropylene. In yet another embodiment the first material is polybutylene.

[0044] Examples of polyamides are polyamide 6, polyamide 6T, polyamide 6,3 polyamide 6,4, polyamide 6,6, polyamide 11, polyamide 12 and polyamide 6,10, or copolymers or mixtures thereof. In one embodiment the first material is polyamide 6. In another embodiment the first material is polyamide 6T. In one embodiment the first material is polyamide 6,4. In yet another embodiment the first material is polyamide 6,6. In yet a further embodiment the material is polyamide 11. In another embodiment the first material is polyamide 12.

[0045] Examples of polyacrylates are polymethylmetacrylate, polyethylmetacrylate and polyacrylonitrile. In one embodiment the first material is polymethylmetacrylate. In another embodiment the first material is polyethylmetacrylate.

[0046] The first quenching material, including any one of the single compounds mentioned above, or copolymers or mixture thereof or copolymers of such mixtures, may be combined with glass materials up to 40 wt% and/or mineral fillers up to 30 wt%. Thus, the first quenching material may comprise 0 wt%, or up to 10 wt%, 20 wt% or 30 wt% glass material, or between 5 and 40 wt%, or 5 and 30 wt%, or 5 and 20 wt%. The material may further comprise mineral fillers up to 30 wt%, or 20 wt%, or 10 wt%, or between 1 and 15 wt%, or 5 and 15 wt%. Examples of the first quenching material may be a polyethylene including between 0 to 30 wt% glass material and between 0 to 15 wt% filler. Or polypropylene including between 0 to 30 wt% glass material and between 0 to 15 wt% filler. Or polybutylene including between 0 to 30 wt% glass material and between 0 to 20 wt% filler. Or polymethylpentene including between 0 to 30 wt% glass material and between 0 to 10 wt% filler. Or polyamide 6 including between 0 to 30 wt% glass material and between 0 to 15 wt% filler. Or polyamide 6,4 including between 0 to 30 wt% glass material and between 0 to 15 wt% filler. Or polyamide 6,6 including between 0 to 30 wt% glass material and between 0 to 15 wt% filler. Or polyamide 11 including between 0 to 30 wt% glass material and between 0 to 20 wt% filler. Or polyamide 12 including between 0 to 30 wt% glass material and between 0 to 15 wt% filler. Or polyoxymethylene including between 0 to 30 wt% glass material and between 0 to 20 wt% filler. Or a copolymer of polyoxymethylene including between 0 to 30 wt% glass material and between 0 to 15 wt% filler. Or polymethylmetacrylate including between 0 to 20 wt% glass material and between 0 to 20 wt% filler.

[0047] A second quenching material configured for cooling may be ceramic or thermosetting materials selected from the group comprising epoxy and polyesters; or copolymers or mixtures thereof, and optionally including glass materials up to 40 wt% and/ or mineral fillers up to 50 wt%.

[0048] Thermosetting materials may be selected from the group comprising epoxies of bisphenole type, novalak type or alicyclic type, ester type, amino type and phenolic type, or copolymers or mixtures thereof. Examples of bisphenole epoxies may be bisphenole-a type epoxy, bisphenole-f type epoxy.

[0049] Amino type and phenolic type epoxies may be unsaturated polyesters.

[0050] Polyesters may be polyethylenete rphta late or polybutyleneterphtalate, or copolymers or mixtures thereof.

[0051] The second material, including any one of the single compounds mentioned above, or copolymers or mixture thereof, or copolymers of such mixtures, may be combined with glass materials up to 50 wt% and/or mineral fillers up to 50 wt%. Thus, the second quenching material may comprise 0 wt%, or up to 20 wt%, or 30 wt%, or 40 wt%, or 50 wt% glass material, or between 5 and 45 wt%, or 10 and 30 wt%. The material may further comprise mineral fillers up to 40, or 30, or 20, or 10 wt%, or between 5 and 40 wt%, or 10 and 40 wt%, or 5 and 30 wt%. Some examples may be a bisphenole-a type epoxy including between 0 to 40 wt% glass material and between 5 to 40 wt% filler. Or bisphenole-f type epoxy including between 0 to 40 wt% glass material and between 5 to 40 wt% filler. Or amino type unsaturated polyesters including between 0 to 40 wt% glass material and between 5 to 40 wt% filler. Or phenolic type unsaturated polyesters including between 0 to 40 wt% glass material and between 5 to 40 wt% filler. Or novalak type including between 0 to 40 wt% glass material and between 5 to 45 wt% filler. Or alicyclic type including between 0 to 40 wt% glass material and between 5 to 35 wt% filler. Or ester type including between 0 to 40 wt% glass material and between 5 to 45 wt% filler.

[0052] A third quenching material configured for neutralising may be selected from the group comprising polyolefins, polyamids, fluorinated polymers and thermosetting materials, or copolymers or mixtures thereof, and optionally including glass materials up to 40 wt% and/ or mineral fillers up to 50 wt%.

[0053] Polyolefins may be polyethylene, polypropylene, polymethylpentene, polybutylene, or copolymers or mixtures thereof.

[0054] Polyamides may be selected from the group comprising polyamide 6, polyamide 6T, polyamide 6,3, polyamide 6,4, polyamide 6,6, polyamide 11, polyamide 12, polyamide 6,10, or copolymers or mixtures thereof.

[0055] Fluorinated polymers may be selected from the group comprising polytetrafluoroethylene, polyvinylfluoride, polyvinylidenefluoride, polyperfluoroalkoxy, polyfluorinatedethylenepropylene, or copolymers or mixtures thereof.

[0056] Thermosetting materials may be selected from the group comprising epoxies of bisphenole, novalak or alicyclic or ester type, or copolymers or mixtures thereof, and unsaturated polyester of amino type or phenolic type, or copolymers or mixtures thereof, and optionally glass materials up to 40 wt% and/ or mineral fillers up to 50 wt%.

[0057] Polyester may be polyethyleneterphtalate or polybutyleneterphtalate, or copolymers or mixtures thereof.

[0058] The third quenching material, including any one of the single compounds mentioned above, or copolymers or mixture thereof or copolymers of such mixtures, may be combined with glass materials up to 40 wt% and/or mineral fillers up to 50 wt%. Thus, the third quenching material may comprise 0 wt%, or up to 10 wt%, 20 wt% or 30 wt% glass material, or between 5 and 40 wt%, or 5 and 30 wt%, or 5 and 20 wt%. The material may further comprise mineral fillers up to 50 wt%, 40 wt%, 30 wt%, or 20 wt%, or 10 wt%, or between 1 and 50 wt%, or 5 and 45, or 0 and 40 wt%, or 5 and 35 wt%. Examples of the third quenching material may be a polyethylene including between 0 to 30 wt% glass material and between 0 to 35 wt% filler. Or polypropylene including between 0 to 30 wt% glass material and between 0 to 25 wt% filler. Or polybutylene including between 0 to 30 wt% glass material and between 0 to 20 wt% filler. Or polymethylpentene including between 0 to 30 wt% glass material and between 0 to 10 wt% filler. Or polyamide 6 including between 0 to 30 wt% glass material and between 0 to 15 wt% filler. Or polyamide 6,4 including between 0 to 30 wt% glass material and between 0 to 15 wt% filler. Or polyamide 6,6 including between 0 to 30 wt% glass material and between 0 to 15 wt% filler. Or polyamide 11 including between 0 to 30 wt% glass material and between 0 to 20 wt% filler. Or polyamide 12 including between 0 to 30 wt% glass material and between 0 to 15 wt% filler. Or bisphenole-f type epoxy including between 0 to 40 wt% glass material and between 5 to 40 wt% filler. Or polyvinylidenefluoride including between 0 to 20 wt% glass material and between 0 to 20 wt% filler.

[0059] The filler may be metal hydroxides such as compounds of formula $M_m(OH)_n$, wherein M is a metal, m may be 0, 1, 2, 3 or 4 and n may be 0, 1, 2, 3 or 4. In one embodiment m is 1, 2 or 3 and n is 1, 2, 3 or 4. In another embodiment m is 1 or 2 and n is 1, 2 or 3. Examples of metal hydroxides may be selected from the group comprising $Ca(OH)_2$, $Mg(OH)_2$, $Zn(OH)_2$ and $Al(OH)_3$, or hydrates or mixtures thereof. Hydroxides may be advantageously used for neutralising the environment in the quenching chamber. For example a polyamide (e.g. polyamide 6, 6,6, 6,4 or 12) or a polyolefin (e.g. polyethylene or polymethylpentene) together with a glass reinforced epoxy may include 10 to 40 wt% $Al(OH)_3$ and/or its hydrates, or 10 to 40 wt% $Mg(OH)_2$ and/or its hydrates. Or a polyamide (e.g. polyamide 11 or 6,10) or a polyacrylate (e.g. polymethylmetacrylate) together with a glass reinforced epoxy may include 10 to 40 wt% $Zn(OH)_2$ and/or its hydrates, or $Ca(OH)_2$ and/or its hydrates.

[0060] The filler may also be a carbon oxide releasing compound, which may be a carbon oxide or carbon dioxide or carbon trioxide. Examples are compounds of formula $Q_pH_yCO_x$, wherein Q may be an organic or inorganic compound selected from the group comprising Ca, Na, Mg, Ba and K and p may be 1, 2 or 3, y may be 0, 1 or 2 and x may be 1, 2 or 3. These carbon oxide releasing compound may be selected from the group comprising $CaCO_3$, $NaHCO_3$, $KHCO_3$, $MgCO_3$, $BaCO_3$, $CaMg(CO_3)_2$, K_2CO_3 and Na_2CO_3, or hydrates or mixtures thereof. For example a polyamide (e.g. polyamide 6, 6,6 or 12) or a polyolefin (e.g. polyethylene or polymethylpentene) together with a glass reinforced epoxy may include 10 to 40 wt% $MgCO_3$ and/or its hydrates, or $CaMg(CO_3)_2$ and/or its hydrates. Or a polyamide (e.g. polyamide 6, 11 or 12) or a polyolefin (e.g. polyethylene or polymethylpentene) together with a glass reinforced epoxy may include 10 to 40 wt% $CaCO_3$ and/or its hydrates, or $BaCO_3$ and/or its hydrates. Or a polyamide (e.g. polyamides 6, 6,6, 11 or 12) or a polyolefin (e.g. polypropylene or polymethylpentene) together with a glass reinforced epoxy may include 10 to 40 wt% $KHCO_3$ and/or its hydrates. Or a polyamide (e.g. polyamide 6,4 or 6,10) or a polyacrylate (e.g. polymethylmetacrylate) together with a glass reinforced epoxy may include 10 to 40 wt% K_2CO_3 and/or its hydrates.

[0061] Other fillers that may be used are compound of formula T_tR_r, selected from oxides, carbides, nitrides, silicides, borides and sulphates, wherein T may be selected from the group comprising Ca, Al, Si, Zr, Ba, Ti, W, Mo, V, Mg, Zn and B, and R may be selected from the group comprising O, SO_4, C and N, wherein t may be 1, 2 or 3, and r may be 0, 1, 2, 3 or 4. In one embodiment, t is 1, 2 or 3 and r is 1, 2, 3 or 4. The compound of formula T_tR_r may be selected from the group of oxides comprising CaO, MgO, ZnO, BaO, ZrO_2, SiO_2, TiO_2, $ZrSiO_4$, $MgAl_2O_4$ and Al_2O_3. Or the compound of formula T_tR_r may be selected from the group of nitrides comprising BN, AlN, CN, SiN, TiN and Si_3N_4. Or the compound of formula T_tR_r may be selected from the group of carbides comprising SiC, TiC, ZrC, WC, Mo_2C, VC and B_4C. Or the compound of formula T_tR_r may be selected from the group of silicides comprising WSi_2 and $MoSi_2$. Or the compound of formula T_tR_r may be selected from the group of borides comprising TiB_2 and ZrB_2. Or the compound of formula T_tR_r may be selected from the group of sulphates comprising $CaSO_4$, $MgSO_4$ and $Al_2(SO_4)_3$ For example the quenching material may comprise a polyolefin with 2 to 7 wt% of a boride filler such as polymethylpentene with 3 wt% TiB_2. Or polybutylene with 7% ZrB_2. Or polypropylene with 5 wt% TiB_2. Or a polyolefin with 2 to 7 wt% of an oxide filler such as polymethylpentene with 3 wt% MgO. Or polybutylene with 7% ZnO. Or a polyolefin with 2 to 7 wt% of a nitride filler such as polybutylene with 5 wt% TiN, or polypropylene with 5 wt% BN, or polymethylpentene with 5 wt% AlN. Or a polyolefin with 2 to 7 wt% of a carbide filler such as polypropylene with 5 wt% SiC, or polybutylene with 5 wt% B_4C. Or a polyolefin with 2 to 7 wt% of a silicide filler such as polybutylene with 5 wt% WSi_2, or polypropylene with 5 wt% $MoSi_2$. Or a polyolefin with 2 to 7 wt% of a sulphate filler such as polybutylene with 5 wt% $CaSO_4$, or polyethylene with 5 wt% $MgSO_4$.

[0062] The quenching material may also comprise a polyamide with 2 to 7 wt% of a boride filler, such as polyamide 6 or polyamide 12 with 5 wt% TiB_2. Or a polyamide with 3 to 7 wt% of an oxide filler such as polyamide 6.6 with 5 wt% Al_2O_3 Or a polyamide with 2 to 7 wt% of a nitride filler such as polyamide 6 or polyamide 6.6 with 5 wt% AlN, or polyamide 12 with 5 wt% BN. or polyamide 6T with 5 wt% Si_3N_4. Or a polyamide with 2 to 7 wt% of a carbide filler such as polyamide 6,4 or polyamide 12 with 5 wt% SiC, or polyamide 11 with 5 wt% B_4C. Or a polyamide with 2 to 7 wt% of a silicide filler such as polyamide 11 with 5 wt% WSi_2, or polyamide 12 with 5 wt% $MoSi_2$. Or a polyamide with 2 to 7 wt% of a sulphate filler such as polyamide 6 with 5 wt% $CaSO_4$, or polyamide 6,4 with 5 wt% $MgSO_4$.

[0063] The quenching material may also comprise a fluorinated polymers with 2 to 7 wt% of a boride filler, such as polytetrafluoroethylene with 5 wt% TiB_2. Or a fluorinated polymers with 3 to 7 wt% of an oxide filler such as polyperfluoroalkoxy with 5 wt% Al_2O_3 Or a fluorinated polymers with 2 to 7 wt% of a nitride filler such as polytetrafluoroethylene with 5 wt% AlN, or polyvinylidenefluoride 5 wt% BN, or polyperfluoroalkoxy 5 wt% Si_3N_4. Or a fluorinated polymers with 2 to 7 wt% of a carbide filler such as polyperfluoroalkoxy with 5 wt% SiC, or polyvinylidenefluoride with 5 wt% B_4C. Or a fluorinated polymers with 2 to 7 wt% of a silicide filler such as polyfluorinatedethylenepropylene with 5 wt% WSi_2, or polyvinylidenefluoride 5 wt% $MoSi_2$. Or a fluorinated polymers with 2 to 7 wt% of a sulphate filler such as polyfluorinatedethylenepropylene with 5 wt% $CaSO_4$, or polyvinylfluoride with 5 wt% $MgSO_4$.

[0064] The quenching material may also comprise a thermosetting material with 2 to 7 wt% of a boride filler, such as bisphenole-f type epoxy with 5 wt% ZrB_2, or novalak type with 5 wt% TiB_2. Or a thermosetting material with 3 to 7 wt% of an oxide filler such as alicyclic type epoxy with 5 wt% Al_2O_3 Or a thermosetting material with 2 to 7 wt% of a nitride filler such as amino type unsaturated polyester epoxy with 5 wt% AlN, or alicyclic type 5 wt% BN, or bisphenole-a type epoxy 5 wt% Si_3N_4. Or a thermosetting material with 2 to 7 wt% of a carbide filler such as alicyclic type epoxy with 5 wt% SiC, or bisphenole-f type epoxy with 5 wt% B_4C. Or a thermosetting material with 2 to 7 wt% of a silicide filler such as alicyclic type epoxy with 5 wt% WSi_2, or ester type epoxy 5 wt% $MoSi_2$. Or a thermosetting material with 2 to 7 wt% of a sulphate filler such as phenolic type unsaturated polyester epoxy with 5 wt% $CaSO_4$, or bisphenole-a type epoxy with 5 wt% $MgSO_4$.

[0065] The filler may also be any mixture of any of the fillers mentioned above. The mineral filler may be selected from CaO, MgO, ZnO, BaO, ZrO_2, SiO_2, TiO_2, $ZrSiO_4$, $MgAl_2O_4$, Al_2O_3, BN, AlN, CN, SiN, TiN, Si_3N_4, SiC, TiC, ZrC, WC, Mo_2C, VC, B_4C, WSi_2 and $MoSi_2$, TiB_2, ZrB_2, $CaSO_4$, $MgSO_4$, $Al_2(SO_4)_3$, $Ca(OH)_2$, $Mg(OH)_2$, $Zn(OH)_2$, $Al(OH)_3$, $CaCO_3$, $NaHCO_3$, $KHCO_3$, $MgCO_3$, $BaCO_3$, $CaMg(CO_3)_2$, K_2CO_3 and Na_2CO_3 or hydrates or mixtures thereof. Or the mineral filler may be selected from MgO, ZnO, Al_2O_3, BN, AlN, TiN, Si_3N_4, SiC, B_4C, $Ca(OH)_2$, $Mg(OH)_2$, $Al(OH)_3$, Ca-CO_3, $MgCO_3$, $BaCO_3$ and $CaMg(CO_3)_2$, or hydrates or mixtures thereof.

[0066] The glass material may be present in weight percentages of the total weight of the quenching material in a range between 5 to 45 wt%, or 15 to 35 wt%, or 20 to 35 wt%, or 25 to 35 wt%, or 5 to 30 wt%, or 10 to 30 wt%, or 15 to 30 wt%.

[0067] The filler may be present in weight percentages of the total weight of the quenching material in a range between 5 to 45 wt%, or 5 to 40 wt%, or 5 to 30 wt%, or 0 to 25 wt%, or 5 to 25 wt%, or 0 to 15 wt%, or 0 to 10 wt%.

[0068] The quenching material may comprise any of the compounds or any combination of any of the compounds at any percentage and between any of the ranges mentioned in this application.

[0069] The quenching chamber 4 may comprise at least two opposite walls 5a, whereby, within one level a, one wall 5a comprises polyoxymethylene and optionally glass materials up to 35 wt% and/or mineral fillers up to 30 wt% and the opposite wall 5a comprises polymethylpentene and optionally glass materials up to 40 wt% and/or mineral fillers up to 50 wt%. In one embodiment the walls 5a comprise 0 to 40 wt%, or 10 to 35 wt%, or 25 to 35 wt% glass material and 5 to 50 wt%, or 0 to 30 wt%, or 0 to 20 wt%, or 0 to 10 wt% mineral fillers. The mineral filler may be selected from the group comprising CaO, MgO, ZnO, BaO, ZrO_2, SiO_2, $TriO_2$, $ZrSiO_4$, $MgAl_2O_4$, Al_2O_3, BN, AlN, CN, SiN, TiN, Si_3N_4, SiC, TiC, ZrC, WC, Mo_2C, VC, B_4C, WSi_2 and $MoSi_2$, TiB_2, ZrB_2, $CaSO_4$, $MgSO_4$, $Al_2(SO_4)_3$, $Ca(OH)_2$, $Mg(OH)_2$, $Zn(OH)_2$, $Al(OH)_3$, $CaCO_3$, $NaHCO_3$, $KHCO_3$, $MgCO_3$, $BaCO_3$, $CaMg(CO_3)_2$, K_2CO_3 and Na_2CO_3, or hydrates or mixtures thereof.

[0070] The quenching chamber 4 may comprise at least two opposite walls 5a, whereby, within one level a, one wall 5a comprises polyoxymethylene and optionally glass materials up to 35 wt% and/or mineral fillers up to 30 wt% and the opposite wall 5a comprises polyethylene, or polypropylene and optionally glass materials up to 40 wt% and/ or mineral fillers up to 50 wt%. In one embodiment the walls 5a comprise 0 to 40 wt%, or 10 to 35 wt%, or 25 to 35 wt% glass material and 5 to 50 wt%, or 0 to 30 wt%, or 0 to 20 wt%, or 0 to 10 wt% mineral fillers. The mineral filler may be selected from the group comprising CaO, MgO, ZnO, BaO, ZrO_2, SiO_2, TiO_2, $ZrSiO_4$, $MgAl_2O_4$, Al_2O_3, BN, AlN, CN, SiN, TiN, Si_3N_4, SiC, TiC, ZrC, WC, Mo_2C, VC, B_4C, WSi_2 and $MoSi_2$, TiB_2, ZrB_2, $CaSO_4$, $MgSO_4$, $Al_2(SO_4)_3$, $Ca(OH)_2$, $Mg(OH)_2$, $Zn(OH)_2$ and $Al(OH)_3$, $CaCO_3$, $NaHCO_3$, $KHCO_3$, $MgCO_3$, $BaCO_3$, $CaMg(CO_3)_2$, K_2CO_3 and Na_2CO_3 or hydrates or mixtures thereof. In one embodiment the polyethylene is replaced by polypropylene.

[0071] The quenching chamber 4 may comprise at least two opposite walls 5a, whereby, within one level a, one wall 5a comprises polyoxymethylene and optionally glass materials up to 35 wt% and/or mineral fillers up to 30 wt% and the opposite wall 5a comprises a polyamide and optionally glass materials up to 40 wt% and/ or mineral fillers up to 50 wt%. In one embodiment the polyamide is polyamide 6 or 6,6, 11 or 12. In another embodiment the polyoxymethylene is a copolymer. In one embodiment the walls 5a comprise 0 to 40 wt%, or 10 to 35 wt%, or 25 to 35 wt% glass material and 5 to 50 wt%, or 0 to 30 wt%, or 0 to 20 wt%, or 0 to 10 wt% mineral fillers. The mineral filler may be selected from the group comprising CaO, MgO, ZnO, BaO, ZrO_2, SiO_2, TiO_2, $ZrSiO_4$, $MgAl_2O_4$, Al_2O_3, BN, AlN, CN, SiN, TiN, Si_3N_4, SiC, TiC, ZrC, WC, Mo_2C, VC, B_4C, WSi_2 and $MoSi_2$, TiB_2, ZrB_2, $CaSO_4$, $MgSO_4$, $Al_2(SO_4)_3$, $Ca(OH)_2$, $Mg(OH)_2$, $Zn(OH)_2$ and $Al(OH)_3$, $CaCO_3$, $NaHCO_3$, $KHCO_3$, $MgCO_3$, $BaCO_3$, $CaMg(CO_3)_2$, K_2CO_3 and Na_2CO_3 or hydrates or mixtures thereof.

[0072] The invention relates to use of a combination of quenching materials, whereby the quenching materials are selected from poly-oxymethylene or copolymer thereof and optionally glass materials up to 35 wt% and/or mineral fillers up to 30 wt% combined with polymethylpentene, or polyethylene, or polypropylene, or polyamide 6, or polyamide 6,6, or polyamide 11, or polyamide 12, and optionally glass materials up to 40 wt% and/or mineral fillers up to 50 wt%, for extinguishing or quenching an electrical arc between a fixed contact and a movable contact of a contact positioned in a quenching chamber. The percentages for the glass materials and mineral fillers may be replaced by any of the percentages or any of the ranges of percentages mentioned above.

[0073] The quenching chamber 4 as described above may be used in a method for extinguishing or quenching an electrical arc between a fixed contact and a movable contact of a contact positioned in a quenching chamber. Any combinations of any feature described above may be used in the chamber 4 and the method. The chamber 4 may further comprise a vent and the like to improve the quenching performance of the chamber 4.

Experimentals

[0074] Experiments were performed in a RLC circuit under damped conditions using a capacitor bank. The experiments were performed in quenching chambers, whereby one wall 5a comprised polyoxymethylene (POM) and the opposite wall 5a comprised glass reinforced (25 wt%) polyamide 12 containing 5 wt% BN as a filler (PAGFBN). The experiment was repeated using POM or PAGFBN as quenching material on the walls 5a on both sides of the space 6.

[0075] The arc voltages for the different chambers are shown in Fig 7. The mean arc voltage of the combined asymmetric positioned material is clearly higher compared with the mean voltage from either of the materials. The capacitor bank was charged at different voltage levels in order to simulate different operational conditions. The time at which the arc voltage starts to increase is an indication of the beginning of the pressure build up, and the moment that the material starts the ablation. Comparison of the times indicates that the chamber comprising the combination of the asymmetric positioned materials has a faster increase of the voltage (point F). The voltage remains higher in the new chamber 4 according to the invention as shown in points H. The results show that combining the materials in the chamber 4 allows controlling the time at which the gassing of the material takes place.

[0076] The effect of the same materials on gap conductance was measured in the capacitor bank. (Fig 8) These results show that the chamber 4 comprising the combination of the asymmetric positioned materials, has a lower gap conductance compared to the other two chambers (Point L in Fig 8). Also shown is that the gap conductance is lower during most of the breaking time.

[0077] The present invention is not limited to the embodiments disclosed but may be varied and modified within the scope of the following claims.

Claims

1. A quenching chamber (4) for a circuit interrupter (1) comprising a space (6), and at least two walls (5) at least partially enclosing the space (6) and positioned on opposite sides of the space (6), wherein the quenching chamber (4) is configured to comprise, in the space (6), a switch having a fixed contact (2) and a movable contact (3), between which contacts (2, 3) an arc can be generated, each wall (5) of the quenching chamber (4) comprises one or more levels (a) of wall units (9), whereby the wall unit (9) within one level (a) extend over a width (w) of the wall (5) along a first axis (x) and extend along a part or whole length (l) of the wall (5) along a second axis

(y) being perpendicular to the first axis, and whereby each wall unit (9) comprises quenching material, and **characterised in that**
the wall units (9) on opposite sides of the space (6) within the same level (a) comprise quenching material having different quenching capabilities.

2. The quenching chamber (4) according to claim 1, **characterised in that** the quenching material is selected from a first material having ablation capability at a start of a circuit interruption, a second material having cooling capabilities and a third material having neutralisation capabilities, or any mixtures thereof.

3. The quenching chamber (4) according to claim 2, **characterised in that** the first material ablates faster than the second and third material, and the second material cools the space (6) faster than the first and third material, and the third material neutralises faster than the first and second material.

4. The quenching chamber (4) according to any one of claims 1 to 3, **characterised in that** the at least two walls (5) comprise two levels (a, b) of wall units (9).

5. The quenching chamber (4) according to any one of claims 1 to 3, **characterised in that** the at least two walls (5) comprise three levels (a, b, c) of wall units (9), whereby the quenching materials comprised in the middle level (b) has different quenching capabilities from the quenching material comprised in at least one of the other levels (a, c) of wall units (9).

6. The quenching chamber (4) according to any one of claims 1 to 3, **characterised in that** at least three different walls (5) are present in the chamber (4), whereby, within one level (a), the quenching material comprised in the third wall may have the same or different quenching capabilities as the quenching material comprised in one or in both of the two opposite wall (5a).

7. The quenching chamber (4) according to any one of claims 1 to 6, **characterised in that** the first material is selected from the group comprising polyacetals, polyolefins, polyamides and polyacrylates, or copolymers or mixtures thereof, and optionally glass materials up to 35 wt% and/or mineral fillers up to 30 wt%.

8. The quenching chamber (4) according to any one of claims 1 to 6, **characterised in that** the second material is selected from the group comprising ceramic and thermosetting materials selected from the group comprising epoxy and polyesters, or co-polymers or mixtures thereof, and optionally including glass materials up to 40 wt% and/ or mineral fillers up to 50 wt%.

9. The quenching chamber (4) according to any one of claims 5 to 6, **characterised in that** the third material is selected from the group comprising polyolefins, polyamides, fluorinated polymers and thermosetting polymers, or copolymers or mixtures thereof, and optionally including glass materials up to 40 wt% and/or mineral fillers up to 50 wt%.

10. The quenching chamber (4) according to any one of claims 7 to 9, **characterised in that** the filler is selected from the group comprising
compounds of formula $M_m(OH)_n$, wherein M is a metal, m is 0, 1, 2 or 3, and n is 0, 1, 2, 3 or 4, and
compounds of formula $Q_pH_yCO_x$, wherein Q is selected from the group comprising Ca, Na, Mg, Ba and K and p is 0, 1, 2 or 3, y is 0, 1 or 2 and x is 1, 2 or 3, and
compound of formula T_tR_r, wherein T is selected from the group comprising Ca, Al, Si, Zr, Ba, Ti, W, Mo, V, Mg, Zn and B, and R is selected from the group comprising O, SO_4, C and N, wherein t is 1, 2 or 3, and r is 0, 1, 2, 3 or 4,
or hydrates or mixtures thereof.

11. The quenching chamber (4) according to any one of claims 7 to 9, **characterised in that** the filler is selected from the group comprising CaO, MgO, ZnO, BaO, ZrO_2, SiO_2, TiO_2, $ZrSiO_4$, $MgAl_2O_4$, Al_2O_3, BN, AlN, CN, SiN, TiN, Si_3N_4, SiC, TiC, ZrC, WC, Mo_2C, VC, B_4C, WSi_2 and $MoSi_2$, TiB_2, ZrB_2, $CaSO_4$, $MgSO_4$, $Al_2(SO_4)_3$, $Ca(OH)_2$, $Mg(OH)_2$, $Zn(OH)_2$ and $Al(OH)_3$, $CaCO_3$, $NaHCO_3$, $KHCO_3$, $MgCO_3$, $BaCO_3$, $CaMg(CO_3)_2$, K_2CO_3 and Na_2CO_3, or hydrates or mixtures thereof.

12. The quenching chamber (4) according to claim 1, **characterised in** comprising at least two opposite walls (5a) whereby, within one level (a), one wall (5a) comprises polyoxymethylene and optionally glass materials up to 35 wt% and/or mineral fillers up to 30 wt% and the opposite wall (5a) comprises polymethylpentene or polyamide 6, 6,6, 11 or 12 and optionally glass materials up to 40 wt% and/or mineral fillers up to 50 wt%.

13. A switch comprising the quenching chamber (4) according to any one of claims 1 to 12.

14. A method for quenching an electrical arc between a fixed contact (2) and a movable contact (3) comprised in a switch, whereby the switch is positioned in a quenching chamber (4), comprising a space (6), and at least two walls (5) at least partially enclosing the space (6) and positioned on opposite sides of the space (6), and whereby the contacts (2, 3) are provided in the space (6) and between which an arc

can be generated, and each wall (5) of the quenching chamber (4) comprises one or more levels (a) of wall units (9), whereby the wall unit (9) within one level (a) extend over a width (w) of the wall (5) along a first axis (x) and extend along a part or whole length (l) of the wall (5) along a second axis (y) being perpendicular to the first axis, and whereby each wall unit (9) comprises quenching material,
characterised in that the wall units (9) on opposite sides of the space (6) within the same level (a) comprise quenching material having different quenching capabilities.

15. The method according to claim 14, **characterised in that** the quenching material comprises quenching capabilities selected from a first material having ablation capability at a start of a circuit interruption, a second material having cooling capabilities and a third material having neutralisation capabilities, or any mixtures thereof.

Patentansprüche

1. Löschkammer (4) für einen Schutzschalter (1) umfassend einen Raum (6) und mindestens zwei Wände (5), die den Raum (6) mindestens teilweise umschließen und an entgegengesetzten Seiten des Raums (6) positioniert sind, wobei die Löschkammer (4) so konfiguriert ist, dass sie in dem Raum (6) ein Schaltorgan umfasst, das einen fixierten Kontakt (2) und einen beweglichen Kontakt (3) aufweist, zwischen welchen Kontakten (2, 3) ein Lichtbogen erzeugt werden kann, jede Wand (5) der Löschkammer (4) ein oder mehrere Niveaus (a) von Wandeinheiten (9) umfasst, wobei die Wandeinheit (9) innerhalb eines Niveaus (a) sich über eine Breite (w) der Wand (5) einer ersten Achse (x) entlang erstreckt und einem Teil oder der ganzen Länge (1) der Wand (5) entlang einer zweiten Achse (y) entlang erstreckt, die senkrecht zu der ersten Achse liegt, und wobei jede Wandeinheit (9) Löschmaterial umfasst, und
dadurch gekennzeichnet, dass
die Wandeinheiten (9) auf entgegengesetzten Seiten des Raums (6) innerhalb desselben Niveaus (a) Löschmaterial umfassen, das verschiedene Löschfähigkeiten aufweist.

2. Löschkammer (4) nach Anspruch 1, **dadurch gekennzeichnet, dass** das Löschmaterial unter einem ersten Material, das zu Beginn einer Schaltkreisunterbrechung Abschmelzfähigkeit aufweist, einem zweiten Material, das Kühlfähigkeiten aufweist, und einem dritten Material, das Neutralisationsfähigkeiten aufweist, oder einer Mischung davon ausgewählt wird.

3. Löschkammer (4) nach Anspruch 2, **dadurch gekennzeichnet, dass** das erste Material schneller abschmilzt als das zweite und dritte Material und das zweite Material den Raum (6) schneller kühlt als das erste und dritte Material und das dritte Material schneller neutralisiert als das erste und zweite Material.

4. Löschkammer (4) nach einem der Ansprüche 1 bis 3, **dadurch gekennzeichnet, dass** die mindestens zwei Wände (5) zwei Niveaus (a, b) von Wandeinheiten (9) umfassen.

5. Löschkammer (4) nach einem der Ansprüche 1 bis 3, **dadurch gekennzeichnet, dass** die mindestens zwei Wände (5) drei Niveaus (a, b, c) von Wandeinheiten (9) umfassen, wobei die Löschmaterialien, die im mittleren Niveau (b) enthalten sind, andere Löschfähigkeiten aufweisen als das Löschmaterial, das in mindestens einem der anderen Niveaus (a, c) der Wandeinheiten (9) enthalten ist.

6. Löschkammer (4) nach einem der Ansprüche 1 bis 3, **dadurch gekennzeichnet, dass** mindestens drei verschiedene Wände (5) in der Kammer (4) vorliegen, wobei innerhalb eines Niveaus (a) das Löschmaterial, das in der dritten Wand enthalten ist, dieselben oder andere Löschfähigkeiten aufweisen kann als das Löschmaterial, das in einer oder in beiden der entgegengesetzten Wände (5a) enthalten ist.

7. Löschkammer (4) nach einem der Ansprüche 1 bis 6, **dadurch gekennzeichnet, dass** das erste Material aus der Gruppe ausgewählt ist umfassend Polyacetale, Polyolefine, Polyamide und Polyacrylate oder Copolymere oder Mischungen davon und wahlweise Glasmaterialien von bis zu 35 Gew.-% und/oder Mineralfüllstoffe von bis zu 30 Gew.-%.

8. Löschkammer (4) nach einem der Ansprüche 1 bis 6, **dadurch gekennzeichnet, dass** das zweite Material aus der Gruppe ausgewählt ist umfassend Keramik- und duroplastische Materialien ausgewählt aus der Gruppe umfassend Epoxy und Polyester oder Copolymere oder Mischungen davon und wahlweise Glasmaterialien von bis zu 40 Gew.-% und/oder Mineralfüllstoffe von bis zu 50 Gew.-% enthaltend.

9. Löschkammer (4) nach einem der Ansprüche 5 bis 6, **dadurch gekennzeichnet, dass** das dritte Material aus der Gruppe ausgewählt ist umfassend Polyolefine, Polyamide, fluorierte Polymere und duroplastische Polymere oder Copolymere oder Mischungen davon und wahlweise Glasmaterialien von bis zu 40 Gew.-% und/oder Mineralfüllstoffe von bis zu 50 Gew.-% enthaltend.

10. Löschkammer (4) nach einem der Ansprüche 7 bis 9, **dadurch gekennzeichnet, dass** das Füllmaterial aus der Gruppe ausgewählt ist umfassend
Verbindungen der Formel $M_m(OH)_n$, wobei M ein Metall ist, m 0, 1, 2 oder 3 beträgt und n 0, 1, 2, 3 oder 4 beträgt und
Verbindungen der Formel $Q_pH_yCO_x$, wobei Q aus der Gruppe ausgewählt ist umfassend Ca, Na, Mg, Ba und K und p 0, 1, 2 oder 3 beträgt, y 0, 1 oder 2 beträgt und x 1, 2 oder 3 beträgt und
die Verbindung der Formel T_tR_r, wobei T aus der Gruppe ausgewählt ist umfassend Ca, Al, Si, Zr, Ba, Ti, W, Mo, V, Mg, Zn und B und
R aus der Gruppe ausgewählt ist umfassend 0, SO_4, C und N,
wobei t 1, 2 oder 3 beträgt und r 0, 1, 2, 3 oder 4 beträgt,
oder Hydrate oder Mischungen davon.

11. Löschkammer (4) nach einem der Ansprüche 7 bis 9, **dadurch gekennzeichnet, dass** der Füllstoff aus der Gruppe ausgewählt ist umfassend CaO, MgO, ZnO, BaO, ZrO_2, SiO_2, TiO_2, $ZrSiO_4$, $MgAl_2O_4$, Al_2O_3, BN, AIN, CN, SiN, TiN, Si_3N_4, SiC, TiC, ZrC, WC, Mo_2C, VC, B_4C, WSi_2 und $MoSi_2$, TiB_2, ZrB_2, $CaSO_4$, $MgSO_4$, $Al_2(SO_4)_3$, $Ca(OH)_2$, $Mg(OH)_2$, $Zn(OH)_2$ und $Al(OH)_3$, $CaCO_3$, $NaHCO_3$, $KHCO_3$, $MgCO_3$, $BaCO_3$, $CaMg(CO_3)_2$, K_2CO_3 und Na_2CO_3 oder Hydrate oder Mischungen davon.

12. Löschkammer (4) nach Anspruch 1, **dadurch gekennzeichnet, dass** sie mindestens zwei entgegengesetzte Wände (5a) umfasst, wobei, innerhalb eines Niveaus (a), eine Wand (5a) Polyoxymethylen und wahlweise Glasmaterialien von bis zu 35 Gew.-% und/oder Mineralfüllstoffe von bis zu 30 Gew.-% umfasst und die entgegengesetzte Wand (5a) Polymethylenpenten oder Polyamid 6, 6,6, 11 oder 12 und wahlweise Glasmaterialien von bis zu 40 Gew.-% und/oder Mineralfüllstoffe von bis zu 50 Gew.-% umfasst.

13. Schaltorgan umfassend die Löschkammer (4) nach einem der Ansprüche 1 bis 12.

14. Verfahren zum Löschen eines elektrischen Lichtbogens zwischen einem fixierten Kontakt (2) und einem beweglichen Kontakt (3), die in einem Schaltorgan enthalten sind, wobei das Schaltorgan in einer Löschklammer (4) positioniert ist, umfassend einen Raum (6) und mindestens zwei Wände (5), die den Raum (6) mindestens teilweise umschließen und an entgegengesetzten Seiten des Raums (6) positioniert sind, und wobei die Kontakte (2, 3) in dem Raum (6) bereitgestellt sind und zwischen welchen ein Lichtbogen erzeugt werden kann und jede Wand (5) der Löschkammer (4) ein oder mehrere Niveaus (a) von Wandeinheiten (9) umfasst, wobei die Wandeinheit (9) innerhalb eines Niveaus (a) sich über eine Breite (w) der Wand (5) einer ersten Achse (x) entlang erstreckt und einem Teil oder der ganzen Länge (1) der Wand (5) entlang einer zweiten Achse (y) entlang erstreckt, die senkrecht zu der ersten Achse liegt, und wobei jede Wandeinheit (9) Löschmaterial umfasst, und **dadurch gekennzeichnet, dass** die Wandeinheiten (9) auf entgegengesetzten Seiten des Raums (6) innerhalb desselben Niveaus (a) Löschmaterial umfassen, das verschiedene Löschfähigkeiten aufweist.

15. Verfahren nach Anspruch 14, **dadurch gekennzeichnet, dass** das Löschmaterial Löschfähigkeiten umfasst ausgewählt von einem ersten Material, das Abschmelzfähigkeit zu Beginn einer Schaltkreisunterbrechung aufweist, einem zweiten Material, das Kühlfähigkeiten aufweist, und einem dritten Material, das Neutralisationsfähigkeiten aufweist, oder einer Mischung davon.

Revendications

1. Chambre d'extinction (4) pour un interrupteur de circuit (1) comprenant un espace (6), et au moins deux parois (5) entourant au moins partiellement l'espace (6) et positionnées sur des côtés opposés de l'espace (6), la chambre d'extinction (4) étant configurée pour comprendre, dans l'espace (6), un commutateur ayant un contact fixe (2) et un contact mobile (3), contacts (2, 3) entre lesquels un arc peut être généré, chaque paroi (5) de la chambre d'extinction (4) comprenant un ou plusieurs niveaux (a) d'unités de paroi (9), l'unité de paroi (9) au sein d'un niveau (a) s'étendant sur une largeur (w) de la paroi (5) le long d'un premier axe (x) et s'étendant sur une partie ou la totalité d'une longueur (1) de la paroi (5) le long d'un deuxième axe (y) perpendiculaire au premier axe, et chaque unité de paroi (9) comprenant un matériau d'extinction, et
caractérisée en ce que
les unités de paroi (9) sur des côtés opposés de l'espace (6) au sein du même niveau (a) comprennent un matériau d'extinction ayant des capacités d'extinction différentes.

2. Chambre d'extinction (4) selon la revendication 1, **caractérisée en ce que** le matériau d'extinction est choisi parmi un premier matériau ayant une capacité d'ablation au début d'une interruption de circuit, un deuxième matériau ayant des capacités de refroidissement et un troisième matériau ayant des capacités de neutralisation, ou tous mélanges de ceux-ci.

3. Chambre d'extinction (4) selon la revendication 2, **caractérisée en ce que** le premier matériau subit une ablation plus rapide que le deuxième et le troisième matériau, le deuxième matériau refroidit l'espace (6) plus rapidement que le premier et le troisième matériau, et le troisième matériau neutralise plus rapidement que le premier et le deuxième matériau.

4. Chambre d'extinction (4) selon l'une quelconque des revendications 1 à 3, **caractérisée en ce que** les au moins deux parois (5) comprennent deux niveaux (a, b) d'unités de paroi (9).

5. Chambre d'extinction (4) selon l'une quelconque des revendications 1 à 3, **caractérisée en ce que** les au moins deux parois (5) comprennent trois niveaux (a, b, c) d'unités de paroi (9), les matériaux d'extinction contenus dans le niveau du milieu (b) ayant des capacités d'extinction différentes du matériau d'extinction contenu dans au moins un des autres niveaux (a, c) d'unités de paroi (9).

6. Chambre d'extinction (4) selon l'une quelconque des revendications 1 à 3, **caractérisée en ce qu'**au moins trois parois différentes (5) sont présentes dans la chambre (4), dans laquelle, au sein d'un niveau (a), le matériau d'extinction contenu dans la troisième paroi peut avoir des capacités d'extinction identiques ou différentes du matériau d'extinction contenu dans une des deux parois opposées (5a) ou les deux.

7. Chambre d'extinction (4) selon l'une quelconque des revendications 1 à 6, **caractérisée en ce que** le premier matériau est choisi dans le groupe comprenant les polyacétals, les polyoléfines, les polyamides et les polyacrylates, ou les copolymères ou mélanges de ceux-ci, et éventuellement des matériaux vitreux jusqu'à 35 % en poids et/ou des charges minérales jusqu'à 30 % en poids.

8. Chambre d'extinction (4) selon l'une quelconque des revendications 1 à 6, **caractérisée en ce que** le deuxième matériau est choisi dans le groupe comprenant les matériaux céramiques et thermodurcissables choisis dans le groupe comprenant les époxydes et les polyesters, ou les copolymères ou mélanges de ceux-ci, et comporte éventuellement des matériaux vitreux jusqu'à 40 % en poids et/ou des charges minérales jusqu'à 50 % en poids.

9. Chambre d'extinction (4) selon l'une quelconque des revendications 5 à 6, **caractérisée en ce que** le troisième matériau est choisi dans le groupe comprenant les polyoléfines, les polyamides, les polymères fluorés et les polymères thermodurcissables, ou les copolymères ou mélanges de ceux-ci, et comporte éventuellement des matériaux vitreux jusqu'à 40 % en poids et/ou des charges minérales jusqu'à 50 % en poids.

10. Chambre d'extinction (4) selon l'une quelconque des revendications 7 à 9, **caractérisée en ce que** la charge est choisie dans le groupe comprenant
les composés de formule $M_m(OH)_n$, dans laquelle M est un métal, m vaut 0, 1, 2 ou 3, et n vaut 0, 1, 2, 3 ou 4, et
les composés de formule $Q_pH_yCO_x$, dans laquelle Q est choisi dans le groupe comprenant Ca, Na, Mg, Ba et K et p vaut 0, 1, 2 ou 3, y vaut 0, 1 ou 2 et x vaut 1, 2 ou 3, et
les composés de formule T_rR_r, dans laquelle T est choisi dans le groupe comprenant Ca, Al, Si, Zr, Ba, Ti, W, Mo, V, Mg, Zn et B, et R est choisi dans le groupe comprenant O, SO_4, C et N, t valant 1, 2 ou 3, et r valant 0, 1, 2, 3 ou 4,
ou les hydrates ou mélanges de ceux-ci.

11. Chambre d'extinction (4) selon l'une quelconque des revendications 7 à 9, **caractérisée en ce que** la charge est choisie dans le groupe comprenant CaO, MgO, ZnO, BaO, ZrO_2, SiO_2, TiO_2, $ZrSiO_4$, $MgAl_2O_4$, Al_2O_3, BN, AlN, CN, SiN, TiN, Si_3N_4, SiC, TiC, ZrC, WC, Mo_2C, VC, B_4C, WSi_2 et $MoSi_2$, TiB_2, ZrB_2, $CaSO_4$, $MgSO_4$, $Al_2(SO_4)_3$, $Ca(OH)_2$, $Mg(OH)_2$, $Zn(OH)_2$ et $Al(OH)_3$, $CaCO_3$, $NaHCO_3$, $KHCO_3$, $MgCO_3$, $BaCO_3$, $CaMg(CO_3)_2$, K_2CO_3 et Na_2CO_3, ou les hydrates ou mélanges de ceux-ci.

12. Chambre d'extinction (4) selon la revendication 1, **caractérisée en ce qu'**elle comprend au moins deux parois opposées (5a), dans laquelle, au sein d'un niveau (a), une paroi (5a) comprend du polyoxyméthylène et éventuellement des matériaux vitreux jusqu'à 35 % en poids et/ou des charges minérales jusqu'à 30 % en poids, et la paroi opposée (5a) comprend du polyméthylpentène ou du polyamide 6, 6,6, 11 ou 12 et éventuellement des matériaux vitreux jusqu'à 40 % en poids et/ou des charges minérales jusqu'à 50 % en poids.

13. Commutateur comprenant la chambre d'extinction (4) selon l'une quelconque des revendications 1 à 12.

14. Procédé d'extinction d'un arc électrique entre un contact fixe (2) et un contact mobile (3) contenus dans un commutateur, le commutateur étant positionné dans une chambre d'extinction (4) comprenant un espace (6) et au moins deux parois (5) entourant au moins partiellement l'espace (6) et positionnées sur des côtés opposés de l'espace (6), et les contacts (2, 3) étant disposés dans l'espace (6) et un arc pouvant être généré entre eux, et chaque paroi (5) de la chambre d'extinction (4) comprenant un ou plusieurs niveaux (a) d'unités de paroi (9), l'unité de paroi (9) au sein d'un niveau (a) s'étendant sur une largeur (w) de la paroi (5) le long d'un premier axe (x) et s'étendant sur une partie ou la totalité d'une

longueur (1) de la paroi (5) le long d'un deuxième axe (y) perpendiculaire au premier axe, et chaque unité de paroi (9) comprenant un matériau d'extinction,
caractérisé en ce que les unités de paroi (9) sur des côtés opposés de l'espace (6) au sein du même niveau (a) comprennent un matériau d'extinction ayant des capacités d'extinction différentes.

15. Procédé selon la revendication 14, **caractérisé en ce que** le matériau d'extinction comprend des capacités d'extinction choisies parmi un premier matériau ayant une capacité d'ablation au début d'une interruption de circuit, un deuxième matériau ayant des capacités de refroidissement et un troisième matériau ayant des capacités de neutralisation, ou tous les mélanges de ceux-ci.

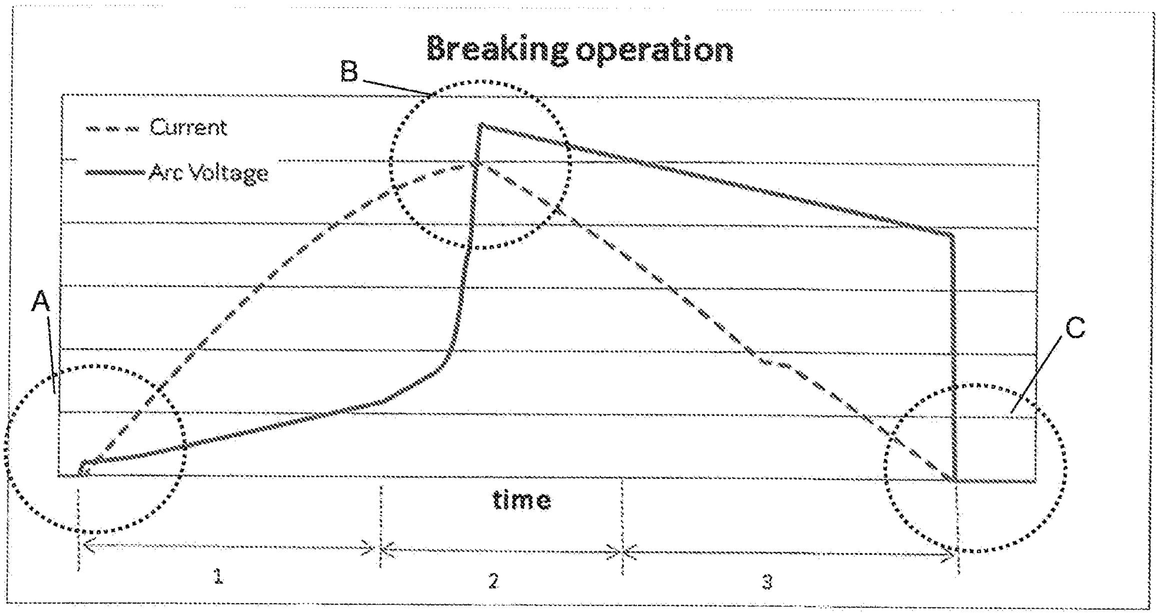

Figure 1

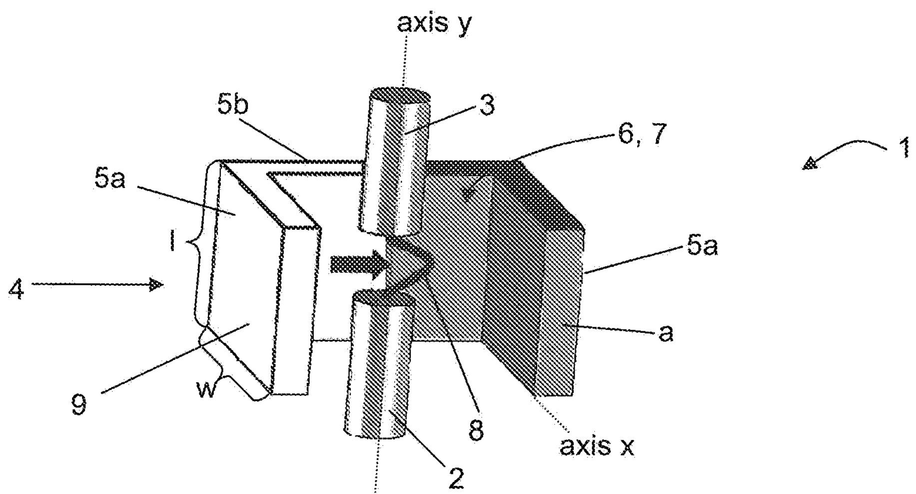

Figure 2

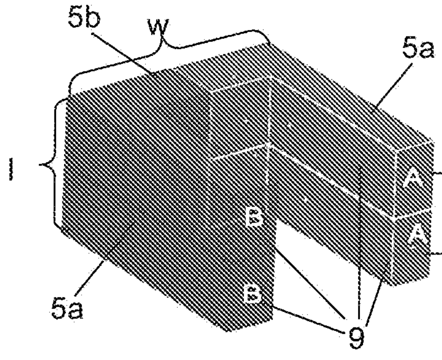

Figure 3a

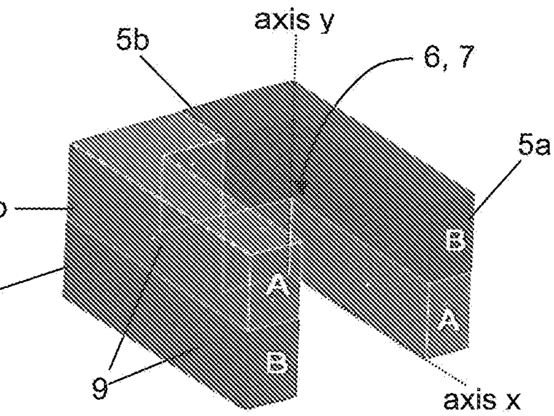

Figure 3b

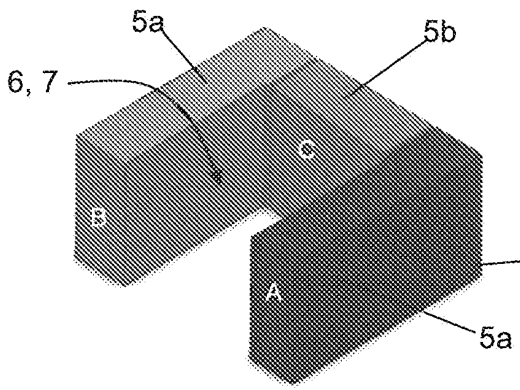

Figure 4

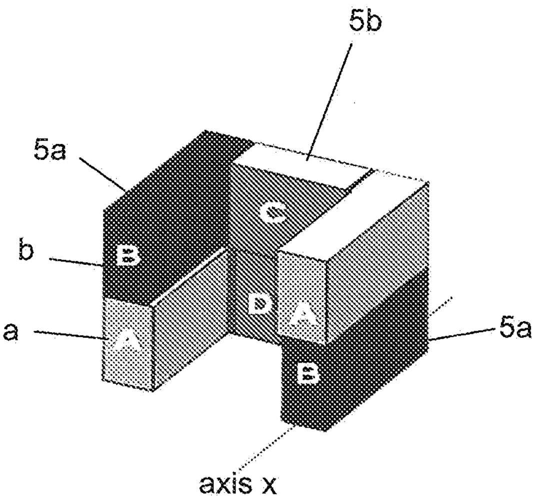

Figure 5

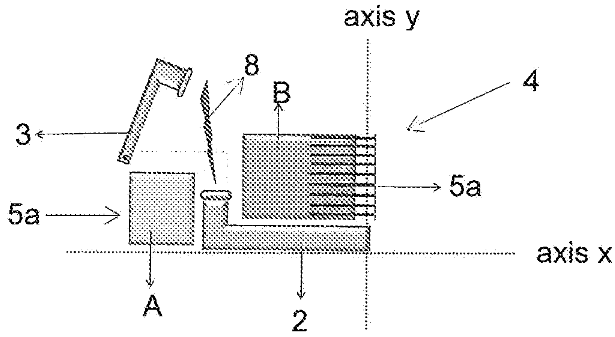

Figure 6

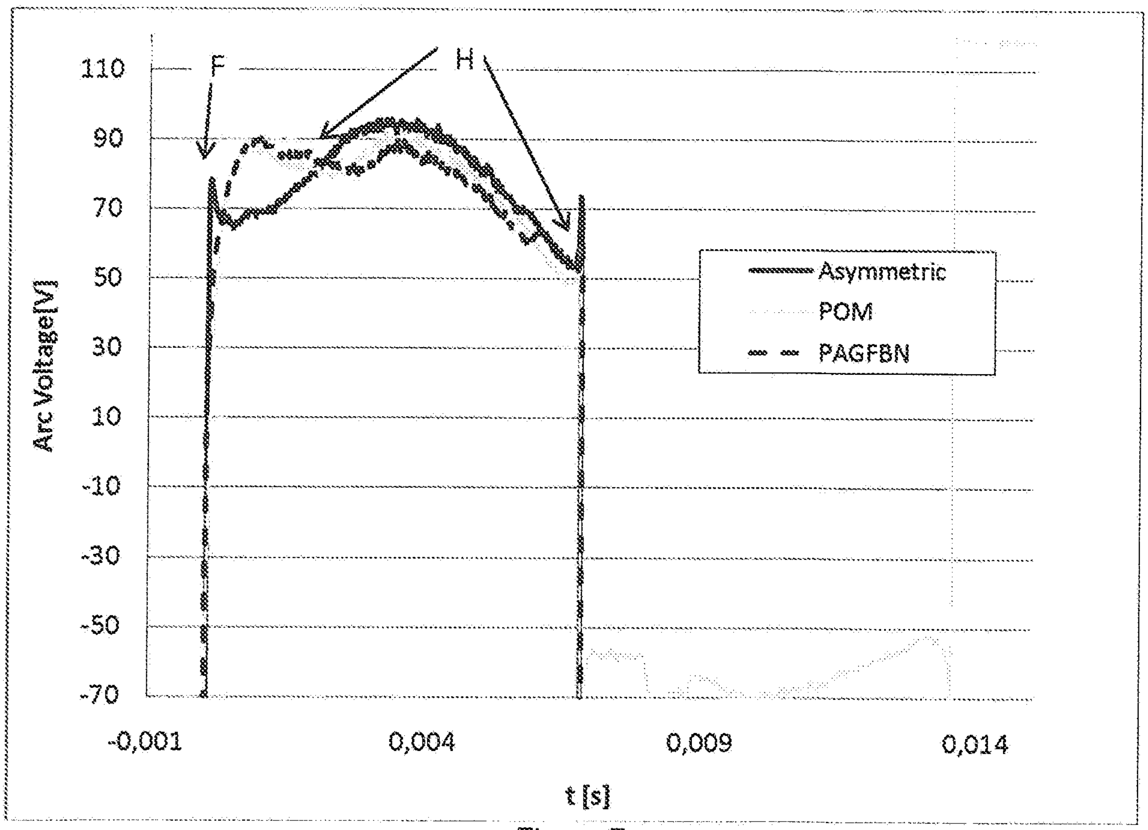

Figure 7

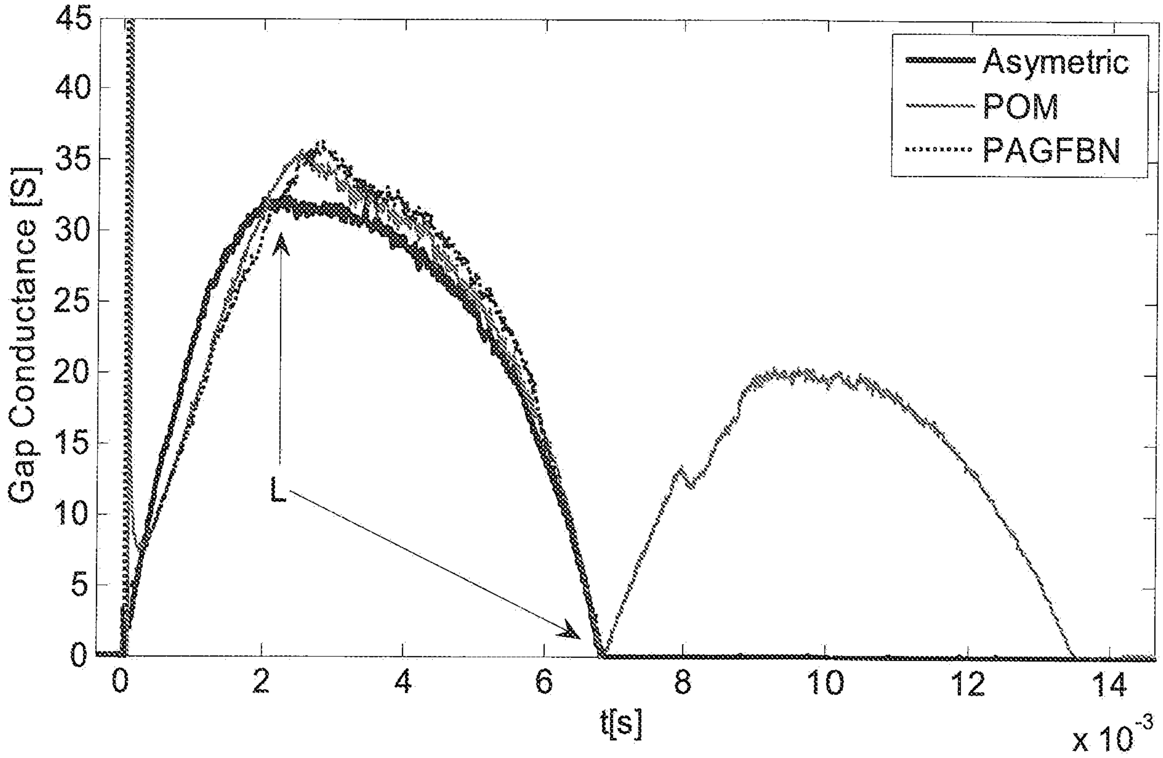
45
40
35
30
25
20
15
10
5
0
Gap Conductance [S]
0
2
4
6
8
10
12
14
t[s]
x 10^-3
Asymetric
POM
PAGFBN
L

Figure 8

REFERENCES CITED IN THE DESCRIPTION

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