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(54) **Method of making a heating resistor with PTC elements**

Verfahren zur Herstellung eines Heizresistors mit PTC-Elementen

Méthode de fabrication d'une résistance chauffante comportant des éléments à coefficient de température positif CTP

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(73) Proprietor: **Mose' Anstalt**
9490 Vaduz (LI)

(72) Inventor: **Nicoli, Alberto**
33170 Pordenone (IT)

(74) Representative: **Coppo, Alessandro**
Ing. Barzanò & Zanardo Milano S.p.A.,
Via Borgonuovo, 10
20121 Milano (IT)

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Description

[0001] The present invention proposes a method to produce class 2 resistors with PTC, in which:

- a double layer of insulating material, particularly kapton™ or teflon™, is arranged inside a tube;
- a heating element constituted of one or more PTC elements clamped between a pair of diffusers is placed inside the tube, centring the assembly using centring rings;
- the space around the heating element is filled with pulverized insulating material, in particular magnesium oxide;
- said insulating material is compacted;

and in which the dimensions of the magnesium oxide grains are below 200 micrometers, and the average dimension of the grains is preferably around 40 micrometers.

[0002] In this way resistors are obtained in which it is no longer necessary to provide control and/or safety devices such as thermostats and/or thermal fuses as the necessary insulation is guaranteed in any case.

[0003] In particular the use of magnesium oxide with the indicated grain size makes it possible to compact the insulating material inside the tube containing the PTC elements without damaging the external coating in kapton™.

[0004] The invention also relates to the resistors obtained with said method as defined in claim 1.

[0005] Generally, to produce class 2 resistors (resistors which must have double insulation) insulating materials, such as magnesium oxide in grains, are used combined with a second material, generally constituted by a double turn of kapton™ or teflon™.

[0006] A first type of resistor in this category comprises a winding of resistive wire fitted inside a tubular container generally made of metal filled with pulverized magnesium oxide.

[0007] This tube is then fitted inside a second tube with a larger diameter and the space between them is also filled with magnesium oxide which is subsequently pressed and compacted.

[0008] This type of resistor has a diameter which for some applications is considered excessive.

[0009] In a second type of resistor the winding of resistive wire is again placed inside a tube which is filled with pulverized magnesium oxide and this tube is then coated with a double layer of kapton™ or teflon™ before being fitted inside a second tube, which constitutes the outer casing.

[0010] This second type of construction makes it possible to obtain resistors with smaller diameters.

[0011] Class 2 resistors in which the heating element is constituted of one or more PTC elements have recently been proposed.

[0012] These elements have the considerable advantage of not requiring control and/or safety devices such as thermostats and/or thermal fuses, even if they still present all the problems mentioned above, in relation to the need to provide double insulation.

[0013] A first solution to this problem is described in the German patent N. 19737241, which relates to a resistor comprising one or more PTC resistors clamped between a pair of heat diffusing elements, with a first layer of insulating material composed of a plurality of rings in material based on magnesium oxide and silicone rubber, which are fitted on the pack composed of the PTCs and relative diffusers and a second insulating layer composed of a double sheet of kapton™ wound around these rings. US-A-4-087 777 describes a composition in which the magnesium oxide have a grain size under 5 micrometers.

[0014] This is all fitted inside a common container composed of a metal tube and then compacted.

[0015] This solution has various advantages compared with prior art, as temperature control devices are no longer necessary and moreover, its dimensions are also smaller than prior art resistors.

[0016] However there is still the problem of a somewhat laborious production process, as the insulating rings in a material based on silicone rubber and magnesium oxide must be produced in advance, making it possible to further improve this solution.

[0017] In fact, it would be useful to produce a class 2 resistor with PTC heating elements using, as insulating material, common magnesium oxide and kapton™ or teflon™.

[0018] Experiments have been conducted in this sense, although these provided somewhat disappointing results as during the phase to compact the magnesium oxide, which is generally performed by hammering, the grains perforated the layer of kapton™, thus invalidating the insulating properties of this material.

[0019] To find a solution to this problem the applicant conducted numerous experiments, varying all the parameters which may influence the final result and, in particular, varying the magnesium oxide grain size.

[0020] In fact, all the resistors produced to date use magnesium oxide in which the average dimension of the grains is around 180 micrometers and the fraction with dimensions below 45 microns is equivalent to around 6% of the total.

[0021] The quantity of fine component is intentionally limited, as this makes filling the element more difficult, so that the general and common tendency of all producers is to use magnesium oxide with grains of a certain dimension.

[0022] As an example, tables A and B below provide two examples of typical grain sizes in micrometers used for this purpose.

TABLE A	TABLE B
> 500 ..... 0.0%	>500 ..... 0,0%

(continued)

TABLE A	TABLE B
425 - 500 ..... 0.0%	>425 ..... <0.1%
250-425 ..... 31.4%	425-355 ..... 4%
180-250 ..... 18.3%	355-250 ..... 24%
100 - 180 .... 26.2%	250-180 ..... 20%
75-100 ..... 8.9%	180-106 ..... 24%
45-75 ..... 9.0%	106-75 ..... 13%
<-45 ..... 6.3%	75-450 ..... 10%
	<45 ..... 5%

[0023] As previously mentioned, the applicant hypothesized that by varying the grain size appropriately it might be possible to obtain satisfactory results without running into the problems that previously caused this course of action to be abandoned.

[0024] Experiments conducted have confirmed this hypothesis to be correct, and have led to the development of the following method, which shall now be illustrated with reference to the attached figures in which:

- figure 1 shows the section along the axis of a resistor according to the invention;
- figure 2 is the section of the resistor in figure 1, according to a direction orthogonal to the previous one.

[0025] In accordance with the invention, a class 2 resistor with heating elements constituted by PTCs is produced as follows.

[0026] A layer of insulating material 2 composed of a few turns of kapton or teflon, are wound in a winding and fitted into a tube 1, which forms the external casing of the resistor, in order to obtain, on the internal surface of the tube, at least two complete turns of insulating material.

[0027] One or more centring elements 3 composed for example of rings made of teflon™, silicon rubber or other material capable of withstanding the temperatures developed by the resistor are then fitted into the tube and subsequently the heating element, composed of one or more PTC elements 4 clamped between a pair of diffusers 5, for example in aluminium, is fitted into the tube.

[0028] These diffusers will preferably have the form, in section, of a circular sector in which the bending radius corresponds to the radius of the internal surface of the centring elements.

[0029] Preferably, the ends of the diffusers will be shaped to define a pair of projecting longitudinal edges, indicated with no. 7 in figure 2, which allow more secure assembly of the PTC plates, preventing them from escaping either entirely or in part from the diffusers and thus guaranteeing optimum electric contact.

[0030] These centring elements will have an annular internal surface while the external surface will preferably be polygonal, for example hexagonal, to facilitate the passage of the magnesium oxide dust which is subsequently introduced to provide the primary insulating layer indicated with 6 in the figures.

[0031] Once the heating element has been fitted into the tube, the finely triturated magnesium oxide is then introduced to fill all the available spaces around the heating element to provide the primary insulation.

[0032] In conformity with one characteristic of the invention, this magnesium oxide has an average grain dimension of around 40 micrometers, and has no grains with dimensions above 200 micrometers and preferably no grains with dimensions above 192 micrometers.

[0033] The table below indicates the grain size which, following experiments conducted by the applicant, provided optimum results.

100% <192 micrometers

96 <7.4%<92 micrometers

48 <28.7%<96 micrometers

12 <55.8%<48 micrometers

8.1%<12 micrometers

[0034] Once the inside of the resistor has been filled with magnesium oxide this is compacted, for example by hammering after which the tube can be closed and the resistor is ready.

[0035] Using magnesium oxide with the grain size indicated it was observed that the subsequent operations to compact and press the grains do not cause any damage to the external coating in kapton™ or teflon™, which thus maintains its integrity.

[0036] In this manner, it is possible to obtain a class 2 resistor with PTCs, with compact dimensions and which can be produced at a relatively low cost, as it may be produced using inexpensive materials, already known to and used in the specific sector for some time.

[0037] Those skilled in the art may then devise different modifications and variants, which however must all be considered as coming within the scope of the present invention.

Claims

1. Method for producing class 2 resistors with PTCs

heating elements, said method including the following phases:

- fitting inside a tube (1) constituting the container of the resistor at least two layers (2) of insulating material, said layers (2) being positioned proximate to the internal surface of said tube (1);
- fitting a heating element composed of at least one PTC element (4) inside said tube (1), after fitting at least one centring element (3) inside the tube (1), said at least one PTC element (4) being clamped between a pair of diffusers (5);
- filling the spaces between said at least one PTC element (4) and said layers (2) of insulating material with pulverised magnesium oxide, in which most of the magnesium oxide grains have dimensions between 12 micrometers and 48 micrometers;
- compacting the magnesium oxide.

2. Method as claimed in claim 1, **characterised in that** said magnesium oxide grains have dimensions below 192 micrometers.

3. Method as claimed in claim 1, **characterised in that** a 28.7% of said magnesium oxide grains have dimensions between 48 micrometers and 96 micrometers, a 8.1% of said magnesium oxide grains have dimensions below 12 micrometers and a 7.4% of said magnesium oxide grains have dimensions between 92 micrometers and 96 micrometers.

4. Class 2 resistors comprising a heating element composed of at least one PTC element (4) clamped between a pair of diffusers (5), a tube (1) containing said heating element, a first insulating layer (2) in kapton which is applied proximate to the internal walls of said tube (1) and a second insulating layer (6) in magnesium oxide which is provided between said heating element and said first insulating layer (2), **characterised in that** most of the magnesium oxide grains have dimensions between 12 micrometers and 48 micrometers.

5. Class 2 resistors as claimed in claim 4, **characterised in that** said diffusers (5) have projecting longitudinal ends (7).

6. Class 2 resistors as claimed in claim 4, **characterised in that** a 28.7% of said magnesium oxide grains have dimensions between 48 micrometers and 96 micrometers, a 8.1% of said magnesium oxide grains have dimensions below 12 micrometers and a 7.4% of said magnesium oxide grains have dimensions between 92 micrometers and 96 micrometers.

Patentansprüche

1. Verfahren zum Herstellen von Klasse 2-Widerständen mit PTC-Heizelementen, wobei das Verfahren die folgenden Phasen umfasst:

- Einpassen von wenigstens zwei Lagen (2) von Isolationsmaterial im Inneren eines Rohres (1), das dem Behälter des Widerstands bildet, wobei die Lagen (2) nahe der inneren Oberfläche des Rohres (1) positioniert sind;
- Einpassen eines Heizelementes welches aus wenigstens einem PTC-Element (4) gebildet ist, im Inneren des Rohres (1), nachdem wenigstens ein Zentrierelement (3) im Inneren des Rohres (1) eingepasst ist, wobei das wenigstens eine PTC-Element (4) zwischen einem Paar von Diffusoren (5) eingefasst ist;
- Füllen der Räume zwischen dem wenigstens einen PTC-Element (4) und den Lagen (2) von Isolationsmaterial mit pulversiertem Magnesiumoxid, in dem die meisten der Magnesiumoxidkörner Abmessungen zwischen 12 Mikrometer und 48 Mikrometer haben;
- Verdichten des Magnesiumoxids.

2. Verfahren beansprucht wie in Anspruch 1, **dadurch gekennzeichnet, dass** die Magnesiumoxidoxidkörner Abmessungen unter 192 Mikrometer haben.

3. Verfahren beansprucht wie in Anspruch 1, **dadurch gekennzeichnet, dass** 28,7% der Magnesiumoxidkörner Abmessungen zwischen 48 Mikrometer und 96 Mikrometer haben, 8,1% der Magnesiumoxidoxidkörner Abmessungen unter 12 Mikrometer und 7,4% der Magnesiumoxidoxidkörner Abmessungen zwischen 92 Mikrometer und 96 Mikrometer haben.

4. Klasse 2-Widerstände enthaltend ein Heizelement bestehend aus wenigstens einem PTC-Element (4), das zwischen einem Paar von Diffusoren (5) eingefasst ist, ein Rohr (1) enthaltend das Heizelement, eine erste Isolierschicht (2) in Kapton, die nahe der inneren Wände des Rohres (1) angebracht ist und eine zweite Isolierschicht (6) in Magnesiumoxidoxid, die zwischen dem Heizelement und der ersten Isolierschicht (2) vorgesehen ist, **dadurch gekennzeichnet, dass** die meisten der Magnesiumoxidoxidkörner Abmessungen zwischen 12 Mikrometer und 48 Mikrometer haben.

5. Klasse 2-Widerstände beansprucht wie in Anspruch 4, **dadurch gekennzeichnet, dass** die Diffusoren (5) vorstehende longitudinale Enden (7) haben.

6. Klasse 2-Widerstände beansprucht wie in An-

spruch 4, **dadurch gekennzeichnet, dass** 28,7% der Magnesiumoxidoxidkörner Abmessungen zwischen 48 Mikrometer und 96 Mikrometer haben, 8,1% der Magnesiumoxidoxidkörner Abmessungen unter 12 Mikrometer und 7,4% der Magnesiumoxidoxidkörner Abmessungen zwischen 92 Mikrometer und 96 Mikrometer haben.

Revendications

1. Procédé pour produire des résistances de classe 2 avec des éléments chauffants PTC, ledit procédé comportant les phases suivantes :

   - adapter à l'intérieur d'un tube (1) constituant le conteneur de la résistance au moins deux couches (2) de matériau isolant, lesdites couches (2) étant placées à proximité de la surface interne dudit tube (1) ;
   - adapter un élément chauffant composé d'au moins un élément PTC (4) à l'intérieur dudit tube (1), après avoir adapté au moins un élément de centrage (3) à l'intérieur du tube (1), ledit (lesdits) élément (s) PTC (4) étant bloqué(s) entre une paire de diffuseurs (5) ;
   - remplir les espaces compris entre ledit (lesdits) élément(s) PTC (4) et lesdites couches (2) de matériau isolant avec de l'oxyde magnésium pulvérisé, dans lequel la plus grande partie des grains d'oxyde de magnésium présentent des dimensions comprises entre 12 microns et 48 microns ;
   - compacter l'oxyde de magnésium.

2. Procédé selon la revendication 1, **caractérisé en ce que** lesdits grains d'oxyde de magnésium présentent des dimensions inférieures à 192 microns.

3. Procédé selon la revendication 1, **caractérisé en ce que** 28,7% desdits grains d'oxyde de magnésium présentent des dimensions comprises entre 48 microns et 96 microns, 8,1 % desdits grains d'oxyde de magnésium présentent des dimensions inférieures à 12 microns et 7,4% desdits grains d'oxyde de magnésium présentent des dimensions comprises entre 92 microns et 96 microns.

4. Résistances de classe 2 comportant un élément chauffant composé d'au moins un élément PTC (4) bloqué entre une paire de diffuseurs (5), un tube (1) contenant ledit élément chauffant, une première couche isolante (2) en kapton qui est appliquée au voisinage des parois internes dudit tube (1) et une seconde couche isolante (6) en oxyde de magnésium qui est fournie entre ledit élément chauffant et ladite première couche isolante (2), **caractérisées en ce que** la plus grande partie des grains d'oxyde de magnésium présentent des dimensions comprises entre 12 mirons et 48 microns.

5. Résistances de classe 2 selon la revendication 4, **caractérisées en ce que** lesdits diffuseurs (5) possèdent des extrémités longitudinales en saillie (7).

6. Résistances de classe 2 selon la revendication 4, **caractérisées en ce que** 28,7 % desdits grains d'oxyde de magnésium présentent des dimensions comprises entre 48 microns et 96 microns, 8,1 % desdits grains d'oxyde de magnésium présentent des dimensions inférieures à 12 microns et 7,4 % desdits grains d'oxyde de magnésium présentent des dimensions comprises entre 92 microns et 96 microns.

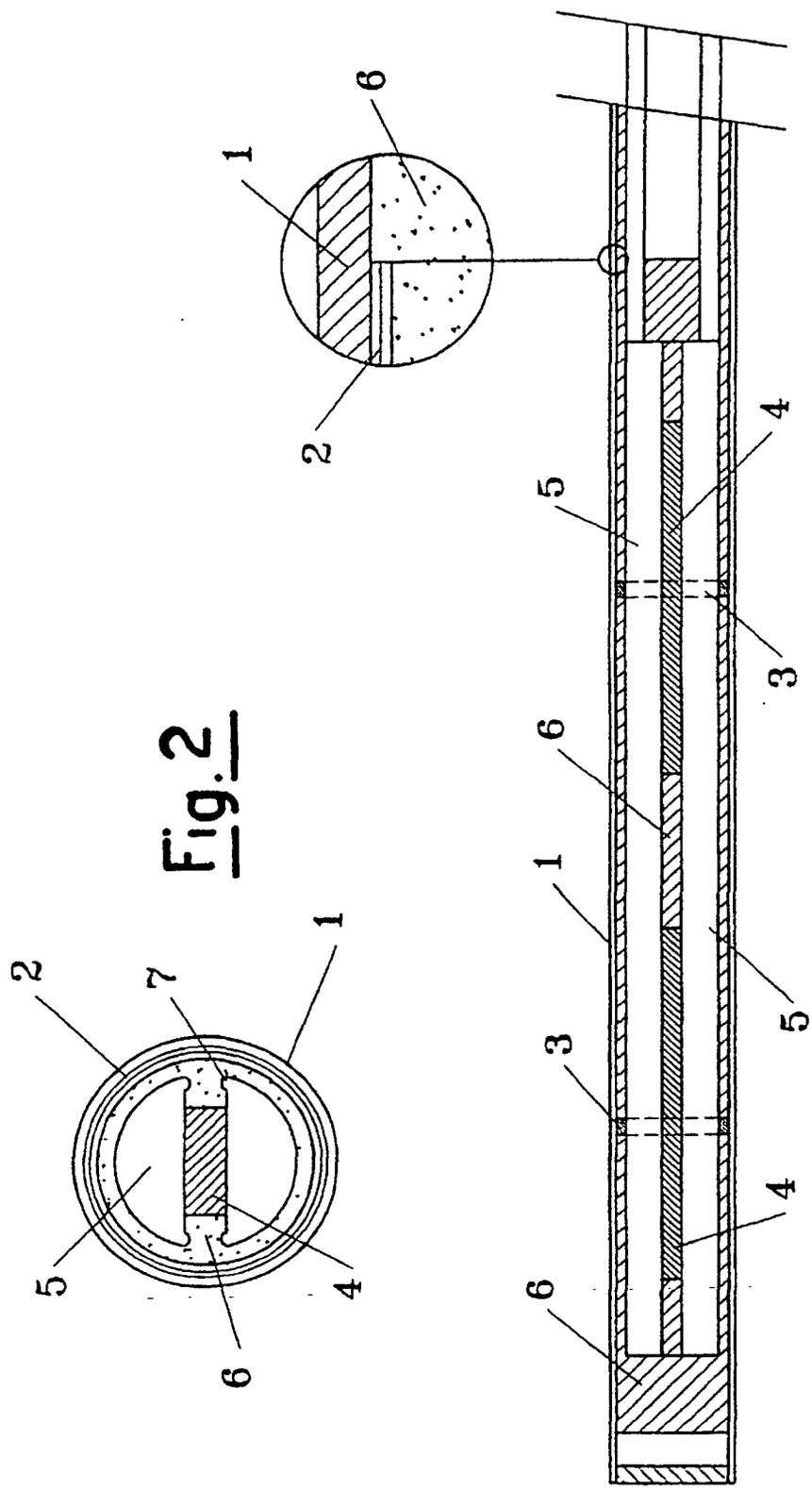


Fig.1

Fig.2