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(54) **POSITIVE TEMPERATURE COEFFICIENT (PTC) HEATER**

(57) The invention relates to a PTC heater (1) with at least one PTC heating element (2). The at least one PTC heating element (2) contains a heating layer (3) made of a PTC material, which is arranged between a first electrode plate (4a) and a second electrode plate (4b) and is electrically contacted therewith. The PTC heater (1) further contains a housing (5) in which the at least one PTC heating element (2) is arranged. The electrode plates (4a, 4b) of the at least one PTC heating element (2) are fixed to the housing (5) in a heat-transmit-

ting and electrically insulated manner.

According to the invention, an electrically conductive plate (8) is arranged parallel to the electrode plates (4a, 4b) and divides the heating layer (3) into a first heating part layer (3a) and a second heating part layer (3b). Furthermore, at least one heat conducting layer (9) is arranged between the electrode plates (4a, 4b) and is connected to the first heating part layer (3a) and/or to the second heating part layer (3b) in a heat-transmitting manner.

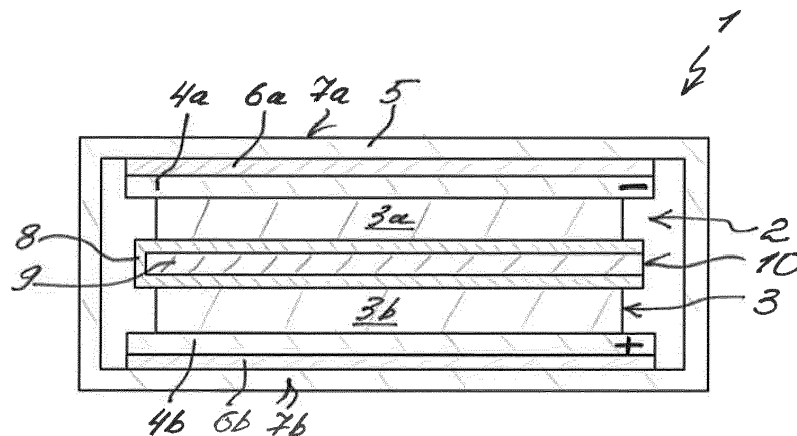


Fig. 1

Description

[0001] The invention relates to a PTC heater comprising at least one PTC heating element according to the preamble of claim 1.

[0002] Modern motor vehicles are increasingly optimized for consumption and less and less waste heat is available for conventionally heating the interior. In particular when cold starting the motor vehicle and in the case of low outside temperatures, the interior can be additionally heated for example by means of a PTC (Positive Temperature Coefficient) heater. PTC heaters are already known from the prior art and are made of typically ceramic PTCs, which are characterized by an electrical resistance, which increases as the temperature increases. The PTC heater is throttled by its own behavior and the heating surfaces of the PTC heater have an even temperature distribution. The temperature of the heating surfaces is in particular independent of boundary conditions - such as for example of the applied voltage, the resistance of the PTC or the air quantity above the PTC heater. The PTC heater is cost-efficient, can be installed in air ducts of the air conditioning system in a space-saving manner and quickly converts the electrical energy into the heat.

[0003] In hybrid or electric vehicles, a PTC heater has a particularly high significance, because no waste heat or only a small amount of waste heat is produced in a hybrid or electric vehicle, and can be used for heating. For an effective heating in a hybrid or electric vehicle, the PTC heater needs to partially have a wattage of more than 3 kW. This is why the PTC heater is operated at a high voltage in order to keep the current as low as possible. The voltages are thereby above 60 V and partially above 300 V. Furthermore, there is a need to further increase the voltage in the hybrid or electric vehicle up to 800 V. Common PTC heaters are not designed for voltages, as they appear in hybrid or electric vehicles, and can thus only be used to a limited extent in hybrid or electric vehicles.

To rule out exposure of the passengers during operation of the PTC heater, the PTC heater needs to also be touch-protected and flashover-protected. Voltage conducting components of the PTC heater need to furthermore be encapsulated in a dust-tight and water-tight manner. To meet the increasing demands on the touch protection, the voltage conducting components are electrically insulated to the outside to an increasing extent. The heat release of the PTC heater to the outside, which causes an unwanted throttling of the PTC heater, is also reduced thereby. The wattage, which the PTC heater can convert into the heat, is also reduced accordingly.

[0004] It is thus the object of the invention to specify an improved or at least alternative embodiment for a PTC heater of the generic type, in the case of which the described disadvantages are overcome.

[0005] According to the invention, this object is solved by the subject matter of independent claim 1. Advanta-

geous further embodiments are the subject matter of the dependent claims.

[0006] A generic PTC (Positive Temperature Coefficient) heater has at least one PTC heating element, which has a heating layer made of a PTC material. The heating layer is thereby arranged between a first electrode plate and a second electrode plate and is electrically contacted therewith. The PTC heater further has a housing, in which the at least one PTC heating element is arranged. The electrode plates of the at least one PTC heating element are thereby fixed to the housing so as to transfer heat and so as to be electrically insulated. According to the invention, an electrically conductive plate is arranged in parallel to the electrode plates and divides the heating layer into a first heating part layer and a second heating part layer. Furthermore, at least one heat conducting layer is arranged between the electrode plates and is connected to the first heating part layer and/or to the second heating part layer so as to transfer heat.

[0007] Advantageously, the at least one heat conducting layer has a heat conductivity, which is higher as compared to the heating layer, and dissipates the heat generated in the heating layer to the outside. Advantageously, an unwanted throttling of the PTC heating element is thus prevented or at least delayed and the heat output of the PTC heating element and of the PTC heater is improved. The electrically conductive plate arranged in parallel to the electrode plates can additionally dissipate the heat generated in the first heating part layer and in the second heating part layer.

[0008] Advantageously, the electrically conductive plate can be a third electrode plate. If a voltage is applied to the two electrode plates and to the electrically conductive plate, the first heating layer and the second heating part layer are divided by the third electrode and are connected in series with one another. A voltage drop thus results at the electrically conductive plate and the applied voltage at the two heating part layers in each case drops by half. Advantageously, the applied voltage can then be increased, without having to change the dimensions of the heating part layers. Furthermore, the creeping distance between potentials is doubled thereby and a flashover is prevented in an advantageous manner.

[0009] Advantageously, the PTC heating element in the PTC heater according to the invention can be switched in two different ways thereby. The voltage - for example 400 V - can thus be applied between the first electrode plate and the second electrode plate, so that the applied voltage - thus 400 V - drops across the entire heating layer. In the alternative, the voltage - for example 800 V - can be applied between the first and second electrode plates and the electrically conductive plate. In this case, the first heating part layer and the second heating part layer are connected in series, and the voltage at the two heating part layers in each case drops by half - thus in each case 400 V. The PTC heating element can be operated at two different voltages with a constant heat output in this way. The PTC heating element can further-

more also be switched over from the outside during operation and an additional engaging with the PTC heating element is not necessary.

[0010] Provision can advantageously be made for the at least one heat conducting layer to divide the first heating part layer vertically to the first electrode plate. In the alternative or in addition, the at least one heat conducting layer can divide the second heating part layer vertically to the second electrode plate. Advantageously, the respective heat conducting layer thereby has a higher heat conductivity than the first heating part layer or the second heating part layer and can dissipate the heat generated in the respective heating part layer via the electrode plates. On both sides of the housing, the electrode plates arranged at the housing and electrically insulated therefrom in each case form a heating surface, at which the heat generated in the heating layer is released into the surrounding area. The heat can be released more effectively to the electrode plates and to the respective heating surfaces of the housing by means of the at least one heat conducting layer. An unwanted throttling of the PTC heating element in the first heating part layer as well as in the second heating part layer can be prevented in an advantageous manner in this way. Advantageously, the respective heat conducting layer is electrically insulated from the respective heating part layer and does not influence electrical properties of the PTC heating element.

[0011] The at least one heat conducting layer can thereby abut on the electrically conductive plate on one side and the second heating part layer on the other side.

[0012] In the alternative or in addition, the at least one heat conducting layer can abut on the electrically conductive plate on one side and the first heating part layer on the other side. A mutual influencing of the first heating part layer and of the second heating part layer through the electrically conductive plate is prevented in this way. As a whole, the heat output of the PTC heating element can be increased thereby in an advantageous manner.

[0013] Advantageously, the at least one heat conducting layer can consist of a sintered ceramic, which preferably has aluminum nitride or boron nitride, or consists thereof. The heating layer - and correspondingly also the first heating part layer and the second heating part layer - can consist of the sintered PTC material, which is preferably a barium titanate. The heating layer of the sintered barium titanate has a heat conductivity of approximately 2 W/mK. In the case of the sintered aluminum nitride, the heat conducting layer has a heat conductivity of approximately 130 W/mK and in the case of the sintered boron nitride a heat conductivity of approximately 60 W/mK. The heat conducting layer can thus effectively dissipate the heat generated in the heating layer to the outside and can thus prevent an unwanted throttling of the PTC heating element and of the PTC heater.

[0014] In the case of a further development of the PTC heater according to the invention, provision is advantageously made for the at least one heat conducting layer to be arranged in parallel to the electrode plates and to

be enclosed at least in some areas by the electrically conductive plate, which is embodied in a U-shaped manner. The heat conducting layer is then coupled to the first heating part layer on the one side and to the second heating part layer on the other side so as to transfer heat via the enclosing electrically conductive plate, and can effectively dissipate the heat generated in the heating part layers, in particular from a middle area of the PTC heating element. An unwanted throttling of the PTC heating element is prevented in an advantageous manner in this way and the PTC heating element can be operated at two different voltages with a constant heat output.

[0015] To effectively dissipate the heat generated in the heat conducting layer to the outside, a heat distribution body of the PTC heating element can be fixed to the at least one heat conducting layer on one side and to the housing on the other side so as to transfer heat. The heat distribution body can consist for example of a sintered ceramic, which preferably has aluminum nitride or boron nitride, or consists thereof. The heat distribution body dissipates the heat from the respective heat conducting layer to the housing, to which the heat distribution body is fixed so as to transfer heat, and thus forms at least one body heating surface of the PTC heater. The body heating surface expands the heating surface of the PTC heater and the heat generated in the PTC heating element can be released into the surrounding area in a large-scale and effective manner.

[0016] Provision can advantageously be made for an electrically insulating insulating plate to be arranged in each case between the electrode plates and the housing. The respective electrode plate is fixed to the housing so as to transfer heat and electrically insulates the electrode plates from the housing. The PTC heater is protected against touch and flashover in this way. The respective insulating plate can additionally be connected to the heat distribution body of the PTC heating element so as to transfer heat, in order to effectively release the heat generated in the PTC heating element to the heating surface and to the body heating surface. Advantageously, the respective insulating plate can consist of an aluminum oxide or a sintered ceramic, which preferably has aluminum nitride or boron nitride, or consists thereof.

[0017] As a whole, the PTC heater according to the invention can be operated at a higher voltage, without having to increase dimensions of the heating layer.

[0018] Different voltages can furthermore be applied to the PTC heater, wherein a switchover of the PTC heating element from the outside can also take place during operation. In the case of the PTC heater according to the invention, the heat generated in the heating layer can also be effectively dissipated to the outside and an unwanted throttling of the PTC heating element can thus be prevented in an advantageous manner.

[0019] Further important features and advantages of the invention follow from the subclaims, from the drawings, and from the corresponding figure description by means of the drawings.

[0020] It goes without saying that the above-mentioned features and the features, which will be explained below, cannot only be used in the respective specified combination, but also in other combinations or alone, without leaving the scope of the invention at hand.

[0021] Preferred exemplary embodiments of the invention are illustrated in the drawings and will be explained in more detail in the description below, whereby identical reference numerals refer to identical or similar or functionally identical components.

[0022] In each case schematically

Figs. 1 and 2 show sectional views of a PTC heater according to the invention comprising a U-shaped electrically conductive plate;

Fig. 3 shows a view of a PTC heater according to the invention according to Fig. 1 and Fig. 2 comprising a heat distribution body;

Figs. 4 and 6 show sectional views of an alternatively embodied PTC heater comprising a flat electrically conductive plate;

Figs. 5 and 7 show views of PTC heating elements in the PTC heater according to Fig. 4 and Fig. 6.

[0023] Fig. 1 and Fig. 2 show sectional views of a PTC heater 1 according to the invention. The PTC heater 1 thereby has a PTC heating element 2 comprising a heating layer 3, which is arranged between a first electrode plate 4a and a second electrode plate 4b and which is electrically contacted therewith. The heating layer 3 consists for example of a sintered PTC material, which is preferably a barium titanate or has barium titanate. The PTC heating element 2 is encapsulated in a housing 5 of the PTC heater 1 in a dust-tight and water-tight manner, wherein insulating plates 6a and 6b are arranged between the electrode plates 4a and 4b and the housing 5. The respective insulating plates 6a and 6b are fixed to the housing 5 so as to transfer heat and electrically insulate the electrode plates 4a and 4b from the housing 5. The PTC heater 1 is protected against touch and flashover in this way. The insulating plates 6a and 6b can consist of or can have an aluminum oxide or a sintered ceramic, preferably an aluminum nitride or a boron nitride. The heat generated in the heating layer 3 is released to heating surfaces 7a and 7b of the housing 5 via the electrode plates 4a and 4b as well as the insulating plates 6a and 6b.

[0024] An electrically conductive plate 8, which divides the heating layer 3 into a first heating part layer 3a and a second heating part layer 3b, is arranged in parallel to the electrode plates 4a and 4b. The electrically conductive plate 8 is embodied in a U-shaped manner and encloses a heat conducting layer 9, which is arranged in

the U-shaped electrically conductive plate 8 in parallel to the electrode plates 4a and 4b. The electrically conductive plate 8 thereby abuts on the heating part layers 3a, 3b and the heat conducting layer 9 in a flat manner. Advantageously, the heat conducting layer 9 has a heat conductivity, which is higher as compared to the heating layer 3 and accordingly also as compared to the heating part layers 3a and 3b, and can consist for example of a sintered ceramic, which is preferably an aluminum nitride or a boron nitride. In the case of the sintered aluminum nitride, the heat conducting layer 9 then has a heat conductivity of approximately 130 W/mK and a heat conductivity of approximately 60 W/mK in the case of the sintered boron nitride. In contrast, the heating layer 3 and accordingly the heating part layers 3a and 3b for example of the sintered barium titanate have a heat conductivity of approximately 2 W/mK. The heat conducting layer 9 is connected to the first heating part layer 3a on the one side and to the heating part layer 3b on the other side via the electrically conductive plate 8 so as to transfer heat, and can effectively dissipate the heat generated in the heating part layers 3a and 3b, in particular from a middle area 10 of the PTC heating element 2. An unwanted throttling of the PTC heating element 2 is prevented in an advantageous manner in this way.

[0025] The PTC heating element 2 can be switched in two different ways in the PTC heater 1. The voltage - for example 400 V - can thus be applied between the first electrode plate 4a and the second electrode plate 4b, as is shown in Fig. 1. The applied voltage - thus 400 V - drops across the entire heating layer 3 and the wattage is converted into the heat. In the alternative, the voltage - for example 800 V - can be applied between the electrode plates 4a and 4b as well as the electrically conductive plate 8, as is shown in Fig. 2. Here, the electrically conductive plate 8 forms a third electrode plate 11, and the first heating part layer 3a and the second heating part layer 3b are connected in series. At the two heating part layers 3a and 3b, the voltage in each case drops by half - thus in each case 400 V. The PTC heating element 2 can be operated at two different voltages - 400 V and 800 V - with a constant heat output in this way. The PTC heating element 2 can thereby also be switched over from the outside during operation and an additional engaging with the PTC heating element 2 can be avoided.

[0026] Fig. 3 shows a perspective view of the PTC heater 1 comprising a heat distribution body 12. The heat distribution body 12 can for example consist of a sintered ceramic, which is preferably an aluminum nitride or a boron nitride. The heat distribution body 12 is fixed to the heat conducting layer 9 on the one side and to the housing 5 on the other side so as to transfer heat and dissipates the heat from the heat conducting layer 9 to the housing 5. Body heating surfaces 13a, 13b, at which the heat is released into the surrounding area, are thus formed on the housing 5. The body heating surface 13a and 13b expands the heating surfaces 7a and 7b of the PTC heater 1 and the heat generated in the PTC heating element

2 can be released into the surrounding area in a large-scale and effective manner.

[0027] Fig. 4 and Fig. 6 show sectional views of the alternatively embodied PTC heater 1. Fig. 5 and Fig. 7 show perspective views of the PTC heating element 2. In this exemplary embodiment, the heat conducting layer 9 divides the first heating part layer 3a vertically to the first electrode plate 4a. Two heat conducting layers 9 are arranged on both sides of the second heating part layer 3b so as to abut thereon and vertically to the electrode plate 4b. To prevent a mutual influencing of the divided heating part layer 3a and of the heating part layer 3b via the electrically conductive plate 8, the heat conducting layers 9 and the heating part layers 3a and 3b are arranged on the electrically conductive plate 8 in an alternating manner. The heat conducting layer 9 thus abuts on the electrically conductive plate 8 on one side and the divided heating part layer 3a or the heating part layer 3b on the other side. The electrically conductive plate 8 is thereby embodied so as to be flat.

[0028] Advantageously, the respective heat conducting layers 9 have a higher heat conductivity than the heating part layers 3a and 3b and can effectively dissipate the heat generated in the respective heating part layer 3a and 3b via the electrode plates 4a and 4b. An unwanted throttling of the PTC heating element 2 in the first heating part layer 3a as well as in the second heating part layer 3b can be prevented in an advantageous manner in this way. The heat conducting layers 9 furthermore extend into the PTC heating element 2, as is shown in Fig. 5 and Fig. 7, and the heat generated in the heating part layers 3a and 3b is evenly released across the entire depth of the PTC heating element 2. The heat conducting layers 9 are electrically insulated from the respective heating part layer 3a and 3b and do not influence electrical properties of the PTC heating element 2. As also in the PTC heater 1, which is embodied alternatively in Fig. 1 to Fig. 3, the heat conducting layer 9 can consist of an aluminum nitride or of a boron nitride. The heating layer 3 and thus the heating part layers 3a and 3b can consist of the sintered barium titanate.

[0029] In the PTC heating element 2 in Fig. 4 and Fig. 5, the voltage - for example 400 V - is applied between the first electrode plate 4a and the second electrode plate 4b. The applied voltage - thus 400 V - drops across the entire heating layer 3 and the wattage is converted into the heat. In Fig. 6 and Fig. 7, the voltage - for example 800 V - is applied between the electrode plates 4a and 4b as well as the electrically conductive plate 8 or the third electrode plate 11, respectively, and the first heating part layer 3a and the second heating part layer 3b are connected in series. At the two heating part layers 3a and 3b, the voltage in each case drops by half - thus in each case 400 V. The PTC heating element 2 can be operated at two different voltages - 400 V and 800 V - with a constant heat output in this way. The PTC heating element 2 can thereby also be switched over from the outside during operation and an additional engaging with

the PTC heating element 2 can be avoided.

[0030] Advantageously, the PTC heater 1 according to the invention can be operated at two different voltages, wherein the PTC heating element can also be switched over from the outside during operation. In the PTC heater 1 according to the invention, the heat generated in the heating part layer 3a and 3b can furthermore be effectively dissipated to the outside and an unwanted throttling of the PTC heating element 2 in the PTC heater 1 can be prevented in an advantageous manner thereby.

Claims

1. A PTC heater (1) comprising at least one PTC heating element (2),

- wherein the at least one PTC heating element (2) has a heating layer (3) of a PTC material, which is arranged between a first electrode plate (4a) and a second electrode plate (4b) and is electrically contacted therewith,
- wherein the PTC heater (1) has a housing (5), in which the at least one PTC heating element (2) is arranged, and
- wherein the electrode plates (4a, 4b) of the at least one PTC heating element (2) are fixed to the housing (5) so as to transfer heat and so as to be electrically insulated,

characterized in

- **that** an electrically conductive plate (8) is arranged in parallel to the electrode plates (4a, 4b) and divides the heating layer (3) into a first heating part layer (3a) and a second heating part layer (3b),
- **that** at least one heat conducting layer (9) is arranged between the electrode plates (4a, 4b) and is connected to the first heating part layer (3a) and/or to the second heating part layer (3b) so as to transfer heat.

2. The PTC heater according to claim 1,

characterized in

that the electrically conductive plate (8) is a third electrode plate (11).

3. The PTC heater according to claim 1 or 2,

characterized in

- **that** the at least one heat conducting layer (9) divides the first heating part layer (3a) vertically to the first electrode plate (4a), and/or
- **that** the at least one heat conducting layer (9) divides the second heating part layer (3b) vertically to the second electrode plate (4b).

4. The PTC heater according to claim 3,
characterized in
- **that** the at least one heat conducting layer (9) abuts on the electrically conductive plate (8) on one side and the second heating part layer (3b) on the other side, and/or
 - **that** the at least one heat conducting layer (9) abuts on the electrically conductive plate (8) on one side and the first heating part layer (3a) on the other side.
5. The PTC heater according to one of the preceding claims,
characterized in
- **that** the at least one heat conducting layer (9) is made of a sintered ceramic, preferably has aluminum nitride or boron nitride, or consists thereof, and/or
 - **that** the heating layer (3) is made of the sintered PTC material, preferably has barium titanate or is made thereof.
6. The PTC heater according to one of the preceding claims,
characterized in
that the at least one heat conducting layer (9) is arranged in parallel to the electrode plates (4a, 4b) and is enclosed at least in some areas by the electrically conductive plate (8), which is embodied in a U-shaped manner.
7. The PTC heater according to claim 6,
characterized in
that a heat distribution body (12) of the PTC heating element (2) is fixed to the at least one heat conducting layer (9) on one side and to the housing (5) on the other side so as to transfer heat.
8. The PTC heater according to claim 7,
characterized in
that the heat distribution body (12) is made of a sintered ceramic, preferably has aluminum nitride or boron nitride, or consists thereof.
9. The PTC heater according to one of the preceding claims,
characterized in
that an electrically insulating insulating plate (6a, 6b), which fixes the respective electrode plate (6a, 6b) to the housing (5) of the PTC heater (1) so as to transfer heat, is arranged in each case between the electrode plates (4a, 4b) and the housing (5).
10. The PTC heater according to claim 9,
characterized in
that the respective insulating plate (6a, 6b) is made

of a sintered ceramic, preferably has aluminum nitride or aluminum oxide or boron nitride, or consists thereof.

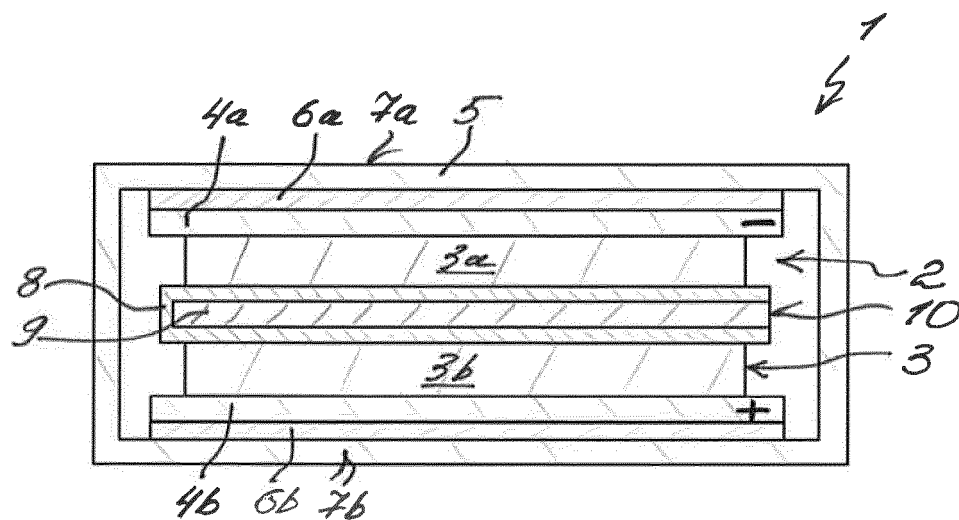


Fig. 1

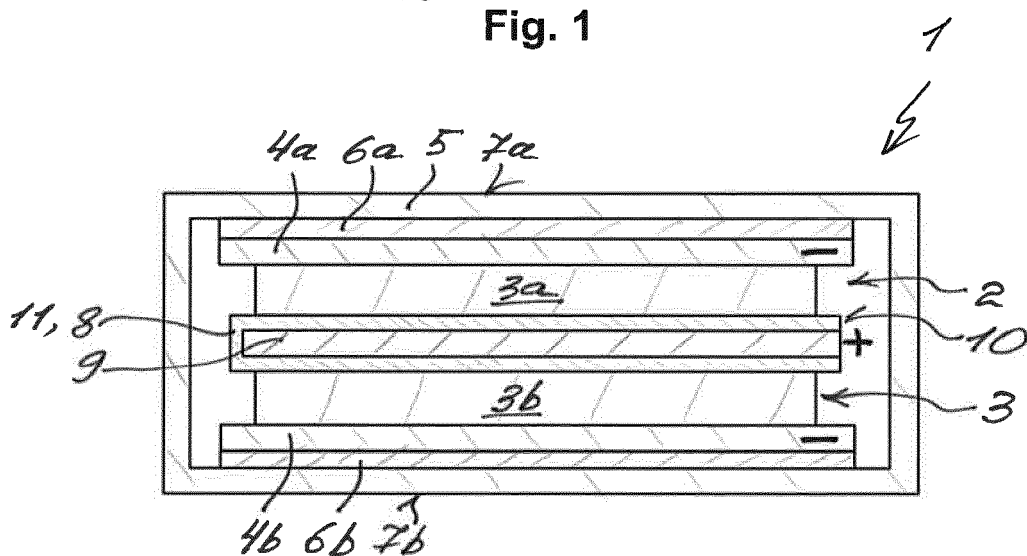


Fig. 2

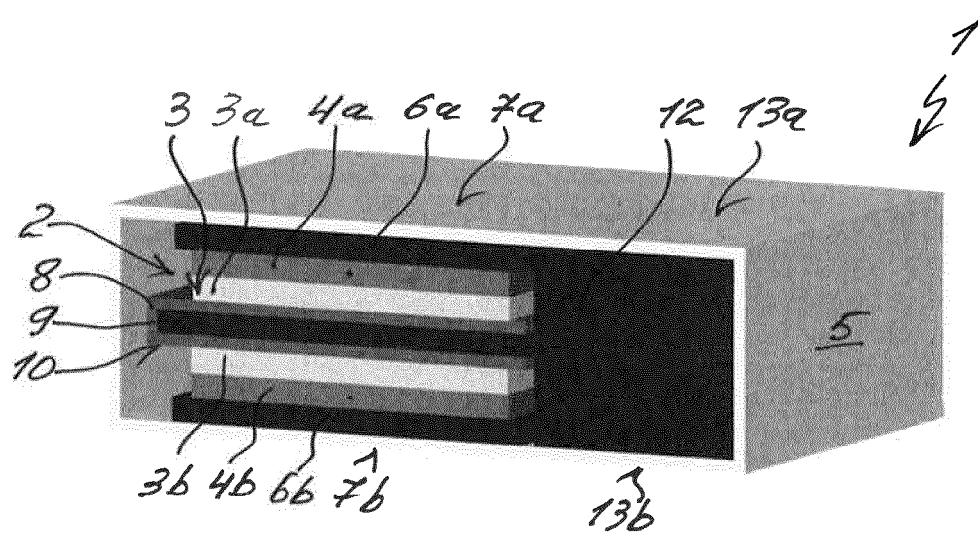


Fig. 3

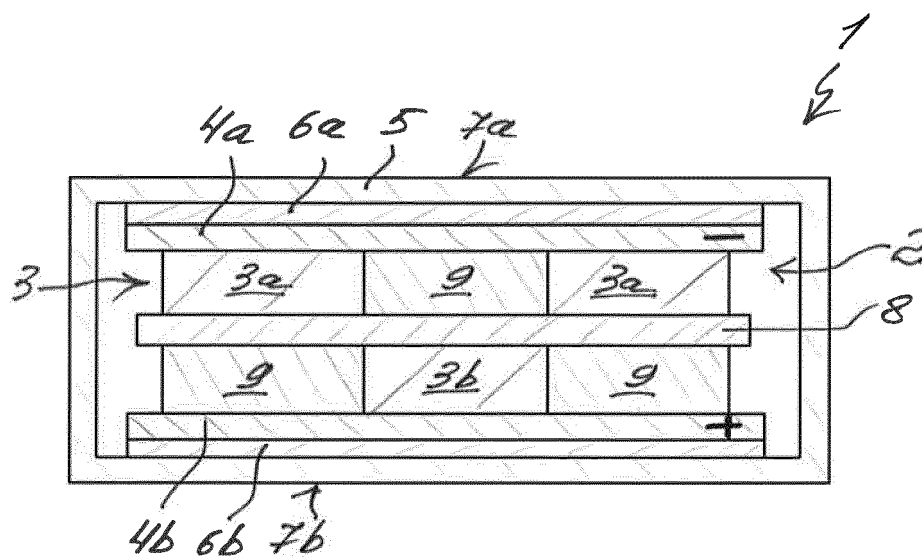


Fig. 4

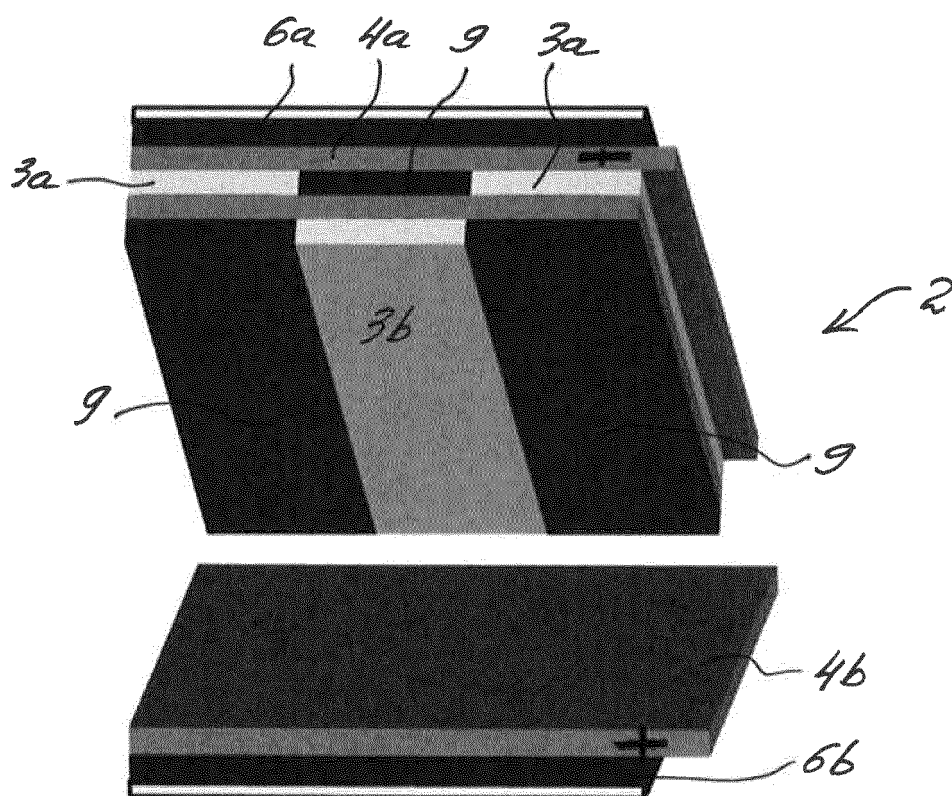


Fig. 5

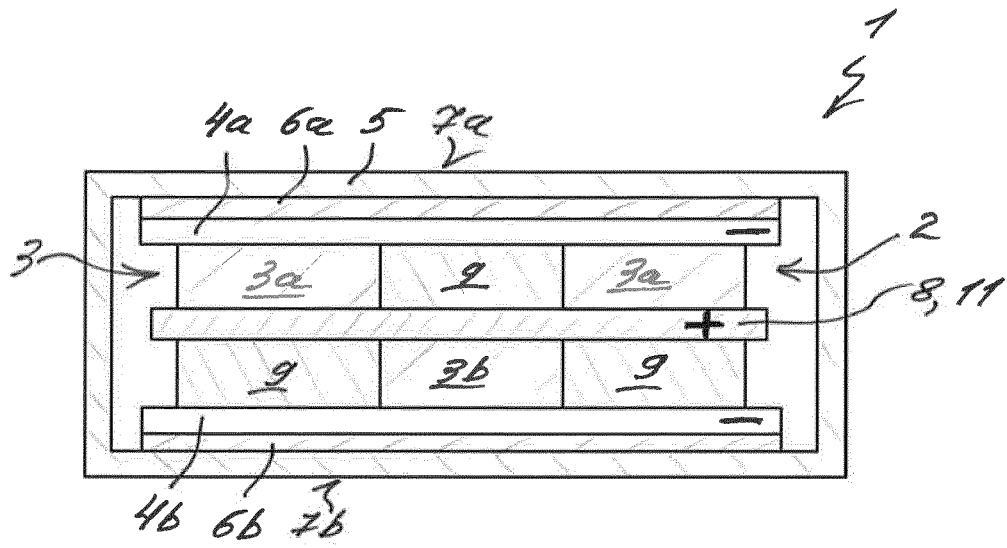


Fig. 6

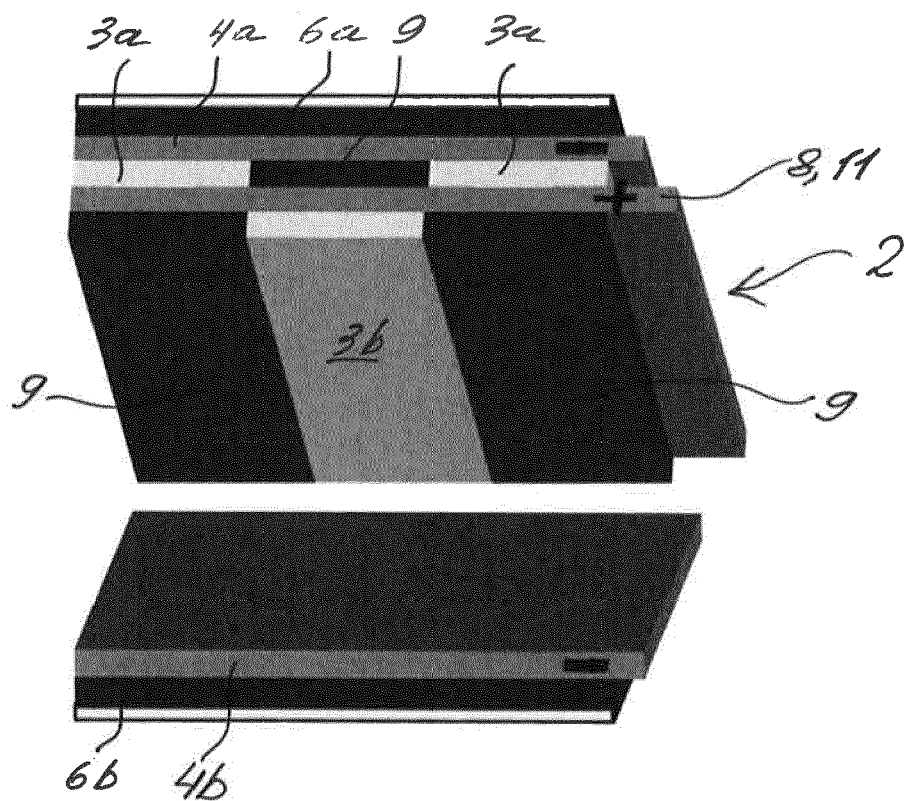


Fig. 7



EUROPEAN SEARCH REPORT

Application Number
EP 17 20 3817

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DOCUMENTS CONSIDERED TO BE RELEVANT			
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 4 May 2018	Examiner Barzic, Florent
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EPO FORM 1503 03/82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82