

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
18 September 2008 (18.09.2008)

PCT

(10) International Publication Number  
**WO 2008/111101 A1**

(51) International Patent Classification:  
**H05B 3/48** (2006.01)

(21) International Application Number:  
PCT/IT2007/000347

(22) International Filing Date: 15 May 2007 (15.05.2007)

(25) Filing Language: Italian

(26) Publication Language: English

(30) Priority Data:  
TO2007A000185 13 March 2007 (13.03.2007) IT

(71) Applicant (for all designated States except US): **ROTFIL S.r.l.** [IT/IT]; Via Praglia 15, I-10044 Pianezza (Torino) (IT).

(72) Inventor; and

(75) Inventor/Applicant (for US only): **RAVAGLIA, Riccardo** [IT/IT]; Via Lanzo 7, I-10044 PIANEZZA (Torino) (IT).

(74) Agents: **GERBINO, Angelo** et al.; Jacobacci & Partners SpA, Corso Emilia 8, I-10152 Torino (IT).

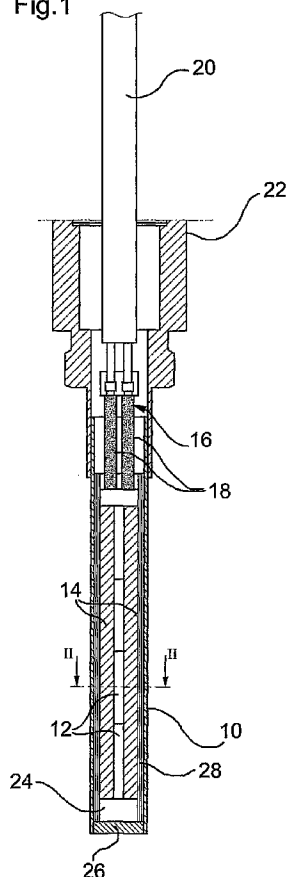
(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) Title: CARTRIDGE HEATER

Fig.1



(57) Abstract: Cartridge heater The cartridge heater, in particular for electric radiators, comprises an outer housing (10), one or more PTC resistors (12) disposed in the housing (10) and electrically insulating material interposed radially between the housing (10) and the PTC resistors (12). This electrically insulating material consists substantially of a polyimide obtained by polycondensation of an aromatic tetrabasic acid and an aromatic diamine.



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- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
- *of inventorship (Rule 4.17(iv))*

**Published:**

- *with international search report*

### Cartridge heater

The present invention relates to a cartridge heater in particular for water- or oil-based electric radiators.

A heater of this type more particularly comprises an outer housing, at least one PTC (positive temperature coefficient) resistor disposed in the housing and electrically insulating material interposed radially between the housing and the PTC resistor.

According to the prior art, this electrically insulating material typically consists at least partly of magnesium oxide disposed in the form of a circular crown which is radially internal with respect to the housing.

However, magnesium oxide is a highly hygroscopic material which makes the environment inside the heater rather moist and likely to damage the PTC resistors and generate internal short-circuits with a slow but progressive deterioration of the properties of these resistors.

These problems may be prevented by providing special leak-tight closures such as resin and/or rubber caps and the like which prevent any penetration of moisture. The use of such structural arrangements nevertheless complicates the structure of the heater.

In order to remedy these drawbacks of the prior art, the present invention relates to a heater of the type described above, characterized in that the electrically insulating material interposed radially between the housing and the at least one PTC resistor consists substantially of a polyimide obtained by polycondensation of an aromatic tetrabasic acid and an aromatic diamine.

The insulating material of the heater of the invention does not therefore comprise hygroscopic material, in particular magnesium oxide, with the result that special leak-tight closures such as caps or the like are not required. It therefore has a simplified and economic structure which can be produced by production processes which are not complex, are inexpensive and can be readily automated.

The low residual moisture in the heater of the invention is automatically eliminated each time that it is started with the result that it is highly reliable and has a very long service life.

Moreover, the resistance and dielectric rigidity of the insulating material of the heater of the invention are much greater than those of the insulating materials based on magnesium oxide which are conventionally used.

Further advantages and characteristic features of the invention are set out in the following detailed description, given solely by way of non-limiting example, with reference to the accompanying drawings, in which:

Fig. 1 is a view in longitudinal section of a heater of the invention;

Fig. 2 is a view in cross-section along the line II-II of Fig. 1;

Fig. 3 is a view in cross-section corresponding to Fig. 2, showing further possibilities for the connection of conducting pins to electrodes of the heater of the invention;

Figs. 4 and 5 are perspective views of respective embodiments of electrodes adapted to provide the connections of Fig. 3.

A cartridge heater, in particular for electric radiators, comprises (Figs. 1 and 2) an outer housing 10 of tubular shape and circular section and a plurality of PTC resistors 12 disposed longitudinally in succession in an inner diametrical segment of the housing 10.

A first and a second electrode 14 of approximately semi-circular cross-section are disposed on opposite sides of the PTC resistors 12 disposed in succession. These electrodes 14 are connected in a manner known per se (and not shown in Figs. 1 and 2) by means of metal pins 16 surrounded by insulating sheaths 18 to a cable 20 supplying electric current which projects from a threaded cap 22 closing one end of the housing 10. The opposite end is closed by a disc 24 and by a welded base 26.

The assembly formed by the PTC resistors 12 and the electrodes 14 has a substantially cylindrical overall shape and is surrounded by three electrically insulating layers 28 disposed coaxially about one another and surrounded in turn by the housing 10.

During the production process of the heater of the invention, once the above-mentioned components have been assembled in the housing 10, the latter is compressed by conventional appliances, for instance a hammering machine, a rolling mill or a radial press, in order to obtain a solid and compact structure.

The insulating layers 28 are substantially formed by a polyimide obtained by polycondensation of an aromatic tetrabasic acid and an aromatic diamine. A polyimide of this kind is marketed by the company Du Pont De Nemours under the registered trade mark Kapton and may contain conventional additives for plastics materials, as well as protective films. The insulating layers 28 may for instance be in the form of a spiral-wound strip or a tube.

As a result of the inclusion of the three insulating layers 28, the heater of the invention satisfies the CEI EN 60335-1 specifications under which at least a double insulation is required. If the heater has to satisfy less strict specifications, only one insulating layer 28 could be provided. Vice versa, the number of insulating layers 28 could be increased to cope with particularly onerous uses.

The polyimide used as insulating material is not hygroscopic with the result that the heater does not require special closures which prevent moisture from penetrating therein, thereby greatly simplifying its structure.

The dielectric rigidity of the insulating material used is very high with the result that the electric performance of the heater is excellent.

Fig. 3 shows further possibilities for the connection of the metal conducting pins 16 to the electrodes 14 which have a cross-section shaped as a circular segment with a perimeter defined by a circumferential arc 30 and by a chord 32 (which may possibly correspond to the diameter of the circumference). The electrodes 14 have a longitudinal seat adapted to house the respective pin 16, which seat may be provided either at the perimetral section of the electrode 14 defined by the chord 32 (see reference numeral 34a) or in the body of the electrode (see reference numeral 34b). Fig. 3 shows both constructional solutions, although

it will be appreciated that one only will be used in practice, while Figs. 4 and 5 show the two solutions separately. During assembly of the heater, the pin 16 is inserted in the respective seat 34a or 34b in which it is then clamped during the above-mentioned compression stage so as to ensure electrical continuity.

According to the prior art, the pins 16 are on the contrary located in seats provided in the perimetral section of the electrode 14 defined by the circumferential arc 30. This location has the drawback that, during the compression stage, any projections, cutting edges or irregularities may damage the adjacent insulating layers 28 thereby comprising their electrical insulation properties. This drawback is remedied by locating the pins 16 according to the invention, since any contact between the seats 34a and 34b and the insulating layers 28 is prevented.

Without prejudice to the principle of the invention, its details and embodiments may obviously be widely varied with respect to those described purely by way of example, without thereby departing from the scope of the invention.

CLAIMS

1. A cartridge heater, in particular for electric radiators, comprising an outer housing (10), at least one PTC resistor (12) disposed in the housing (10) and electrically insulating material interposed radially between the housing (10) and the at least one PTC resistor (12),

said resistor being characterized in that the electrically insulating material interposed radially between the housing (10) and the at least one PTC resistor (12) consists substantially of a polyimide obtained by polycondensation of an aromatic tetrabasic acid and an aromatic diamine.

2. A heater according to claim 1, characterized in that it comprises at least one polyimide insulating layer (28) disposed coaxially about the PTC resistor.

3. A heater according to any one of the preceding claims, characterized in that it comprises a plurality of polyimide insulating layers (28) disposed coaxially about the PTC resistor.

4. A heater according to any one of the preceding claims, characterized in that said at least one polyimide insulating layer (28) is made in the form of a spiral- wound strip.

5. A heater according to any one of the preceding claims, characterized in that said at least one polyimide insulating layer (28) is made in the form of a tube.

6. A heater according to any one of the preceding claims, characterized in that the housing (10) has a tubular shape of circular section and at least one PTC resistor (12) is disposed in an inner diametrical segment of the housing (10) with a first and a second electrode (14) disposed on opposite sides of the at least one PTC resistor (12), the assembly formed by the at least one PTC resistor (12) and the electrodes (14) having a substantially cylindrical shape and being surrounded by at least one polyimide insulating layer (28).

7. A heater according to claim 6, characterized in that it comprises three polyimide insulating layers (28) disposed coaxially about one another and surrounded by said housing (10).
8. A heater according to claim 6 or 7, characterized in that it comprises a plurality of PTC resistors (12) disposed longitudinally in succession in an inner diametrical segment of said housing (10).
9. A heater according to any one of claims 6 to 8, characterized in that the first and second electrodes (14) each have a cross-section shaped as a circular segment with a perimeter defined by a circumferential arc (30) and by a chord (32) and comprise a longitudinal seat (34a, 34b) adapted to house a respective conducting pin (16), which seat is provided in the section of the perimeter of the electrode (14) defined by the chord (32) or in the body of the electrode (14).

Fig.1

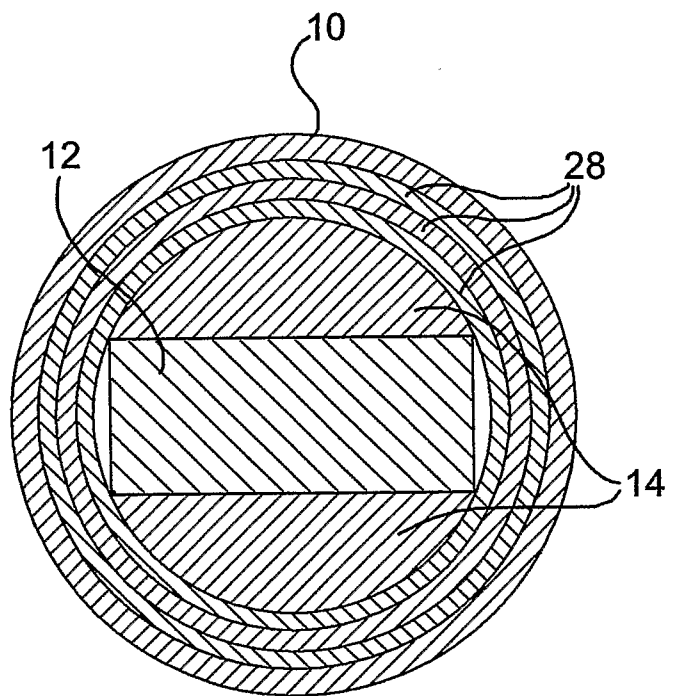
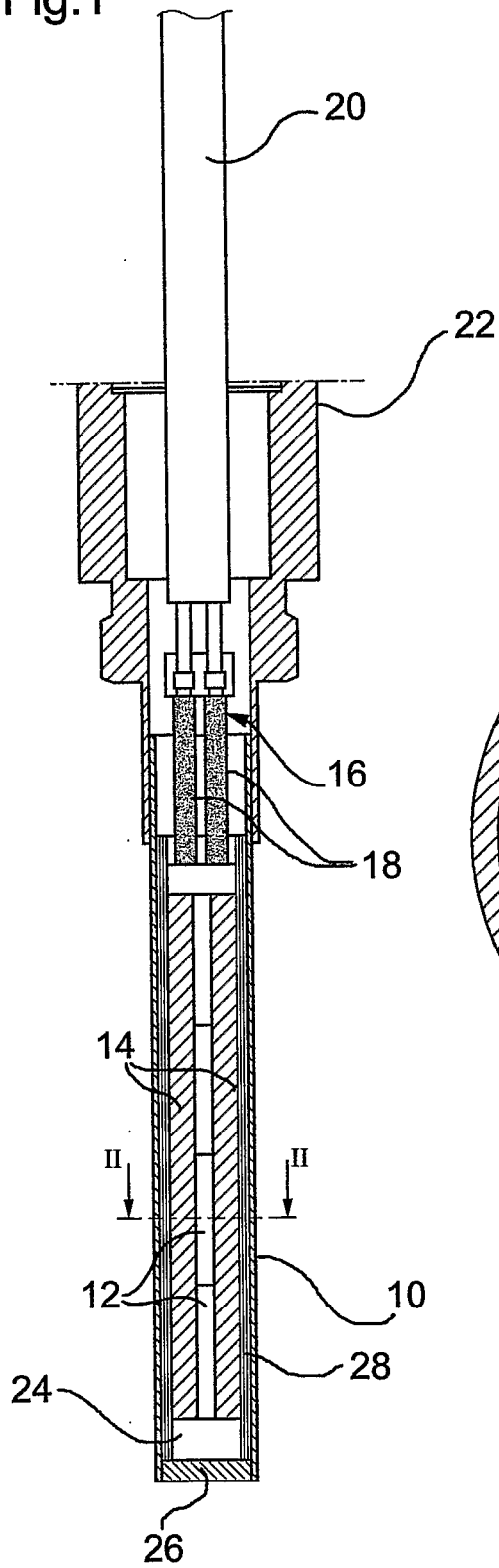


Fig.2

Fig.3

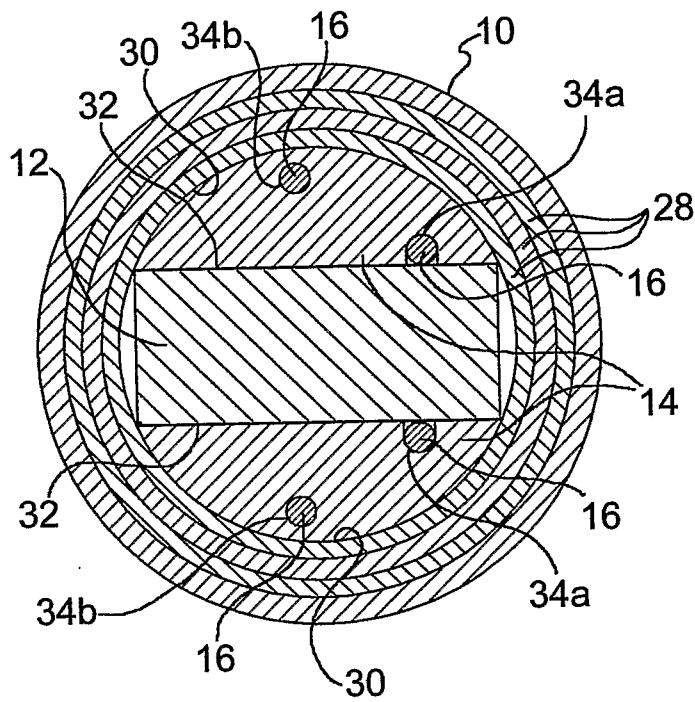


Fig.4

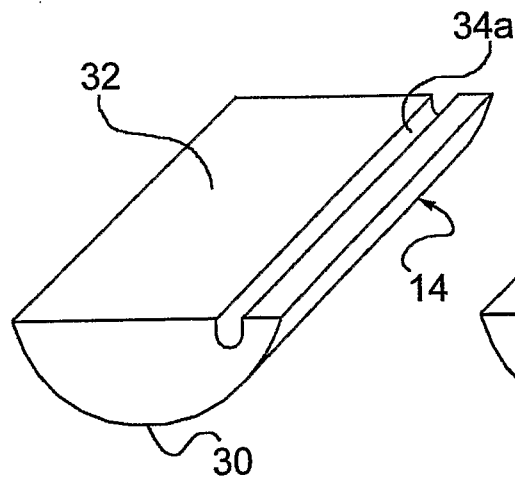
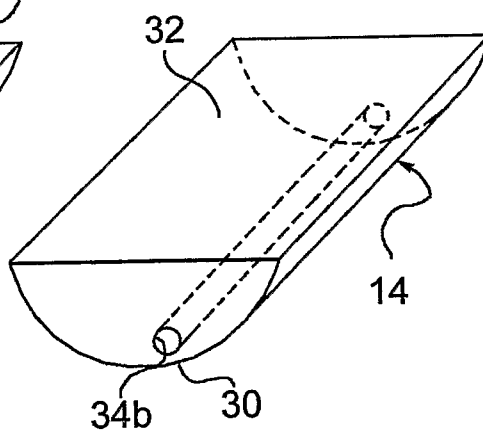


Fig.5



# INTERNATIONAL SEARCH REPORT

International application No

PCT/IT2007/000347

**A. CLASSIFICATION OF SUBJECT MATTER**  
INV. H05B3/48

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

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)  
H05B H01C

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

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

EPO-Internal, WPI Data, PAJ

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                                                                         | Relevant to claim No. |
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|           | -----<br>-/--                                                                                                                                                              |                       |

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Date of the actual completion of the international search

9 October 2007

Date of mailing of the international search report

19/10/2007

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+31-70) 340-3016

Authorized officer

Gea Haupt, Martin

## INTERNATIONAL SEARCH REPORT

International application No

PCT/IT2007/000347

## C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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Information on patent family members

International application No

PCT/IT2007/000347

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