BESCHWERDEKAMMERN DES EUROPÄISCHEN PATENTAMTS

BOARDS OF APPEAL OF THE EUROPEAN PATENT OFFICE

CHAMBRES DE RECOURS DE L'OFFICE EUROPEEN DES BREVETS

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File No.: T 0252/92 - 3.4.2

Application No.: 82 305 756.7

Publication No.: 0 078 675

Classification: G01K 7/22

Title of invention: Heat sensitive cable and method of making same

D E C I S I O N
of 17 June 1993

Proprietor of the Patent: Xco International Incorporated

Opponent: Degussa AG, Frankfurt
- Zweigniederlassung Wolfgang -
Zentrale Abteilung Patente

Headword:

EPC: Art. 83, 84 and 56

Keyword: "Disclosure sufficient (yes)" - "Clarity and inventive step (after amendment: yes)"

Headnote
Catchwords

Case Number: T 0252/92 - 3.4.2

D E C I S I O N
of the Technical Board of Appeal 3.4.2
of 17 June 1993

Appellant: (Proprietor of the patent)
Xco International Incorporated
339 West River Road
Elgin
Illinois 60120 (US)

Representative:
Dr. Bernhard GEISSLER et al
Galileiplatz 1
D - 81679 München (DE)

Respondent: (Opponent)
Degussa AG, Frankfurt
- Zweigniederlassung Wolfgang -
Zentrale Abteilung Patente
Rodenbacher Chaussee 4
Postfach 1345
D - 63457 Hanau (DE)

Representative:
Stoffregen, Hans-Herbert, Dr. Dipl.-Phys.
Patentanwalt
Salzstrasse 11 a
Postfach 21 44
D - 63450 Hanau (DE)

Decision under appeal: **Decision of the Opposition Division of the European Patent Office dated 19 November 91 and posted on 21 January 92 revoking European patent No. 0 078 675 pursuant to Article 102(2) EPC.**

Composition of the Board:

Chairman: E. Turrini
Members: M. Chomentowski
M.K.S. Auz Castro

Summary of Facts and Submissions

I. European patent No. 0 078 675 was granted on the basis of European patent application No. 82 305 756.7.

The patent was directed to heat sensitive cables comprising thermoelectrically dissimilar conductor means separated by an insulation material having a resistance variable with temperature, a method of manufacturing heat sensitive cables with the same features and a powdered insulation material having features required for use in a heat sensitive cable.

II. The Respondent (Opponent) filed an opposition against the European patent on the grounds that its subject-matter did not involve an inventive step having regard to the disclosure in

E1: GB-A-1 013 800,
E2: US-A-2 805 272 and
E3: US-A-3 737 997.

During the opposition procedure,

E4: US-A-2 868 935 and
E5: US-A-2 848 587

were cited in addition.

III. The patent was revoked. The Opposition Division took the view that since the insulation material having a negative temperature coefficient of resistance, independently or as part of the heat sensitive cables, was mentioned as having a resistance variable between

definite values and since the length, cross section or volume of the insulation material were not indicated, the subject-matter for which protection was sought by the amended claims submitted by the Proprietor was not clearly defined. Moreover, the heat sensitive cable of the amended Claim 1 had an insulation resistance which was variable and continuous within a broader temperature range as compared with that of the device known from E1; for the skilled person intending to provide continuous temperature measurements in a broader temperature range, it would be obvious to look for the suitable insulating material among those known from the other prior art documents E2 to E5 and to select the features thereof concerning the method of fabrication of the cable or the properties of the insulation material accordingly.

IV. The Appellant (Proprietor) lodged an appeal against this decision. In the oral proceedings which took place on 17 June 1993, it submitted a new set of claims of which the independent Claims 1, 2 and 14 read as follows:

"1. A heat sensitive cable comprising: an elongated substantially temperature resistant and moisture impervious tubular metallic sheath (12); a pair of elongated thermoelectrically dissimilar conductor means (16a, 16b) positioned within said sheath, said conductor means being disposed in spaced and substantially parallel relation to each other and said sheath, said conductor means extending out of at least one end of said metallic sheath; and a compacted insulation material (14) for electrically insulating said conductor means from each other and said sheath

and maintaining said conductor means in spaced and substantially parallel relation to each other and said sheath, said insulation material having an insulation resistance variable with temperature, wherein said insulation material has an insulation resistance variable within a temperature range of between approximately -30°C and 900°C between approximately 50,000 and 100 ohms and is such that a measurable and predictable voltage is generated in said temperature range between said conductor means, said measurable and predictable voltage being indicative of the temperature existing along the entire cable length, or if temperatures are unequal, at the hottest point along the cable length when subjected to external temperatures, said voltage being generated continuously in said temperature range in a passive, self-generating manner, and said insulation material is obtainable by heating manganese dioxide in a vacuum furnace at a temperature of approximately 900°C, for a period of time of between approximately 3 and 10 minutes, with said vacuum furnace drawn to a vacuum of approximately 66.661 Pa (500 microns of mercury) or less.

2. A heat sensitive cable comprising: an elongated substantially temperature resistant and moisture impervious tubular metallic sheath (12'); and elongated conductor means (16a') positioned within said sheath, said conductor means being thermoelectrically dissimilar to said sheath and being disposed in spaced and substantially parallel relation to said sheath, said conductor means extending out of at least one end of said metallic sheath; and a compacted insulation material (14') for electrically insulating said conductor means from said sheath and maintaining said

conductor means in spaced and substantially parallel relation to said sheath, said insulation material having an insulation resistance variable with temperature, wherein said insulation material has an insulation resistance variable, over a temperature range of between approximately -30°C and 900°C between approximately 50,000 and 100 ohms and is such that a measurable and predictable voltage is generated in said temperature range between said conductor means and said sheath, said measurable and predictable voltage being indicative of the temperature existing along the entire cable length, or if temperatures are unequal, at the hottest point along the cable length when subjected to external temperatures, said voltage being generated continuously in said temperature range in a passive, self-generating manner, and said insulation material is obtainable by heating manganese dioxide in a vacuum furnace at a temperature of approximately 900°C, for a period of time of between approximately 3 and 10 minutes, with said vacuum furnace drawn to a vacuum of approximately 66.661 Pa (500 microns of mercury) or less.

14. A method of manufacturing a heat sensitive cable operable over a temperature range, comprising the steps of:

advancing at least one thermoelectric conductor means from a starting position through a given region lying generally forwardly and axially of said starting position;

advancing a strip of flat metal material past tubular sheath forming means so as to form a tubular sheath therefrom in a position surrounding said given region;

concurrently depositing a sufficient amount of an insulation material within the formed sheath to fill said tubular formed sheath; and
advancing said sheath, said insulation material contained therein and said conductor means through means for reducing the diameter of said sheath and applying tension to said conductor means to compact said insulation material and permanently position said conductor means therein;
wherein prior to depositing said insulation material within the formed sheet (read "sheath"), said insulation material is obtained by the steps of:
providing manganese dioxide to be converted from a conductor into said insulation material and heating said manganese dioxide in a vacuum furnace at a temperature of approximately 900°C for a period of time of between approximately 3 and 10 minutes with said vacuum furnace drawn to a vacuum of approximately 66.661 Pa (500 microns of mercury) or less to convert said manganese dioxide to said insulation material having as said cable an insulation resistance variable with temperature in the range of between approximately 50,000 and 100 ohms within a temperature range of between -30°C and 900°C."

Claims 3 to 13 and 15 to 29 are dependent claims.

V. The Appellant submitted the following arguments:

The device claims comprise features of the fabrication of the insulation material because there is no other way for defining said features; the resistance values in the subject-matter in dispute are understood by the skilled person as being small as compared with the

internal resistance of the voltameter instrument. Therefore, the claims in dispute are clear.

The prior art devices of E2, E5 or E1, are of the switching type; only temperature changes near predetermined temperature values can be detected. The heat sensitive cables in dispute allow the detection of changes of temperature in a broader range of temperature, between approximately -30°C and 900°C; the related resistance values (from 50,000 to 100 ohms) which are small as compared with the internal resistance of the voltameter instrument, allow predictable measurement of thermoelectric voltage, independently of the length of the cable, continuously over said whole range of temperature. This surprising effect results in particular from the used vacuum heating and the selection of the definite conditions of the treatment, which were not suggested by the prior art. The commercial success in a field wherein for reasons of security (fire detection) technique and not price is important is a further indication that the devices and method in dispute involve an inventive step.

The Appellant requested that the decision under appeal be set aside and that the patent be maintained on the basis of Claims 1 to 29 filed during oral proceedings, a description yet to be adapted and Figures 1 to 7 as granted.

VI. The Respondent requested that the appeal be dismissed. It argued as follows in support of his request:

Since the current claims have been submitted only during the oral proceedings, they should be disregarded.

Concerning the heat sensitive cables in dispute, it is to be noted that they are not correctly disclosed because their resistance values in ohms without the corresponding dimensions thereof are meaningless. Moreover, the principle of operation of the cables in dispute and the use of manganese oxides as insulation material therein are known from E2, whereby E5 indicated therein discloses specifically manganese dioxide. All the steps of the method of fabrication of the heat sensitive cable in dispute are known; for instance, E3 discloses steps of the heat treatment and compacting for the same type of powdered insulation material for the same type of device. Moreover, there is no directly derivable causal relation between the vacuum heat treatment and the specific properties of the negative coefficient insulation material and the contribution of this feature can be disregarded. Therefore, the skilled person intending to broaden the range of detection of the heat sensitive cables and thus to modify the negative coefficient of temperature of the resistance of the insulation material application would arrive at the device and method in dispute in an obvious way.

Reasons for the Decision

1. The appeal is admissible.

2. *Disclosure of the invention*

2.1 As credibly argued by the Appellant, the feature that the resistance of the cable in dispute has a resistance between approximately 50,000 and 100 ohms means for the skilled person that this resistance is very low as compared with the internal resistance of voltage measuring instruments employed to measure the electromotoric forces involved and resulting from the thermoelectric effect between the dissimilar conductors brought into contact by the decrease of resistance of the separating insulation material with temperature; this results in a voltage generated by the thermocouple which is largely independent from the actual resistance of the cable. Moreover, as convincingly argued by the Appellant, the feature that the powder of the cable in dispute is compacted refers to a small percentage of voids in the ceramic material and is generally understood so by persons skilled in this field. Therefore, the Board is satisfied that the patent in suit discloses the invention in a manner sufficiently clear and complete for it to be carried out by a person skilled in the art (Article 83 EPC).

3. *Admission of new claims*

3.1 The new set of claims filed at the beginning of the oral proceedings is admitted into the proceedings. The present claims in dispute only result from the combination of the claims which were opposed; they thus relate to a restricted class of devices and processes of manufacturing them and in particular do not concern any more the powdered insulation material. There was, thus, only a restriction of subject-matter making necessary no further documents or arguments. Therefore, their consideration can reasonably be expected from the

Respondent who is familiar with the subject-matter of the patent in suit.

4. *Allowability of the amendments*

4.1 Claim 1 in dispute results from the combination of the features of Claim 1 and dependent Claims 3 to 5, all as granted. Independent Claim 2 in dispute results from the combination of the features of independent Claim 2 and dependent Claims 3 to 5, all as granted. Independent Claim 14 in dispute results from the combination of the features of independent Claim 17 and dependent Claims 18 and 22, all as granted. Therefore, the Board is satisfied that the claims of the European patent have not been amended in such a way as to extend the protection conferred (Article 123(3) EPC).

4.2 The Board is satisfied that the European patent has not been amended in such a way that it contains subject-matter which extends beyond the content of the application as filed (Article 123(2) EPC).

5. *Clarity*

5.1 For the sake of clarity, since in particular Claims 1 and 2 in dispute relate to different types of device, with a pair of conductors means or a conductor means, respectively, main claims with statement and characterising portion according to Rule 29(1) EPC are not appropriate. Moreover, the considerations in paragraph 2.1 above concerning particular features of the cables and method of manufacturing cables in dispute also apply for determining the meaning derivable from the corresponding claims. It is also to

be noted that the patent in suit (column 7, lines 19 to 39) mentions that although the insulation material has a final chemical composition which is not known, it has, when compacted in final form, the resistance range in the operating temperature range specified in the claims in dispute. Since the only convenient way for expressing said material feature is based on the process of preparation of said material, it is acceptable. Therefore, the Board is satisfied that the claims are clear in the sense of Article 84 EPC.

6. *Novelty*

6.1 The novelty of the subject-matter of the claims in dispute has not been contested and also the Board has no objection in this respect (Article 54 EPC).

7. *Inventive step*

7.1 Claim 2

7.1.1 Since heat sensitive cables comprising manganese oxides are known from E2, it is the closest prior art document. Moreover, independent Claim 2 in dispute is treated first because E2 discloses with more details a cable structure with an elongated conductor means, i.e of the same type as in said claim.

A heat sensitive cable is known from E2 (see column 1, line 16 to column 2, line 2; column 2, line 14 to column 4, line 49; column 4, line 65 to column 5, line 14; Figures 1 and 2); it comprises an elongated substantially temperature resistant and moisture impervious tubular metallic sheath (11) and elongated

conductor means (12) positioned within the sheath; the conductor means (12) is thermoelectrically dissimilar to the sheath (11), is disposed in spaced and substantially parallel relation to the sheath and extends out of at least one end of the sheath; insulation material (13) having a negative temperature coefficient has the function of positioning and electrically insulating the conductor means from the sheath; said insulation material (13) is a micropulverised material, rendered somewhat plastic by a subsequent treatment and then submitted to a process in which the sheath wherein the material is placed is drawn for reducing the diameter of the sheath to bring the inner wall thereof into firm contact with the spacing material, and thus the spacing material is compacted.

According to the indications in E2 (see column 2, lines 58 to 62) the insulation material can be fabricated by a process disclosed in E5 (see column 2, line 28 to column 5, line 65; Figures 1 to 3), and thus, said insulation material comprises heat treated manganese dioxide having an insulation resistance within the sheath variable with temperature, whereby a measurable temperature indicative voltage is continuously and passively self-generated.

It is to be noted that the electrical resistivity of the semiconductive spacing material of the cable known from E2 (see column 4, lines 29 to 49) can be selected, for a mentioned length of the cable, as being 100 ohms, i.e. within an insulation range bounded by a maximum insulation range of between approximately 100 and 50,000 ohms.

7.1.2 However, contrary to the insulation material of the cable of Claim 2 in dispute, the manganese dioxide of E2 and E5 is heat treated in air or in a reducing or neutral atmosphere such as hydrogen or nitrogen and there is no indication that it is submitted to any heating treatment in vacuum. As mentioned in paragraph 5.1 above, this feature of the preparation of the insulation material corresponds to specific material features thereof.

Moreover, there is no indication in E2 or E5 that the resistance of the cable should be approximately 50,000 ohms for a temperature of approximately -30°C.

7.1.3 As convincingly submitted by the Appellant, the device of E2 (see column 1, lines 16 to 23 and 34 to 38) is of a "switch" type nature because a "predetermined temperature" is repeatedly mentioned; moreover, since E2 indicates that the material can be fabricated according to the teaching in E5 and since E5 (see in particular column 3, lines 71 to 74) stresses the feature of "a family of cables using the same basic metal oxide to meet specific requirements of different fire-detection applications", it is derivable that a predetermined temperature is meant for each cable of said family. The switching character of the device fabricated with an insulation material according to E5 (see column 5, lines 50 to 65; Figure 3) is also derivable from the values of measured resistance of the cable using manganese oxides, which provide a very steep slope (for instance 100,000/10, i.e. 10,000 for a range of temperature of about 400°F, i.e. about 220°C) as compared with a ratio of 50,000/100, i.e. 500 for a range of temperature of about 1000°C in the patent in

suit. It is also to be noted that the operating range for devices fabricated according to E5 (see column 3, lines 62 to 71) is from approximately 200°F to 1000°F, i.e. 93°C to 537°C as compared with approximately between -30°C and 900°C for the cable in dispute. Extrapolating the values derivable from the curves of Figure 3 shows that the resistance of the cable for -30°C would be in any case much higher than 50,000 ohms.

7.1.4 Thus, as indicated in the patent in suit (see column 1, lines 30 to 42 and column 1, line 63 to column 2, line 3), the known devices have a limited range of operation in temperature and are thus not versatile. It is the object of the invention to provide a heat sensitive cable allowing continuous control over a broad range of temperature, and namely between approximately -30°C and 900°C. The non-switching character of the cable in dispute, i.e. the gentle slope of the change in resistance as a function of temperature resulting from the particular method of treatment of the insulation material, credibly allows continuous predictable measurement over said wider range of temperature.

7.1.5 There is no indication in E2 or E5 for treating a semiconductive oxide such as manganese dioxide in vacuum. Moreover, such a teaching cannot be derived from the other prior art documents concerning heat sensitive cables. For instance, it is derivable from E1 (see page 2, line 11 to page 3, line 86 and more in particular page 3, lines 44 to 61; Figure 1) that the insulation material, i.e. magnesium oxide (and not manganese oxide), of the disclosed heat sensitive cable is mainly an inert spacing material and that it is the

impurity, e.g. sodium chloride, which provides the suitable resistance/temperature characteristics; E3 (see column 4, line 46 to column 8, line 26; Figures 1 to 5) also discloses an insulation material which may be anhydrous metallic oxide such as magnesium oxide but does not provide any information about manganese dioxide or vacuum heat treatment.

Indeed, the treatment of material comprising manganese dioxide for thermosensitive electric components is known from E4 (see column 1, lines 15 to column 2, line 3; column 2, line 68 to column 5, line 33), but in relation with different devices and namely conventional thermistors, wherein the resistance of the material varies with temperature; moreover, there is no indication that the powdered crystalline material of the insulation material of E4, which is suspended in a thermoplastic binder, is compacted or submitted to a vacuum heating treatment.

It is to be noted that vacuum heat treatments of materials were not unknown to people skilled in the art; however, as credibly submitted by the Appellant, the required properties of the insulation material are not obtained with any vacuum treatment but are directly related to the precise limited conditions specified in Claim 2 in dispute and there is thus a surprising effect depending from, i.e. causally resulting from an additional selection.

7.1.6 Therefore, the subject-matter of Claim 2 in dispute involves an inventive step in the sense of Article 56 EPC.

7.2 Claim 1

7.2.1 A heat sensitive cable having a pair of conductors in a sheath and forming a thermocouple with a separating insulation material which can become more conductive when heated, is known from E2 (see column 4, lines 50 to 64; Figure 3); the known device is thus of the same type as that of Claim 1 in dispute. However, as mentioned above, neither E2 nor any of the other prior art documents suggests the specific vacuum heat treatment necessary for obtaining an insulation material having the required properties and, thus, the subject-matter of Claim 1 also involves an inventive step.

7.3 Claim 14

7.3.1 Independent Claim 14 in dispute concerns a method for manufacturing a heat sensitive cable and has the same features as those recited in Claim 1 or Claim 2 in dispute, and also involves an inventive step for the same reasons.

7.4 Claims 3 to 13 and 15 to 29 are also allowable due to their dependence on the main claims in dispute.

8. Therefore, since, taking into consideration the amendments made by the Proprietor, the patent and the invention to which it relates meet the requirements of the Convention, the patent is to be maintained in amended form (Article 102(3) EPC).

Order

For these reasons, it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the first instance with the order to maintain the patent on the basis of Claims 1 to 29 filed during oral proceedings of 17 June 1993, a description yet to be adapted and Figures 1 to 7 as granted.

The Registrar: The Chairman:

P. Martorana E. Turrini