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(71) Applicant: **MAHLE International GmbH**
70376 Stuttgart (DE)

(72) Inventors:
- **CMELIK, Alain**
68760 Willer sur Thur (FR)
- **HILDENBRAND, Mathieu**
68000 Colmar (FR)
- **MAGNIER, Gilles**
90110 Rougemont-le-Chateau (FR)

(74) Representative: **BRP Renaud & Partner mbB**
Rechtsanwälte Patentanwälte
Steuerberater
Königstraße 28
70173 Stuttgart (DE)

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Amended claims in accordance with Rule 137(2) EPC.

(54) **PTC HEATER AND METHOD**

(57) The invention relates to a PTC heater (1) with an electrically energizable PTC heating element (2), comprising a block-shaped PTC thermistor (3) having two opposing contact surfaces (4a, 4b), on each of which there is an electrical contact plate (5a, 5b) for electrically contacting the PTC thermistor (3) with an electrical power supply. The PTC heating element (2) also has a thermally conductive adapter layer (6a, 6b) made of an electrically insulating material, each of which is arranged on an outer surface (14a, 14b) of the two contact plates (5a, 5b) facing away from the PTC thermistor (3). The PTC heater (1) further comprises an envelope (7) of a metal extending along an extending direction (ER) and surrounding an envelope inner space (8) in which the PTC heating element (2) is arranged. The envelope (7) is open at its two ends opposite in the direction of extension (ER) and, in profile perpendicular to the direction of extension (ER), has two end sections (11a, 11b) which can be connected to one another by material bonding. In the profile, the envelope (7) lies flat against the two opposing adapter layers (6a, 6b).

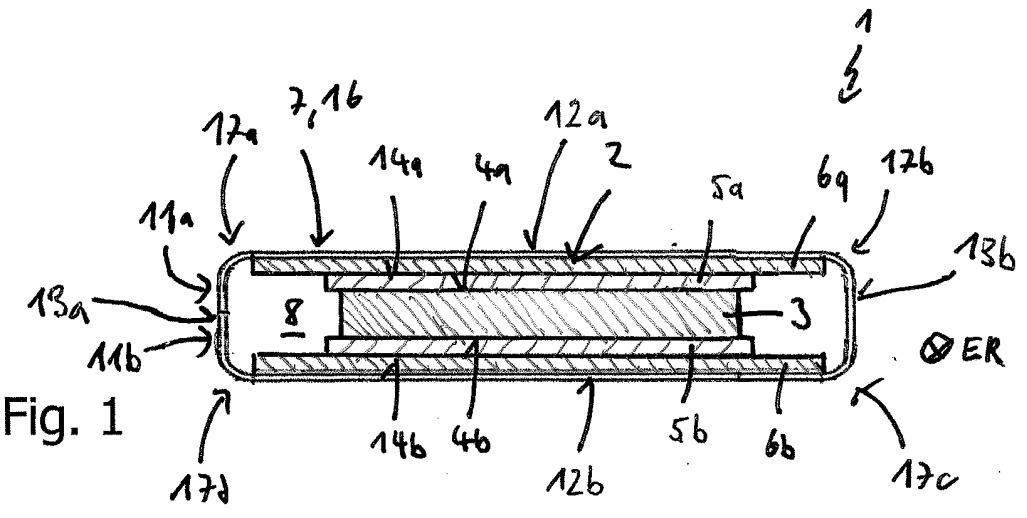

Fig. 1

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Description

[0001] The invention relates to a PTC heating device and a method for manufacturing a PTC heating device.

[0002] A PTC heating device typically comprises a block-shaped PTC thermistor arranged between two contact plates for electrically connecting the PTC thermistor to an electrical power supply. The PTC thermistor and the two contact plates together form a PTC heating element, which can be mounted in a housing - hereinafter referred to as an "envelope". When an electrical voltage is applied to the contact plates, the PTC thermistor generates heat that can be dissipated to the outside via the envelope.

[0003] Such PTC heating devices are known from DE 10 2012 107 985 A1 and from US 2014/0061174 A1.

[0004] A good thermal coupling of the PTC heating element to the envelope proves to be decisive for a high efficiency of the PTC heating device, so that the heat generated by the PTC heating element can also be efficiently dissipated to the external environment of the PTC heating device.

[0005] It is therefore an object of the present invention to create an improved embodiment for the PTC heating device described at the beginning, which is characterized in particular by improved thermal efficiency and at the same time simple manufacturability.

[0006] This object is solved by the subject-matter of the independent patent claims. Preferred embodiments are the subject of the dependent patent claims.

[0007] Accordingly, the basic idea of the invention is to provide the PTC heating element described at the beginning with an envelope which extends - preferably rectilinearly - along an extension direction and is open at its two ends opposite in the extension direction. The envelope is thus designed in the manner of a tubular body. In addition, the envelope profile is formed open with an opening perpendicular to the direction of extension at least for assembling the PTC heater; because this is accompanied by an increase in the volume of an envelope inner space surrounded by the envelope, which facilitates insertion of the PTC heater into the envelope inner space. After insertion of the PTC heating element into the envelope interior, the two end sections of the envelope bounding the opening in the profile can be joined together, closing the opening that was still present up to that point. This is accompanied by a reduction in the volume of the envelope interior, whereby the PTC heating element introduced into the envelope interior is brought into contact with the envelope over its entire surface in a simple manner. In this way, good thermal coupling of the PTC heating element to the envelope is achieved, in particular without having to press the envelope and the PTC heating element together in a separate assembly step, as is usual in the assembly of conventional PTC heating devices. The PTC heating element can be inserted into the interior of the envelope via the open profile or, alternatively, through one of the two ends of the envelope that are open in the direction of extension.

[0008] In any case, with the PTC heating device according to the invention presented here, a highly effective thermal connection between the PTC heating element and the envelope can be created in a simple manner, without having to press the PTC heating element and the envelope together for this purpose after the PTC heating element has been inserted into the interior of the envelope. This also ensures a very simple assembly of the PTC heating device.

[0009] In detail, the PTC heating device according to the invention comprises an electrically energizable PTC heating element comprising a block-shaped PTC thermistor having two opposing contact surfaces, on each of which an electrical contact plate is arranged for electrically contacting the PTC thermistor with an electrical power supply. Furthermore, the PTC heating element comprises a thermally conductive adapter layer made of an electrically insulating material, which is arranged on an outer surface of each of the two contact plates facing away from the PTC thermistor. Furthermore, the PTC heating device comprises a metal envelope extending along an extension direction, which surrounds an envelope interior in which the PTC heating element is arranged. The envelope is open at its two ends opposite each other in the direction of extension and has two end sections in the profile perpendicular to the direction of extension which can be joined together by material bonding. In the profile, the envelope lies flat against the two opposing adapter layers.

[0010] In a preferred embodiment, the covering in the profile has the geometry of a rectangle with at least one, preferably four, rounded corners. An envelope with such a geometry can be produced in a simple manner, in particular by using a sheet metal forming, whereby particularly preferably said rectangle can be produced by corresponding bending of an original flat sheet metal plate.

[0011] In another preferred embodiment, the envelope in profile has two opposite broad sides and two opposite narrow sides. In this embodiment, a first of the two broad sides lies flat against a first of the two adapter layers and a second of the two broad sides lies flat against a second of the two adapter layers. In this way, both sides of the PTC heating element are used to transfer heat to the envelope.

[0012] Particularly preferably, the two broad sides can be in contact with the two adapter layers without forming an intermediate space. In this way, the thermal contact between the PTC heating element and the envelope is improved.

[0013] Particularly expediently, the two broad sides, and preferably also the two narrow sides, can each extend in a straight line in the profile. This facilitates a flat contact of the broad sides to the PTC heating element, whereby the desired thermal contact of the envelope with the PTC heating element can be generated particularly easily.

[0014] In another preferred embodiment, the two broad

sides are biased against the PTC heating element. In this way, the envelope is pressed with its two broad sides flat against the two contact plates of the PTC heating element, increasing their thermal contact with the PTC heating element.

[0015] According to an advantageous further development, the two end sections overlap in the profile in an overlap area and are joined to each other in a material bond in this overlap area. In this way, the opening present during assembly of the PTC heating element can be permanently and tightly closed.

[0016] It is expedient for the material connection to be a soldered connection or a welded connection.

[0017] According to a further preferred embodiment, the envelope is a sheet metal forming. Such a sheet metal forming can be easily provided with the geometry of an open profile described above.

[0018] Particularly preferably, the two adapter layers can be bonded to the envelope, preferably by means of an adhesive bond. In this way, the desired flat contact of the envelope to the PTC heating element is ensured and the thermal connection between the envelope and the two contact plates is additionally improved.

[0019] The invention also relates to a method for producing a PTC heating device, in particular a PTC heating device according to the invention presented above, so that in this case the advantages of the PTC heating device according to the invention described above are transferred to the method according to the invention. This comprises four measures a) to d). In measure a), a PTC heating element is provided which comprises a block-shaped PTC thermistor having two opposing contact surfaces. An electrical contact plate for electrically contacting the PTC thermistor with an electrical power supply is arranged on each of the two contact surfaces. The PTC heating element also has a thermally conductive adapter layer made of an electrically insulating material, which is arranged in each case on an outer surface of the two contact plates facing away from the PTC thermistor.

[0020] In measure b), an envelope of a metal, preferably aluminum, extending along an extension direction is provided, which partially surrounds an envelope interior and is open at its two ends opposite in the extension direction and has two end sections spaced apart in profile perpendicular to the extension direction. In measure c), the PTC heating element is inserted into the envelope interior. In measure d), the two end sections are joined together so that the envelope lies flat against the two opposing adapter layers of the PTC heating element. In the process, the opening is closed. In this way, a two-dimensional thermal contact of the PTC heating element with the envelope is created.

[0021] Preferably, measure a) is carried out in time before measure b), but measure a) can alternatively be carried out in time after measure b).

[0022] In a preferred embodiment of the process according to the invention, the following is done in the course of measure c), the PTC heating element is inserted into the envelope along the direction of extension.

[0023] In another preferred embodiment, in measure c) the PTC heating element is introduced into the envelope interior via an opening formed in the profile to the direction of extension between the two end sections.

[0024] Alternatively, in measure c), the PTC heating element may also be introduced into the envelope interior along the direction of extension.

[0025] Further important features and advantages of the invention will be apparent from the subclaims, from the drawings and from the accompanying figure description based on the drawings.

[0026] It is understood that the above-mentioned features and those still to be explained below can be used not only in the combination indicated in each case, but also in other combinations or on their own, without leaving the scope of the present invention.

[0027] Preferred embodiments of the invention are shown in the drawings and will be explained in more detail in the following description, whereby the same reference signs refer to identical or similar or functionally identical components.

[0028] It is shown, each schematically:

Fig. 1 an example of a PTC heating device according to the invention,

Fig. 2 shows the envelope of the PTC heating device of Fig. 1 during assembly of the PTC heating device,

Fig. 3 a variant of the envelope of Figs. 1 and 2 in separate illustration.

[0029] Figure 1 illustrates in a sectional view an example of a PTC heating device 1 according to the invention. The PTC heating device 1 comprises an electrically energizable PTC heating element 2, which comprises a block-shaped PTC thermistor 3 having two opposing contact surfaces 4a, 4b. On each of the two contact surfaces 4a, 4b, an electrical contact plate 5a, 5b is arranged for electrically contacting the PTC thermistor 3 with an electrical power supply. Furthermore, the PTC heating element 2 comprises thermally conductive adapter layers 6a, 6b made of an electrically insulating material, each of which is arranged on an outer surface 14a, 14b of the two contact plates 5a, 5b facing away from the PTC thermistor 3.

[0030] Furthermore, the PTC heating device 1 comprises an envelope 7 of a metal extending along an extension direction ER and surrounding an envelope interior 8 in which the PTC heating element 2 is arranged. The envelope 7 may be formed by a sheet metal forming.

[0031] Figure 1 shows the PTC- PTC heater 1 in profile perpendicular to the direction of extension ER. Accordingly, the envelope 7 is open at its two opposite ends in the direction of extension ER (not visible in the sectional view of Figure 1) and has, in the profile perpendicular to

the direction of extension ER, two end sections 11a, 11b which can be connected to one another by a material bond. In the profile, the envelope 7 lies flat against the two opposing adapter layers 6a, 6b. The two adapter layers 6a, 6b can be joined to the envelope 7 by a material bond, preferably by means of an adhesive bond.

[0032] According to Figure 1, the envelope 7 in profile has two opposite broad sides 12a, 12b and two opposite narrow sides 13a, 13b. Here, a first 12a of the two broad sides 12a, 12b lies flat against a first 6a of the two adapter layers 6a, 6b. Accordingly, a second 12a of the two broad sides 12a, 12b lies flat against a second 6b of the two adapter layers 6a, 6b. As shown, the two broad sides 12a, 12b can thereby abut the two adapter layers 6a, 6b without forming an intermediate space. The two broad sides 12a, 12b and the two narrow sides 13a, 13b can each extend in a straight line in profile as shown. Optionally, both broad sides 12a, 12b can also be biased against the PTC heating element 2. In the example scenario of Figure 1, the envelope 7 in the profile shown has the geometry of a rectangle 16 with four rounded corners 17a-17d.

[0033] Figure 3 illustrates a variant of the envelope 7 according to Figure 1. In this variant, the two end sections 11a, 11b are located in the profile in an overlap region 15 and are joined to each other in a material bond in this overlap region 15. In this case, this material-locking connection 10 can be a soldered connection or a welded connection.

[0034] In the following, the method according to the invention is explained by way of example with reference to Figures 2 and 1. The process comprises four measures a) to d).

[0035] In a first measure a), the PTC heating element 2 presented above, which comprises a block-shaped PTC thermistor 3 having two opposing contact surfaces 4a, 4b, on each of which in turn an electrical contact plate 5a, 5b is arranged for electrically contacting the PTC thermistor 3 with an electrical power supply. As already explained, the PTC heating element 2 also has a thermally conductive adapter layer 6a, 6b made of an electrically insulating material, each of which is arranged on an outer surface 14a, 14b of the two contact plates 5a, 5b facing away from the PTC thermistor.

[0036] According to a second measure b), an envelope 7 of a metal - for example of aluminum - extending along an extension direction ER is provided. The envelope 7 is open at its two ends opposite in the direction of extension ER and partially surrounds an enclosure interior 8 and has, at and in the profile perpendicular to the direction of extension ER, two end portions 11a, 11b spaced apart from one another. Thus, an opening 9 is formed in the profile at the narrow side 13a between the two end portions 11a, 11b.

[0037] As can be seen in Figure 2, the envelope 7 can be bent open to form the opening 9.

[0038] The first measure a) can be carried out in time before the second measure b). Alternatively, the first measure a) can also be carried out after the second measure b).

[0039] In a third measure c), the PTC heating element 2 is introduced into the envelope interior 8. Here, the PTC heating element 2 will be introduced into the envelope interior 8 either along the direction of extension ER - i.e. not through the opening 9 formed in the profile between the two end sections 11a, 11b - or, alternatively, through this opening 9.

[0040] According to a fourth measure d), the two end sections 11a, 11b are joined together so that the envelope 7 lies flat against the two opposing adapter layers 6a, 6b of the PTC heating element 2. In the course of this measure, the opening 9 is closed.

Claims

1. PTC heating device (1),

- having an electrically energizable PTC heating element (2) comprising a block-shaped PTC thermistor (3) which has two mutually opposing contact surfaces (4a, 4b), on each of which there is an electrical contact plate (5a, 5b) for electrically contacting the PTC thermistor (3) with an electrical power supply,
- the PTC heating element (2) also having a thermally conductive adapter layer (6a, 6b) made of an electrically insulating material, which is arranged in each case on an outer surface (14a, 14b) of the two contact plates (5a, 5b) facing away from the PTC thermistor (3),
- with an envelope (7) of a metal extending along an extension direction (ER) and surrounding an envelope interior (8) in which the PTC heating element (2) is arranged,
- wherein the envelope (7) is open at its two ends lying opposite one another in the direction of extension (ER) and has, in profile perpendicular to the direction of extension (ER), two end sections (11a, 11b) which can be connected to one another in a materially bonded manner,
- wherein the envelope (7) in the profile lies flat against the two adapter layers (6a, 6b) lying opposite one another.

2. PTC heating device according to claim 1, **characterized in that** the profile of the envelope (7) has the geometry of a rectangle (16) with at least one, preferably four, rounded corners (17a-17d).

3. PTC heating device according to claim 1 or 2, **characterized in that**

- the envelope (7) in profile has two opposite broad sides (12a, 12b) and two opposite narrow

sides (13a, 13b),
- a first (12a) of the two broad sides (12a, 12b) bears flat against a first (6a) of the two adapter layers (6a, 6b), and a second (12a) of the two broad sides (12a, 12b) bears flat against a second (6b) of the two adapter layers (6a, 6b).

4. PTC heating device according to claim 3,
characterized in that
the two broad sides (12a, 12b) bear against the two adapter layers (6a, 6b) without forming an intermediate space.

5. PTC heating device according to claim 3 or 4,
characterized in that
the two broad sides (12a, 12b), preferably additionally also the two narrow sides (13a, 13b), each extend in a straight line in the profile.

6. PTC heating device according to one of claims 3 to 5,
characterized in that
the two broad sides (12a, 12b) are biased against the PTC heating element (2).

7. PTC heating device according to one of the preceding claims,
characterized in that
the two end sections (11a, 11b) in the profile overlap in an overlap region (15) of the envelope (7) and are connected to one another in a materially bonded manner in this overlap region (15).

8. PTC heating device according to claim 7,
characterized in that
the materially bonded connection is a soldered connection or a welded connection.

9. PTC heating device according to one of the preceding claims,
characterized in that
the envelope (7) is a sheet metal forming.

10. PTC heating device according to any one of the preceding claims,
characterized in that
the two adapter layers (6a, 6b) are connected to the envelope (7) by a material bond, preferably by means of an adhesive bond.

11. Method for producing a PTC heating device (1), in particular according to any of the preceding claims, comprising the following measures:

a) providing a PTC heating element (2) comprising a block-shaped PTC thermistor (3) having two opposing contact surfaces (4a, 4b) on each of which an electrical contact plate (5a, 5b) is arranged for electrically contacting the PTC thermistor (3) with an electrical power supply, the PTC heating element (2) also having a thermally conductive adapter layer (6a, 6b) made of an electrically insulating material, which is arranged in each case on an outer surface (14a, 14b) of the two contact plates (5a, 5b) facing away from the PTC thermistor (3),
b) providing an envelope (7) which extends along an extension direction (ER), is made of a metal, preferably aluminum, partially surrounds an envelope interior (8) and is open at its two ends opposite in the extension direction (ER) and has two end sections (11a, 11b) spaced apart in profile perpendicular to the extension direction (ER), so that an opening (9) is formed in the profile between the two end sections 11a, 11b.
c) Placing the PTC heating element in the envelope interior (8),
d) connecting the two end sections (11a, 11b) to each other so that the envelope (7) lies flat against the two opposing adapter layers (6a, 6b) of the PTC heating element (2).

12. Method according to claim 11,
characterized in that
in the course of measure c), the PTC heating element (2) is introduced into the envelope (7) along the direction of extension (ER).

13. method according to claim 11,
characterized in that
in measure c) the PTC heating element is introduced into the envelope interior (8) via the opening (9) formed between the two end sections (11a, 11b) in profile to the direction of extension (ER).

Amended claims in accordance with Rule 137(2) EPC.

1. PTC heating device (1),

- having an electrically energizable PTC heating element (2) comprising a block-shaped PTC thermistor (3) which has two mutually opposing contact surfaces (4a, 4b), on each of which there is an electrical contact plate (5a, 5b) for electrically contacting the PTC thermistor (3) with an electrical power supply,
- the PTC heating element (2) also having a thermally conductive adapter layer (6a, 6b) made of an electrically insulating material, which is on an outer surface (14a, 14b) of the two contact plates (5a, 5b) facing away from the PTC therm istor (3), respectively,
- with an envelope (7) of a metal extending along an extension direction (ER) and surrounding an

envelope interior (8) in which the PTC heating element (2) is arranged,
- wherein the envelope (7) is open at its two ends lying opposite one another in the direction of extension (ER) and has, in profile perpendicular to the direction of extension (ER), two end sections (11a, 11b) which are connectable to one another in a materially bonded manner,
- wherein the envelope (7) in the profile lies flat against the two adapter layers (6a, 6b) lying opposite one another,
characterized in that
the two broad sides (12a, 12b) are biased against the PTC heating element (2).

2. PTC heating device according to claim 1,
characterized in that
the profile of the envelope (7) has the geometry of a rectangle (16) with at least one, preferably four, rounded corners (17a-17d).

3. PTC heating device according to claim 1 or 2,
characterized in that

- the envelope (7) in profile has two opposite broad sides (12a, 12b) and two opposite narrow sides (13a, 13b),
- a first (12a) of the two broad sides (12a, 12b) bears flat against a first (6a) of the two adapter layers (6a, 6b), and a second (12a) of the two broad sides (12a, 12b) bears flat against a second (6b) of the two adapter layers (6a, 6b).

4. PTC heating device according to claim 3,
characterized in that
the two broad sides (12a, 12b) bear against the two adapter layers (6a, 6b) without forming an intermediate space.

5. PTC heating device according to claim 3 or 4,
characterized in that
the two broad sides (12a, 12b), preferably additionally also the two narrow sides (13a, 13b), each extend in a straight line in the profile.

6. PTC heating device according to one of the preceding claims,
characterized in that
the two end sections (11a, 11b) in the profile overlap in an overlap region (15) of the envelope (7) and are connected to one another in a materially bonded manner in this overlap region (15).

7. PTC heating device according to claim 6,
characterized in that
the materially bonded connection is a soldered connection or a welded connection.

8. PTC heating device according to one of the preceding claims,
characterized in that
the envelope (7) is a sheet metal forming.

9. PTC heating device according to any one of the preceding claims,
characterized in that
the two adapter layers (6a, 6b) are connected to the envelope (7) by a material bond, preferably by means of an adhesive bond.

10. Method for producing a PTC heating device (1) according to any of the preceding claims, the method comprising the following measures:

a) providing a PTC heating element (2) comprising a block-shaped PTC thermistor (3) having two opposing contact surfaces (4a, 4b) on each of which an electrical contact plate (5a, 5b) is arranged for electrically contacting the PTC thermistor (3) with an electrical power supply, the PTC heating element (2) also having a thermally conductive adapter layer (6a, 6b) made of an electrically insulating material, which is arranged in each case on an outer surface (14a, 14b) of the two contact plates (5a, 5b) facing away from the PTC thermistor (3),
b) providing an envelope (7) which extends along an extension direction (ER), is made of a metal, preferably aluminum, partially surrounds an envelope interior (8) and is open at its two ends opposite in the extension direction (ER) and has two end sections (11a, 11b) spaced apart in profile perpendicular to the extension direction (ER), so that an opening (9) is formed in the profile between the two end sections 11a, 11b.
c) Placing the PTC heating element in the envelope interior (8),
d) connecting the two end sections (11a, 11b) to each other so that the envelope (7) lies flat against the two opposing adapter layers (6a, 6b) of the PTC heating element (2).

11. Method according to claim 10,
characterized in that
in the course of measure c), the PTC heating element (2) is introduced into the envelope (7) along the direction of extension (ER).

12. method according to claim 10,
characterized in that
in measure c) the PTC heating element is introduced into the envelope interior (8) via the opening (9) formed between the two end sections (11a, 11b) in profile to the direction of extension (ER).

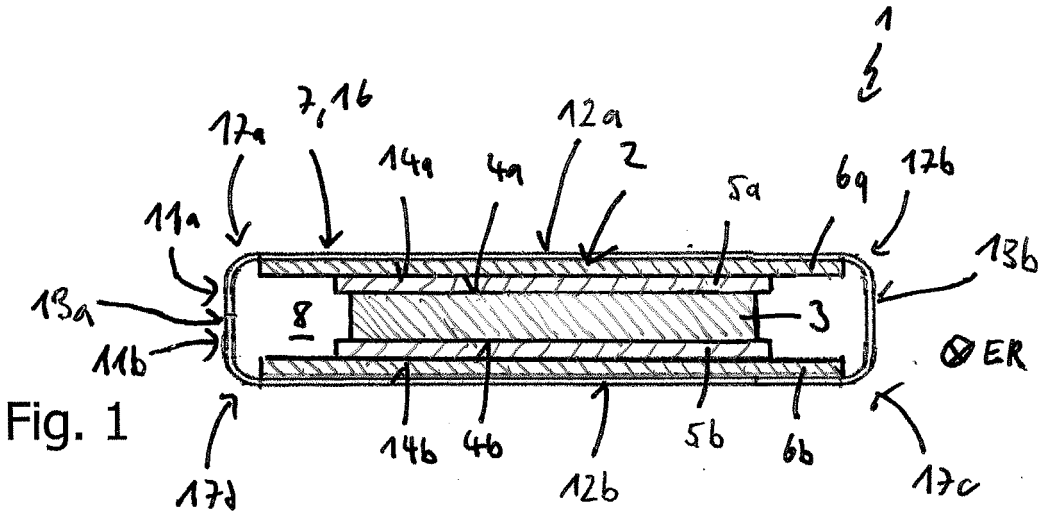

Fig. 1

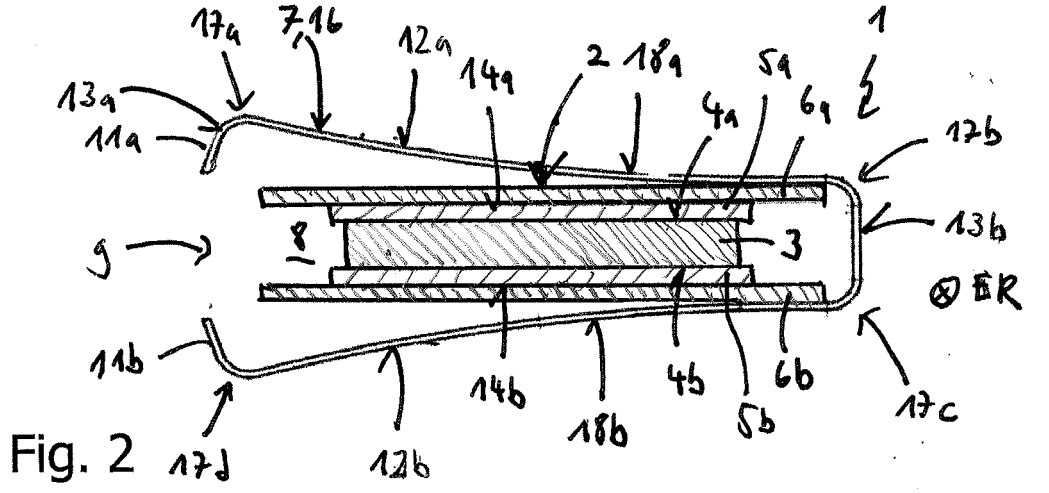

Fig. 2

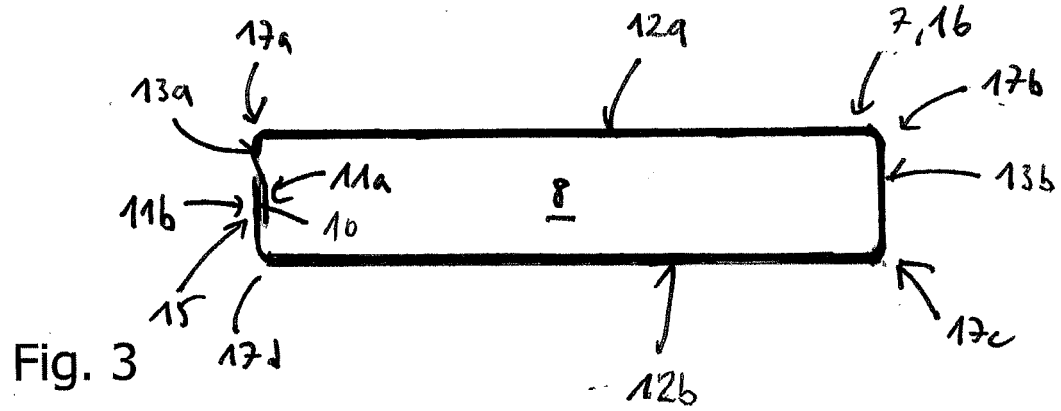

Fig. 3

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EUROPEAN SEARCH REPORT

Application Number
EP 22 19 3230

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 2 346 304 A1 (BEHR GMBH & CO KG [DE]; BEHR FRANCE ROUFFACH SAS [FR]) 20 July 2011 (2011-07-20) * abstract * * paragraph [0006]; figures 1-9 * * paragraph [0015] - paragraph [0016] * * paragraph [0019] - paragraph [0023] * * paragraph [0030] - paragraph [0036] *	1-13	INV. H05B3/24 H05B3/40
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	17 February 2023	Chelbosu, Liviu

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 22 19 3230

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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REFERENCES CITED IN THE DESCRIPTION

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