(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 930 803 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
21.07.1999 Bulletin 1999/29

(51) Int. Cl.[6]: **H05B 3/48**, H05B 3/04

(21) Application number: **98124095.5**

(22) Date of filing: **18.12.1998**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **15.01.1998 IT PN980004**

(71) Applicant: **IRCA S.p.A.**
I-31020 S. Vendemiano, Treviso (IT)

(72) Inventors:
- **Grillo, Mauro**
  30020 Teglio Veneto, Venezia (IT)
- **Mazzucato, Lorenzo**
  33070 Stevenà di Caneva, Treviso (IT)

(74) Representative:
Giugni, Valter et al
PROPRIA S.r.l.,
Via Mazzini 13
33170 Pordenone (IT)

(54) Improvement in the sheathing of sheathed heating elements

(57) Sheathed heating element comprising an outer sheathing, an inner conductor provided with a protruding portion, an insulating filling mass and at least a terminal insulating sealing element of an annular shape formed by a cap of plastic material moulded into the annular gap existing between said outer sheathing and said inner conductor, and extending with a protrusion that continues to envelop and seal the protruding portion of said inner conductor. Said protrusion is in a cylindrical shape aligned with the cylindrical contour of the outer edge of said sheathing.

Method for providing said sealing through the use of any of such processes as transfer-compression moulding, injection moulding or casting.

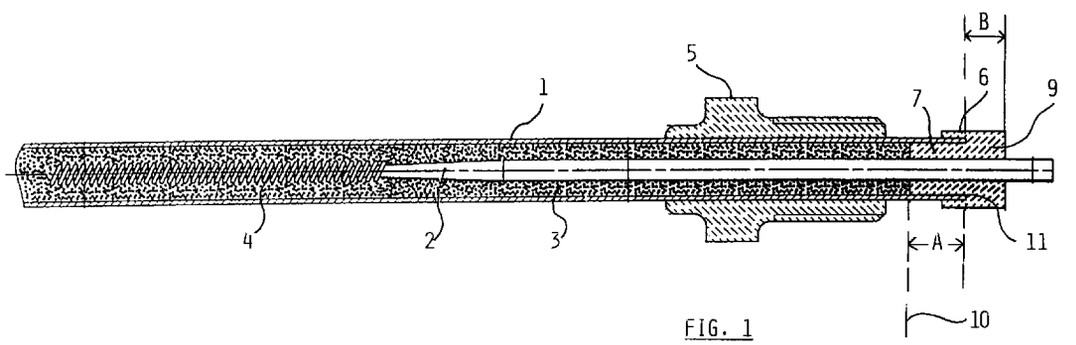


FIG. 1

EP 0 930 803 A1

Description

[0001] The present invention refers to a particularly improved type of electrical resistance-type sheathed heating elements, which are currently used in all those applications requiring such heating elements to operate inmedium-to-highly corrosive environments.

[0002] Reference is generally made in the following description to a particular type of resistance-type heating elements, which are commonly referred to as "sheathed" since the actual resistive element is isolated from and both thermally and mechanically guarded against the environment, ie. the medium that they have to heat up. It shall however be appreciated that this invention may extent to cover a wide range of applications involving processes aimed at forming tubular elements of any kind that have to be resistant to corrosive agents.

[0003] Sheathed heating elements are generally known to be substantially formed by an inner controlled-resistivity metal element and an outer metal casing, ie. the so-called sheathing, wherein said resistive element and said sheathing are separated and insulated from each other by a layer of insulating, heat-resistant material, such as for instance magnesium oxide.

[0004] The manufacturing process of these sheathed heating elements includes a step in which the annular gap around the inner metal element is duly sealed, in such a manner as to both maintain the insulation between such an inner element and the outer sheathing and at the same time prevent insulating material to escape outside.Most generally, such a step consists in applying an annular sealing element around the inner conductor, wherein such an annular sealing element is so sized as to allow it to be inserted into said annular gap.

[0005] Generally, the material which such a cylindrical element is made of is a ring of ceramic material that is inserted around the inner conductor after the magnesium oxide has been filled into said gap, an epoxy resin being eventually applied onto said ring so as to tightly seal the entrance mouth of the sheathing. Cross-linking of said resin may take place under either cold or hot conditions depending on the properties of the resin itself and the particular application of the sheathed healing element.

[0006] In this way, the latter acquires a due extent of stability and can therefore be further processed, typically bent and press-formed, without any risk for the insulation characteristics thereof being impaired.

[0007] Upon completion of their fabrication process, such sheathed heating elements are then usually completed through the application of the members required to ensure their connection with the appliances to which said heating elements are ultimately associated, such connection members usually including one or more of a wide range of available means in the most varied form thereof, such as clamps, over-associated threads and the like, wherein said members are usually welded on to the outer sheathing near the terminals of the same heating element.

[0008] Such a prior-art technique is generally well-known to those skilled in the art and is set forth here to mere purposes of general introduction.

[0009] Anyway, the above described technique, which may be considered as quite mature in all of its aspects, enables reliable products to be generally obtained on an industrial scale, without any particular problem from either a technical or a manufacturing point of view.

[0010] However, the various phases involved in the above described manufacturing step for inserting said sealing ring, melting it, sealing the sheathing and applying the connection members make such a manufacturing process rather complex and expensive. Furthermore, they make it more susceptible to possible manufacturing defects, since anyone skilled in the art is well aware of the fact that each manufacturing or production step carries a possible source of defects with it.

[0011] It would therefore be clearly advantageous to provide for the availablity of a manufacturing process for sheathed heating elements of a traditional type, which is such to enable said heating elements to be prpoduced on a very large scale, while however ensuring greater overall simplicity, cost-effectiveness and reliability, and can moreover be implemented with the use of currently available technologies.

[0012] This manufacturing process is reached in the features and characteristics as substantially recited in the appended claims.

[0013] Characteristics and advantages of the present invention will anyway be more readily and clearly understood from the description of a preferred embodiment thereof that is given below by way of non-limiting example with reference to the accompanying drawings, in which

- Figure 1 is a schematical view of the longitudinal section of a heating element according to the present invention;
- Figures 2a through to 2d are schematical sectional views, in the same plane as the heating element, of the various phases of the injection-moulding process for the production of heating elements according to the present invention;
- Figures 3a and 3c are axonometric views of the phases corresponding to the Figures 2b and 2d above, respectively;
- Figures 4a through to 4d are schematical sectional views, in the same plane as the heating element, of the various phases of the casting process for the production of heating elements according to the present invention;

- Figures 5a and 5b are axonometric views of the phases corresponding to the Figures 4b and 4d above, respectively;

- Figures 6a through to 6d are schematical sectional views, in the same plane as the heating element, of the various phases of the transfert process for the production of heating elements according to the present invention; while

- Figure 7 is an axonometric, partly see-through view of Figure 6b.

[0014] With reference to Figure 1, the invention can be noticed to substantially consist in providing a sheathed heating element formed by an inner conductor in the preferred shape of a spiral 4, which is connected to a terminal 2 protruding from the sheathing, a mass of insulating material 3, preferably in the form of compressed powder, an outer sheathing 1 resistant to both hot, ie. high-temperature, and corrosive environments, said sheathing being preferably made of metal and in a circular shape. Said mass of insulating material envelops also said terminal 2 up to a level which is indicated at 10 inside the end portion 11 of the sheathing, so that said terminal and said sheathing habe both a final length , indicated at A in the cited Figure, along which they freely face each other, since said length is free of, ie. not occupied by said mass of insulating material.

[0015] The invention substantially lies in the provision of an element 7 capable of performing a closing and sealing task, which shall be referred to simply as cap in the following description and which is preferably a resin featuring particular properties that make it adapted to be applied, according to various methods as this will be more clearly illustrated further on, inside said final portion A and, for a certain length generally indicated at B in the Figure, even outside said final portion, wherein said insulating and sealing element 7 is constituted by a cap fitted in the annular gap existing between said outer sheathing and said inner conductor, said cap extending further with a protrusion 9 outside said sheathing.

[0016] In a preferred manner, said protrusion 9 has a cyclindrical shape aligned with the cylindrical contour of the outer edge of said sheathing, and may be advantageously provided with a counter-protrusion 6 directed bacwards and enveloping the terminal portion of the sheathing from the outside, so as to improve both the mechanical clamping and the sealing effect between said cap and said sheathing.

[0017] The application of said sealing element or cap 7 may be carried out according to any of a number of different methods and technologies available to that purpose, ie.:

- injection moulding, wherein, with particular reference to Figures 2a through to 2d and 3a through to 3c, it can be noticed that the end portions of the sheathing 1 are clamped between two mould halves 21 and 22 provided with appropriate channels 23 connecting the total volume of said sealing element 7, inclusive of its portion intended for insertion in the sheathing as well as its outer portion, with a conduit 24 which is in turn connected to the outflow nozzle 25 of a normal screw extruder 26; the process used to form said cap is as follows:
  - the sheathing, duly completed to include the insulating mass, the inner resistive element and the related terminals, is in the first place arranged in corresponding appropriate seats provided in said mould halves to accommodate them;
  - immediately thereafter, said mould halves are clamped together tightly, according to the traditional technique;
  - material in pelletized form, which is going to be processed into said resin cap 7, and duly loaded into the feeding hopper of the injection-moulding machine, is then metered into the barrel where the melting and plasticization process takes place for transforming said material into a homogeneous semifluid mass under the effect of both the heat generated by electric heating elements wound around the barrel, or the heat of heating media connected to the injection moulding machine, and the heat generated by the friction of the screw or extruder 26 as it rotates inside the same barrel. Such a molten mass is then injected under pressure by the same screw, which acts as a plunger in this case, between said two mould halves, duly coupled together, through the outflow nozzle 25 into the conduit 24 and, from here, the channels 23 and then into the space constituting the total volume of formation of said complete sealing cap 7;
  - upon allowing the resin to undergo cross-linking, which may occur in any of a number of ways in accordance with the properties of the same resin, said mould halves are unclamped and separated from each other, and the sheathed heating element is now complete. It should be noticed in this connection that, with only the above described injection moulding operation the result is fully obtained of sealing the sheathing tightly, which would on the contrary require three distinct operations, ie. introduction of the ceramic ring, filling of the resin material and subsequent cross-linking thereof, with any of the methods according to the prior art.

[0018] The above described injection-moulding process can anyway be replaced with other relatively similar processes leading to much the same result, ie. a completion and tight sealing of the sheathed heating element with a single operation.

[0019] One of said other processes involves resin filling by for instance the so-called casting process, whose basic features are described below.

[0020] The resin and the hardener, with mineral or

reinforcement filters, are initially processed in a vacuum (1 to 5 mbar) in two separate mixers.

[0021] The casting mass is then prepared by transferring, by means of metering pumps, both resin and hardener into a either static or dynamic mixer for homogeneization.

[0022] The so prepared casting mass can then be delivered either directly to the casting point or into a pressure storage reservoir.

[0023] The application technologies for this filling-by-casting process may be any of the following ones:

- Traditional casting, wherein the mould 42 of the item to be moulded or formed is filled by pouring the material into it through appropriate bowls 41 and conduit 43, and is then sent to an oven for the cross-limking cycle.

- Vacuum casting, wherein the mould for the item to be produced is placed in a vacuum booth or chamber, brought to a vacuum condition of 5 to 100 mbar, filled by casting and then sent to the oven for the cross-linking cycle.

- Pressure gelation casting, wherein the casting mass is poured into the mould for the item to be produced, heated directly by means of electric heating elements to temperatures comprised between 120°C and 180°C, from the storage reservoir and the thrust pressure is maintained by means of compressed air (3 to 5 bar) until gelation is reached.

[0024] Figure 4b is a cross-sectional view of said mould, bowls and conduits; Figure 4c is a top view of the same mould with the sheathed heating element still to be completed, while Figure 4d is a view of said sheathed heating element in its completed condition.

[0025] Another process among the above cited ones is the so-called compression-transfer moulding of thermosetting resins. According to such a method, the material to be processed and transformed can be supplied in any of the following manners, ie.:

- directly in the form of pellets, wherein the pelletized material is introduced in a pre-determined amount into the transfer mould or barrel, with or without pre-heating in, say, a high-frequency oven;

- under previous mechanical pelletization, wherein the material is transformed into pellets by means of a mechanical pelletizer and then filled in the transfer mould or barrel, with or without oven pre-heating;

- through pre-plasticization, wherein the material, generally in pelletized form, is filled in the hopper of the pre-plasticizer and then passes on to a barrel where a process of homogeneous fluidization takes place as determined by both the heat generated by the electric heating elements wound around the barrel, or the heat of a heating medium, and the heat generated by the friction of the screw rotating inside the same barrel.

[0026] At the outlet side of the barrel a pellet of the desired weight is then output and introduced in the transfer mould or barrel 61.

[0027] The plastic mass is then compressed, partially molten and injected under pressure by the plunger into the mould through a plurality of conduits 62 and 63. The so injected or compressed material in the mould heats up and the part is in this way formed.

[0028] Figures 6a through to 6d schematically illustrate a sequence of drawings that are quite similar and corresponding to the ones relating to the casting process, so that they shall not be explained any further here, since generally known to those skilled in the art.

[0029] Since, as already stated, the substantial feature of the present invention lies in the ability of unifying at least three distinct operations into a single moulding operation, albeit under utilization of different techniques, in view of sealing the sheathed heating element, it has been found extremely advantageous to further integrate in said single moulding operation also the construction of connection fittings, clamping means or, anyway, fastening means to be applied on to the sheathing of the heating element in view of enabling it to be firmly fastened in its due position with respect to appropriately provided support means (not shown).

[0030] These fittings and/or general fastening means for mechanical connection of the heating element are generally indicated at 77 in the Figures. An advantageous improvement of the invention lies in manufacturing these fastening means at the same time as said sealing caps through the use of the same technique, process, equipment and tooling.

[0031] In practice this is obtained by making in the mould halves or plates, used to clamp the sheathing and hold it firmly, a numver of appropriate cavities in the desired shape and position and, anyway, filling such cavities with the same type of resin as used to seal the heating elements, wherein said cavities are connected through appropriate conduits to the same resin supply source as the one used to mould the cap 7, so that, owing to the fact the the resin supply circuits for the cap 7 are arranged in parallel with respect to the resin supply circuits provided for said fastening and connecting means, the production and the introduction of the resin can in fact be used to complete in a single shot the entire sheathed heating element both as far as the sealing of the end portions thereof and the provision of the various clamping and connecting means to be applied to the outer sheathing of said element are concerned.

[0032] It will be appreciated that the above description and illustrations have only been given by way of non-

limiting example of a possible embodiment of the present invention, and that any of a number of variants and modifications can be made thereto without departing from the scope of the present invention.

Claims

1. Sheathed heating element comprising an outer sheathing (1) having a preferably circular cross-section, an inner conductor (2) provided with a protruding portion, an insulating filling mass (3) and at least an insulating sealing element of an annular shape arranged between said inner conductor and said outer sheathing in correspondence of at least an end portion of said sheathed heating element, characterized in that said insulating sealing element is formed by a cap (7) of plastic material moulded into the annular gap existing between said outer sheathing and said inner conductor, wherein said cap protrudes outward of said sheathing and extends with a protrusion (9) that continues to envelop and seal the protruding portion of said inner conductor of said sheathing.

2. Sheathed heating element according to claim 1, characterized in that said protrusion (9) is in a cylindrical shape aligned with the cylindrical contour of the outer edge of said sheathing.

3. Sheathed heating element according to claim 1 or 2, characterized in that cap (7) of plastic material is made of a thermosetting plastic material or a thermoplastic material or an elastomeric or rubber material or any alloy or blend thereof.

4. Sheathed heating element according to any of the preceding claims, characterized in that the outer sheathing thereof is provided on the outside with auxiliary clamping or fastening means (77), which are applied in a stable manner on to the outer surface of said sheathing and are made of the same material as said cap (7).

5. Sheathed heating element according to any of the preceding claims 2 to 4, characterized in that said protrusion (9) is provided with a counter-protrusion (6) facing backwards and enveloping the terminal portion of the sheathing and the related edge (11) from the outside.

6. Method for manufacturing a sheathed heating element comprising an outer sheathing (1) having a preferably circular cross-section, an inner conductor (2) provided with a protruding portion, an insulating filling mass (3) and at least an insulating sealing element of an annular shape arranged between said inner conductor and said outer sheathing in correspondence of at least an end portion of said sheathed heating element, wherein said insulating sealing element is formed by a cap (7) of plastic material moulded into the annhular gap existing between said outer sheathing and said inner conductor, said cap protruding outward of said sheathing and extending with a protrusion (9) that continues to envelop and seal the protruding portion of said inner conductor of said sheathing , characterized in that said cap and said protrusion are manufactured by means of a single-shot operation of application of said plastic material.

7. Method according to claim 6, characterized in that said single-shot operation of application of said plastic material is a transfer-compression moulding operation.

8. Method according to claim 6, characterized in that said single-shot operation of application of said plastic material is an injection-moulding operation.

9. Method according to claim 6, characterized in that said single-shot operation of application of said plastic material is a filling-by-casting operation.

10. Method according to any of the preceding claims claim 6 to 9, characterized in that one or more fastening or clamping means (77) are made and applied on to the outside of the sheathing through the same method, using the same material and substantially at the same time as said cap and said protrusion.

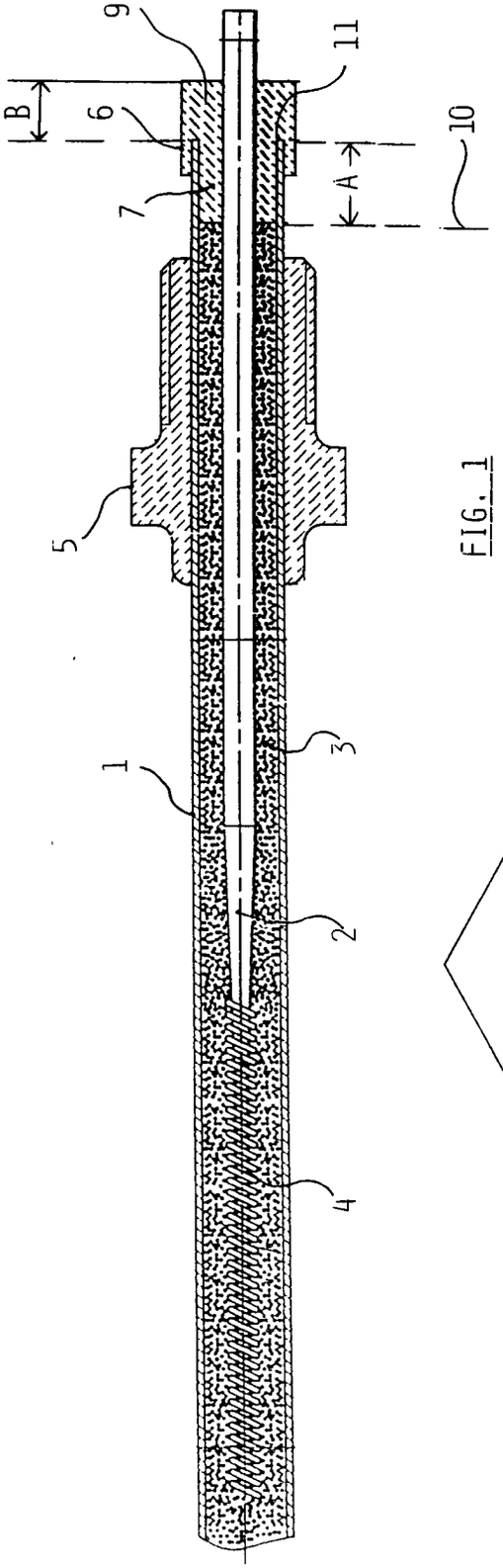


FIG. 1

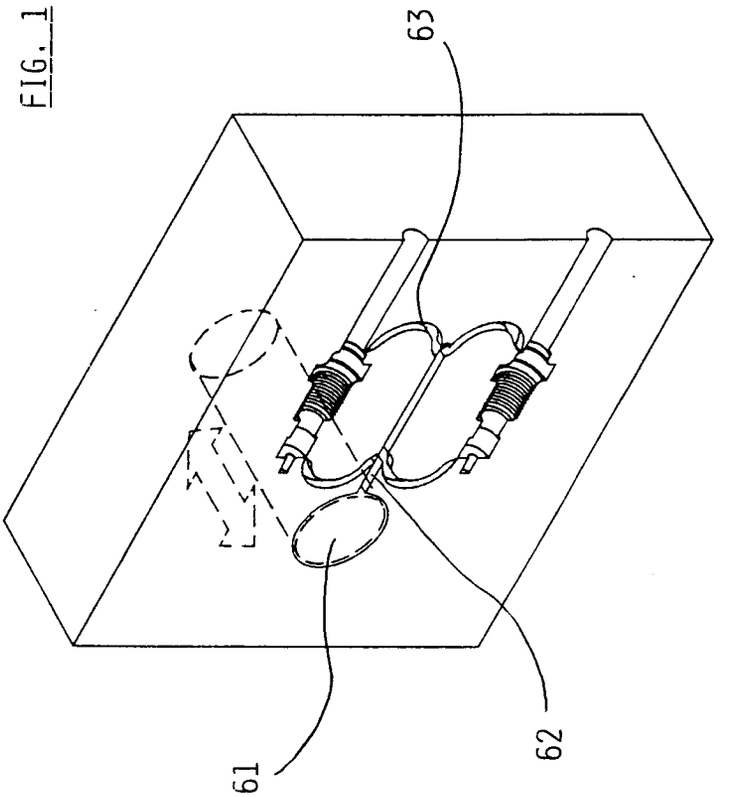


FIG. 7

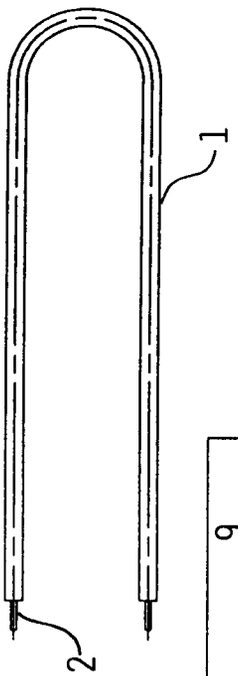


FIG. 2A

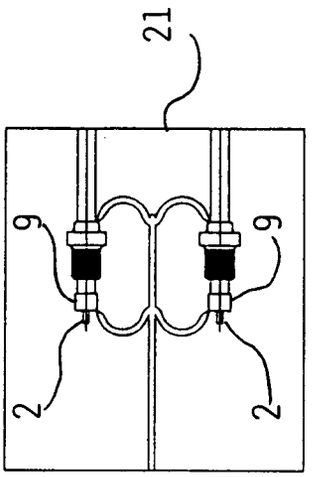


FIG. 2B

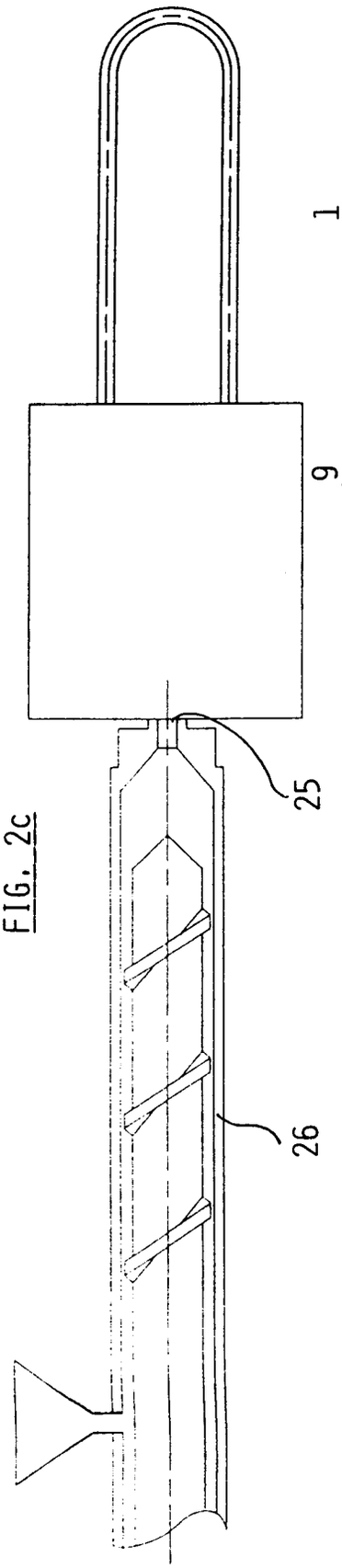


FIG. 2C

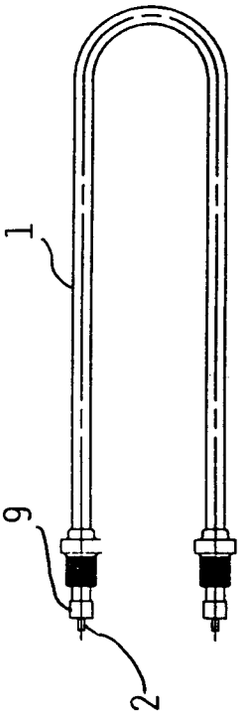
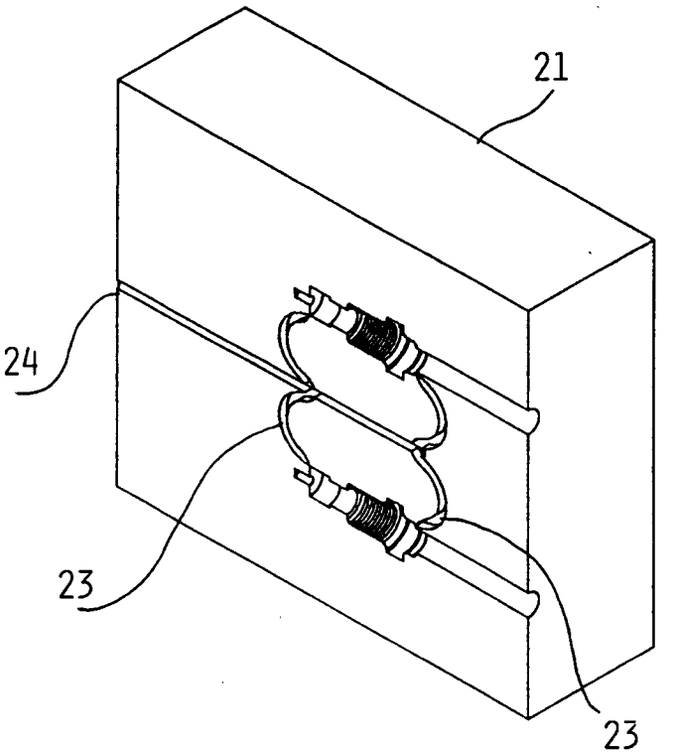


FIG. 2D

FIG. 3A



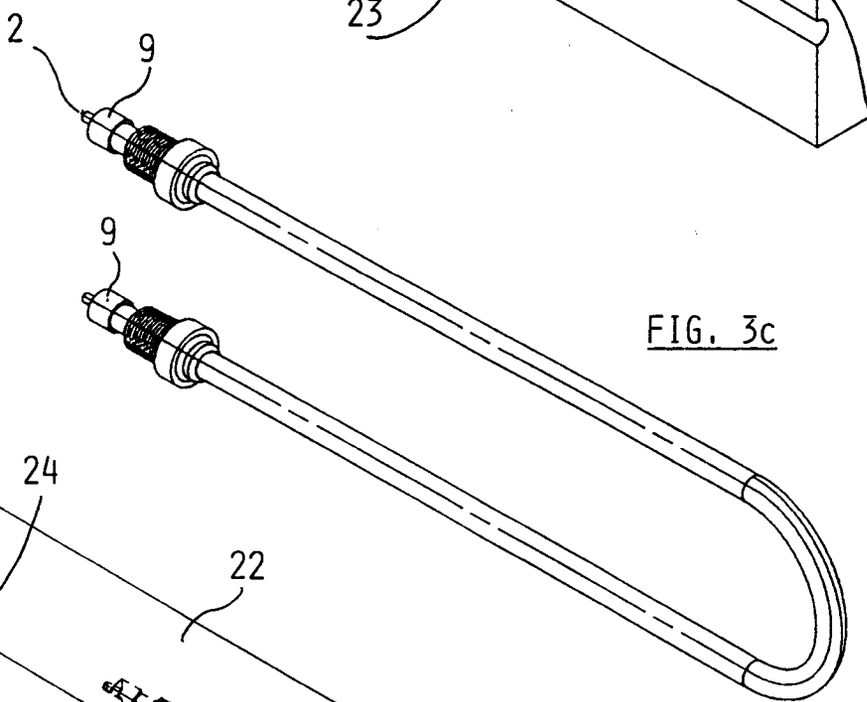


FIG. 3C

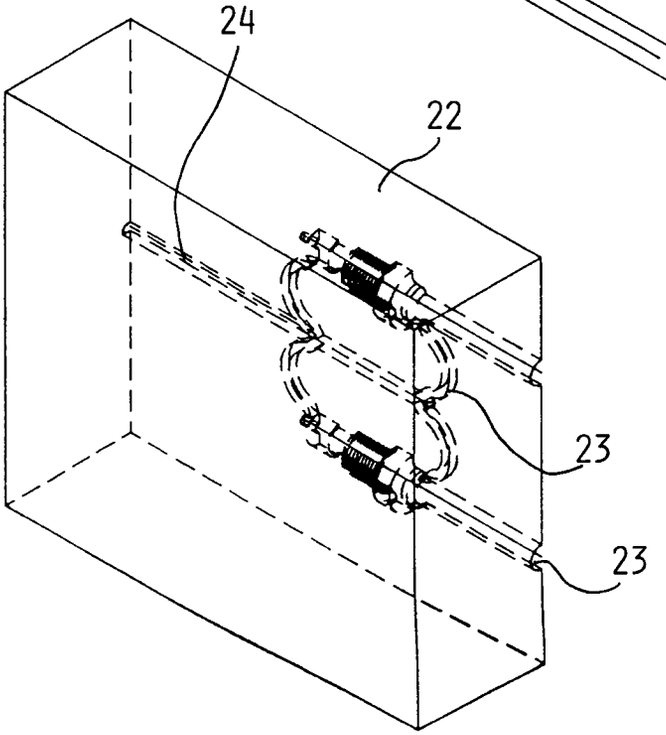


FIG. 3B

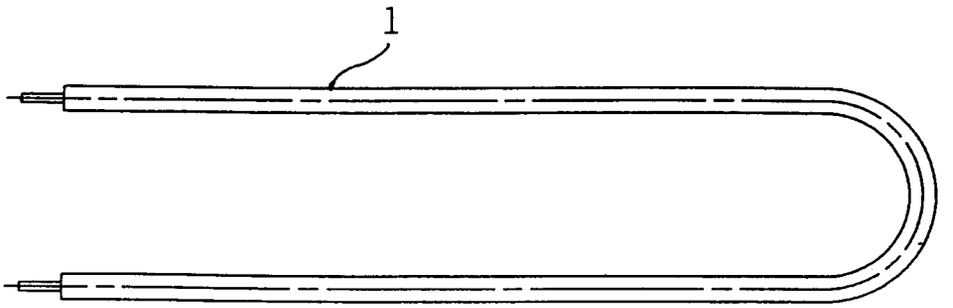


FIG. 4A

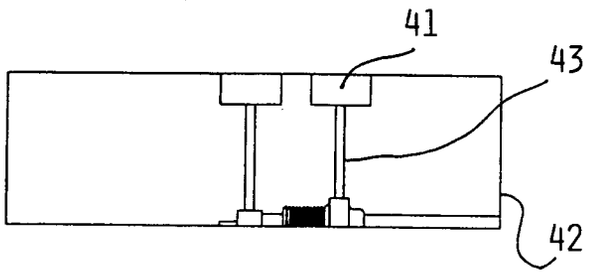


FIG. 4B

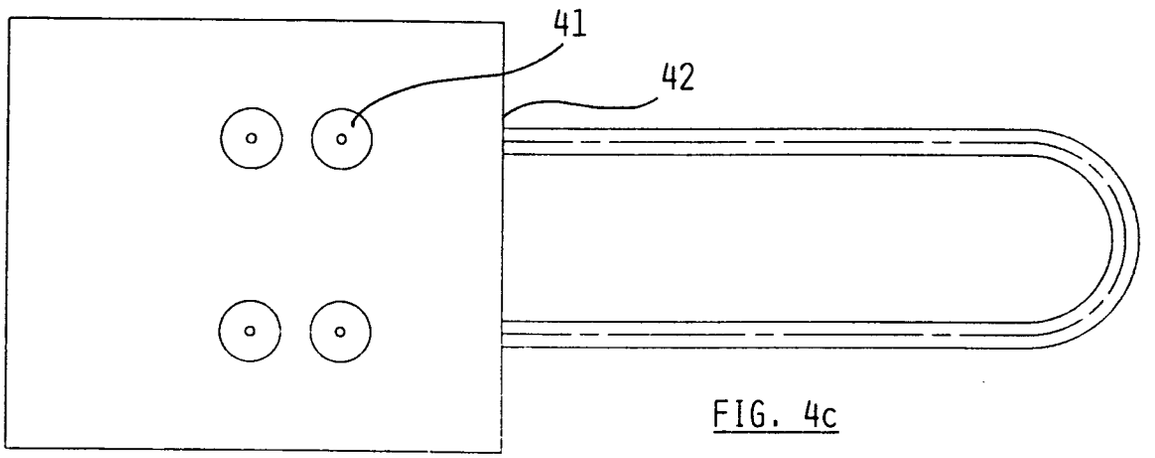


FIG. 4C

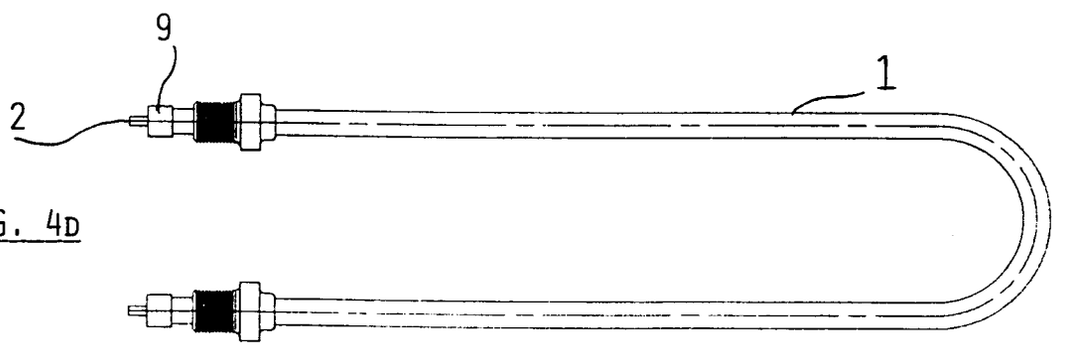


FIG. 4D

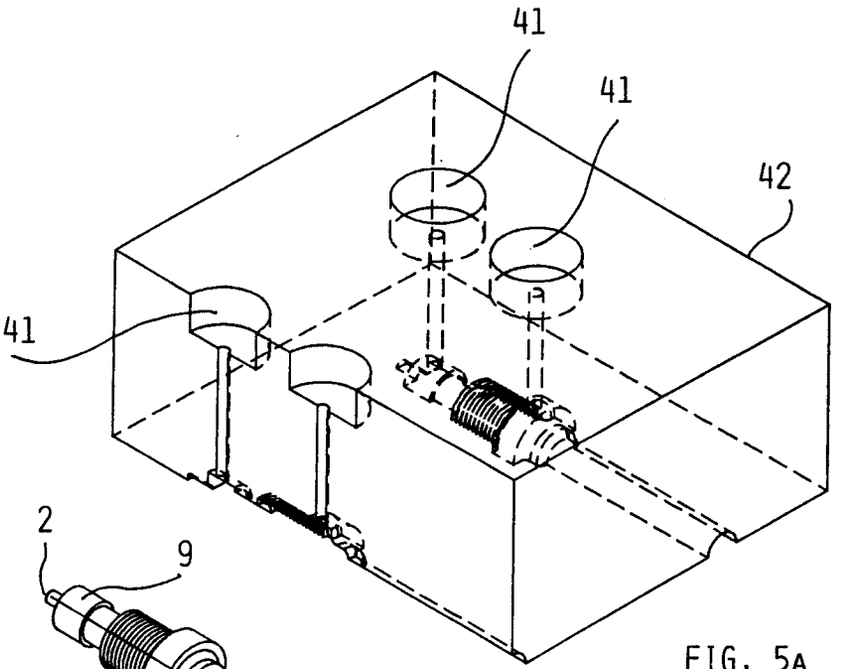


FIG. 5A

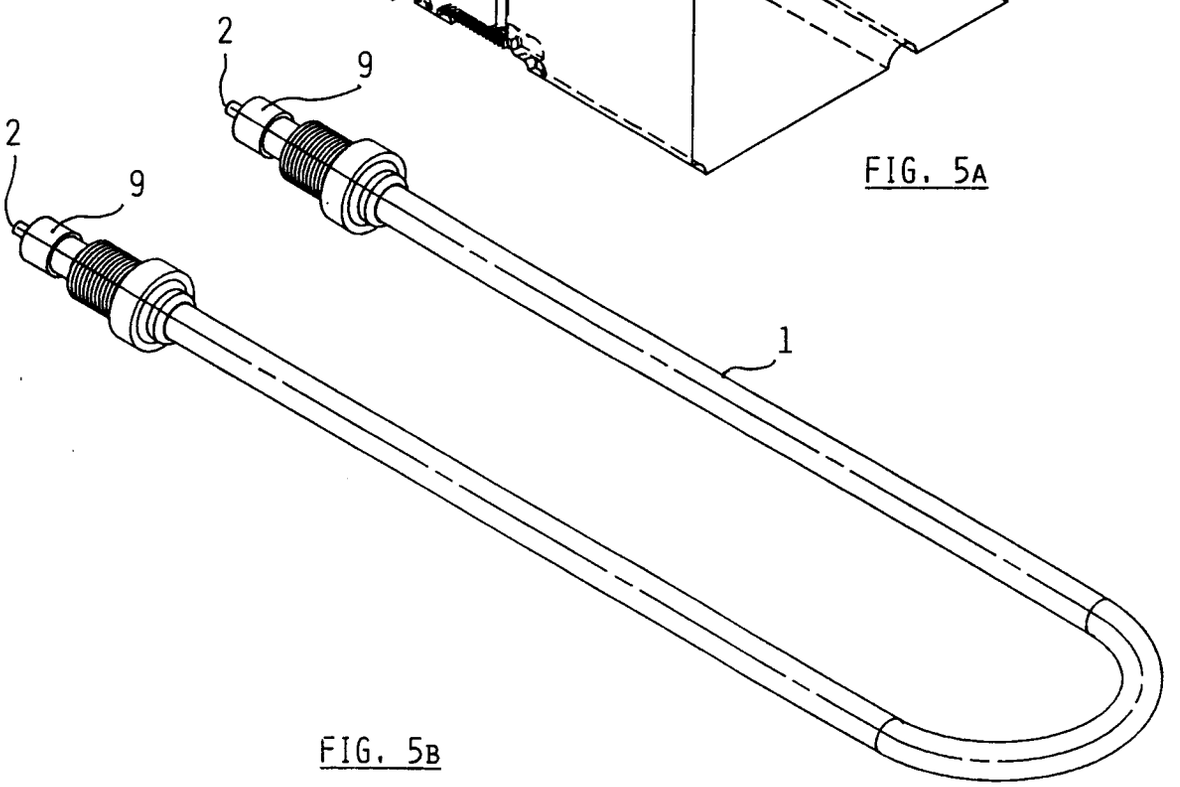


FIG. 5B

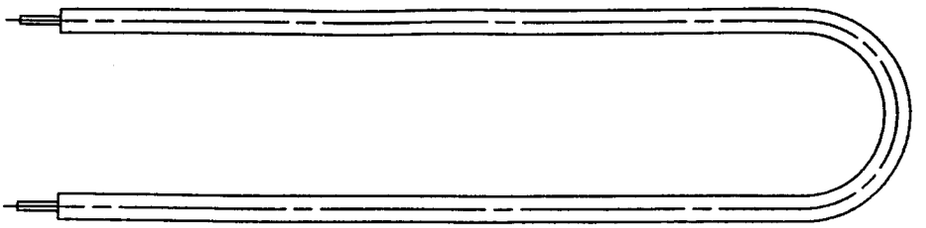


FIG. 6A

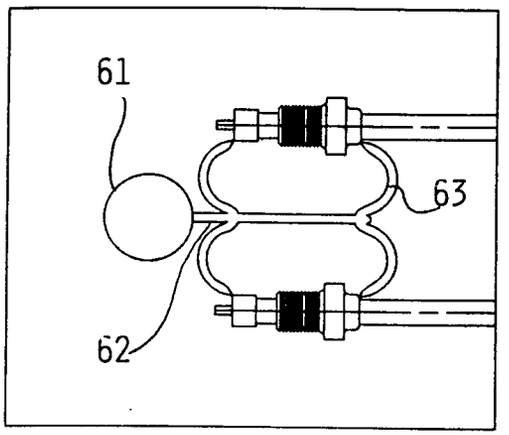


FIG. 6B

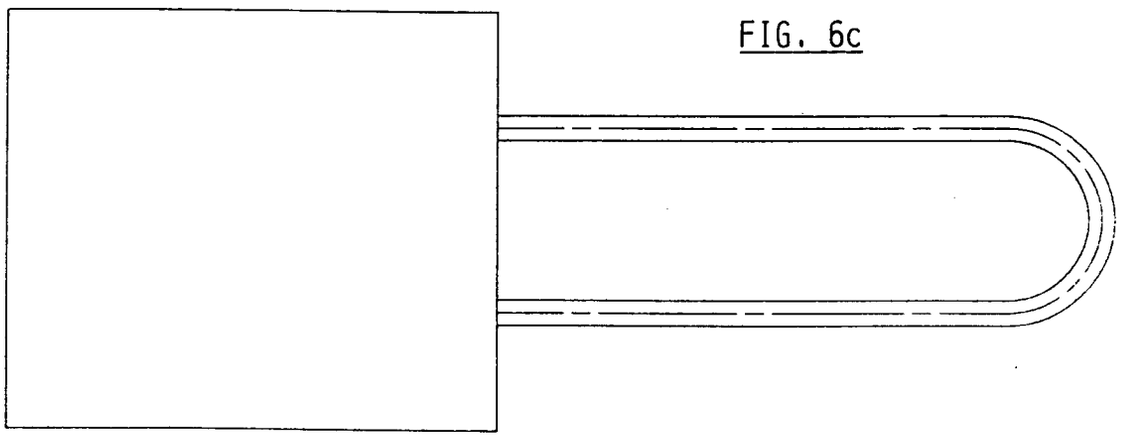


FIG. 6C

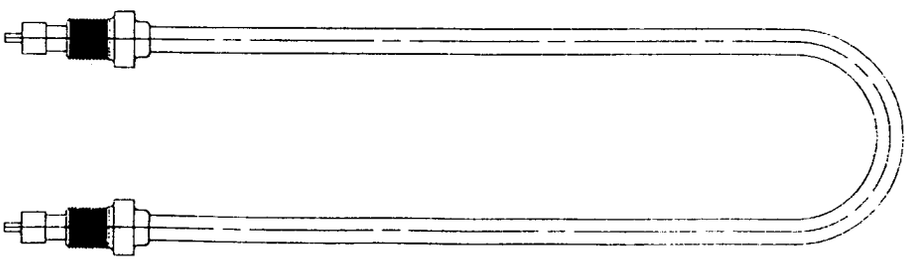


FIG. 6D

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 98 12 4095

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	GB 2 021 908 A (IRCA SPA) 5 December 1979 * claims 1,2,5-7 *	1,3,5	H05B3/48 H05B3/04
X	FR 2 272 568 A (ELPAG AG CHUR) 19 December 1975 * claim 1 *	1,3	
X	DE 42 20 833 A (LICENTIA GMBH) 21 January 1993 * claim 1 *	1,3	
A	DE 195 16 080 A (EGO ELEKTRO BLANC & FISCHER) 7 November 1996 * claim 1 *	1	
A	DE 15 65 455 A (CONTINENTAL ELEKTROINDUSTRIE AG.) 5 March 1970		

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

H05B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	23 April 1999	De Smet, F

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 98 12 4095

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
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

23-04-1999

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB 2021908 A	05-12-1979	FR 2428898 A SE 7904113 A	11-01-1980 12-11-1979
FR 2272568 A	19-12-1975	DE 2425054 A	04-12-1975
DE 4220833 A	21-01-1993	NONE	
DE 19516080 A	07-11-1996	NONE	
DE 1565455 A	05-03-1970	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82