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Bezeichnung der Erfindung:
Title of invention:
Titre de l'invention : Electrical heating element

Klassifikation / Classification / Classement : H05B 3/12

ENTSCHEIDUNG / DECISION
vom / of / du 23 June 1986

Anmelder / Applicant / Demandeur : Bulten-Kanthal AB

Patentinhaber / Proprietor of the patent /
Titulaire du brevet :

Einsprechender / Opponent / Opposant :

Stichwort / Headword / Référence :

EPÜ / EPC / CBE Article 56
"Inventive step"

Leitsatz / Headnote / Sommaire

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Case Number: T 256/85

DECISION

of the Technical Board of Appeal 3.4.1

of 23 June 1986

Appellant: Bulten-Kanthal AB
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SWEDEN

Representative: Larfeldt, Helene
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Decision under appeal: Decision of Examining Division 045 of the European Patent Office dated 23 April 1985 refusing European patent application No 81 850 016.7 pursuant to Article 97(1) EPC

Composition of the Board:

Chairman: O. Huber
Member: J. Roscoe
Member: R. Schulte

SUMMARY OF FACTS AND SUBMISSIONS

I. European patent application no. 81 850 016.7 filed on 30 January 1981, published under publication no. 0 034 133 on 19 August 1981 and claiming priority of 6 February 1980 from an earlier application made in Sweden, was refused by decision of Examining Division 045 of the European Patent Office dated 23 April 1985. The decision was based on Claims 1 to 3 filed on 2 February 1984.

Claim 1, the only independent claim, reads as follows:

Electrical heating element with an outer, metallic casing surrounding a resistor element of a Fe-Cr-Al alloy embedded in an insulating material of MgO, characterized in that the alloy also comprises Y in an amount of 0.01 - 1 percent by weight.

The reason given for the refusal was that the subject-matter of Claim 1 did not involve an inventive step having regard to the prior art disclosed in the application and in DE-A-2 813 569 (4).

According to the description an electrical heating element according to the preamble of Claim 1 was already known. Doc. (4) described an Fe-Cr-Al alloy which included Y (yttrium) in an amount of 0.01 - 3% by weight and was stated to be particularly suited for invariable heating elements. In the application itself it was acknowledged that such a known heating resistor element alloy had improved resistance to oxidation and corrosion in air. While it was true that the alloy according to doc. (4) was disclosed for use in an air environment, it was provided for the purpose of solving essentially the same problem as that which the Applicant set out to solve - the decision did not indicate what this problem was - and the alloy of

doc. (4) and that specified in Claim 1 pertained to the same technical field. It would therefore be obvious to the skilled person to combine the teachings of (4) with that represented by the generic part of Claim 1. It could only be expected that the overall performance of the heating element would be improved when the resistor element, a vital component thereof, was replaced by a superior one. The knowledge of the improved corrosion resistance of the Y -containing allow resistance element, which is therefore superior to similar prior art elements, was an incitement to the skilled person to employ it as the resistor element of an element according to the preamble of Claim 1.

III. On 14 June 1985 the Applicant lodged an appeal against the decision by telex. The telex was duly confirmed in writing and the appeal fee was duly paid. The Statement of Grounds was filed on 28 August 1985.

IV. In a communication pursuant to Article 110(2) EPC the Board of appeal, acting in accordance with the provisions of Article 114(1) EPC introduced the following additional documents into the proceedings:

GB-A-815 312 (1)
US-A-3 369 209 (2)
SE-C-152 930 (3)
DE-A-2 829 373 (5)
UD-A-3 591 365 (6)
McGraw Hill Encyclopaedia of Science and Technology, 1977, Vol. 11, p. 515 (7)
US-A-3 027 252 (8)
and expressed doubts as to whether the subject-matter of the claims involved an inventive step.

V. Following a reply from the Appellant a further communication was issued.

VI. In a letter filed 11 April 1986 the Appellant commented on matters raised in the above-mentioned communication.

VII. The Appellant argues essentially as follows:
The invention aims to provide a tubular heating element with improved life over conventional elements according to the preamble of Claim 1 and improved economy over similar elements using a Ni-Cr alloy resistor wire. The known advantages of adding Y to Fe-Cr-Al high temperature oxidation resistant alloys, that it improves adhesion to the substrate (wire) of the protective Al_2O_3 and prevents its lateral growth, thus reducing the oxide-spalling that occurs during cooling, are obtained when heating in an oxidising atmosphere. However, in the tubular elements in question, the resistor element operates in an atmosphere consisting essentially of nitrogen at low pressure. What is essential therefore is to minimise formation of aluminium nitrides and thus to reduce the loss of aluminium from the alloy which leads to burn out. The inventor's discovery that replacement of the Fe-Cr-A: alloy resistor by the alloy additionally containing Y reduces such nitride formation, hence leading to increased lifetime, was surprising, not least because comparative lifetime tests performed in oxide deficient atmospheres showed the Y-free alloy to have a slight advantage. A theory that a nitrogen-diffusion retarding protective layer of spinel forms at the interface between the wire and the embedding MgO was supported by a SEM examination of the interface. Since such spinel formation was non-predictable and had a beneficial effect on lifetime, the claimed element should be seen as involving an inventive step.

The explanation of the decomposition of the resistance wire given in doc. (3) was now known to be incorrect. The skilled person knew that the oxide (Al_2O_3) layer formed on the wire was only thin. Calculations showed that the maximum thickness which could be formed on the wire in a conventionally dimensioned element by consumption of all the oxygen in the air sealed into the casing was 20-30 µm and that this would afford inadequate protection against diffusion of nitrogen. Moreover the calculation assumed that no spalling occurred. It was denied, despite the statement at page 1, lines 22-23 of the specification itself, that air would leak into the casing via its ends but even if it did the oxygen in it would be consumed before it reached the centre of the casing.

The wire there would thus be exposed to the nitrogen-rich atmosphere. The fact that some oxidation occurred could not lead the skilled person to use a more oxidation resistant alloy for the wire.

The Appellant also contended that the term "an insulating material of MgO" used in Claim 1 did not include the MgO which contained chemically active materials proposed in doc. (3) but was ready to amend it, if necessary, to "an insulating material of solely MgO and common impurities".

V. The Appellant requests that the appealed decision be set aside and a patent granted on the basis of Claims 1 to 3 filed on 2 February 1984.

REASONS FOR THE DECISION

1. The appeal complies with Articles 106 to 108 and Rule 64 EPC and is therefore admissible.

2. Claim 1 is derived from the original Claim 1 by the cancellation of specific alternatives to the originally mentioned Y (yttrium) as the additive to the class of alloy defined in the preamble, and the stipulation of MgO as the embedding insulating material, which finds support in page 1, line 5 and example 2 of the original description. Claims 2 and 3 correspond to the like-numbered original claims. Thus the subject-matter of the claims does not extend beyond the content of the application as originally filed. The amendments to the description are exclusively by way of limitation or clarification. All the amendments are therefore allowable under the terms of Article 123(2) EPC.

3. The generic part (preamble) of Claim 1 summarises the combination of features to be found in combination in what is, in the opinion of the Board, the closest prior art, exemplified by the heating elements disclosed in doc. (3), or under the heading "Example" in doc. (2). Thus Rule 29(1)(1) EPC is also complied with.

4. Neither of documents (2) and (3) proposes the use of a Fe-Cr-Al alloy containing Y as resistor element. Furthermore, of those documents cited in the search report or introduced into the proceedings by the Board itself which do disclose such an alloy, only document (4) proposes its use as a heating resistance element. In neither of these however is the element stated to be embedded in MgO or mounted in a metallic casing. Therefore the subject-matter of Claim 1 and hence also that of the appendant Claims 2 and 3 is novel (Article 54 EPC).

5. In the application in suit it is stated that when using resistor elements of prior art Fe-Cr-Al alloys in tubular casings having the features of the preamble of Claim 1 a protective layer of Al_2O_3 which prevents in and out diffusion is formed initially. After some time the oxygen

within the casing is consumed and aluminium nitrides are formed on and within the body of the element, thereby depleting it of aluminium and thus causing changes in the old resistance and temperature coefficient of the element and limiting its lifetime.

6. It is to the solution of these problems that the invention is directed. The solution according to the invention is to replace the prior art resistor element by one of the per se known yttrium-containing alloys stipulated in the characterising part of Claim 1. Test results given in the specification are designed to show the improvement in lifetime and cold and hot resistance stability achieved by this measure. These results are supplemented by the micrographs forming Appendix 2 to the letter filed 2 February 1984.

7. It remains to be decided whether the subject-matter of Claim 1 involves an inventive step.

7.1 As indicated above it has already been suggested in doc. (4), that the yttrium-containing alloys are particularly suitable for forming heating resistors. In view of this the question resolves into one of determining whether or not the skilled person equipped with the above knowledge would contemplate employing such yttrium alloys for the heating resistor elements of heating elements of the particular type of construction defined in the preamble of the claim.

7.2 The lifetime and changes in the resistance properties of the heating elements in use, both of obvious practical importance, can be readily determined experimentally by the skilled person. There is therefore no question of the discovery by the

Applicant of an unrecognised problem such as could, in certain circumstances, give rise to patentable subject-matter.

7.3 That a heating element according to the preamble of Claim 1 is prior art is confirmed by the documents (2) and (3). In both of these documents it is postulated that during use the atmosphere in the tubular metallic casing may change, the pressure and oxygen content being reduced as a result of oxidation of the casing wall and/or resistance wire (column 1, lines 65-72 of (2) and the paragraph bridging columns 1 and 2 on page 1 of (3)). In (2) it is also stated that the state of compression of the MgO filling in itself constitutes a considerable barrier to air penetration.

7.4 Doc. (3) states that it has been shown that destruction of a heating element consisting of an Fe-Cr-Al alloy embedded in magnesium oxide in a sealed casing can occur after a period of use. A protective layer of aluminium oxide formed in the resistor element peels off after a time but is reformed until the oxygen content of the air in the casing is consumed and is not replaced by inward leakage. On further peeling the element becomes exposed to the residual nitrogen, which reacts with and finally destroys it. This is essentially the explanation of the problem, to which the present alleged invention affords a solution, given at page 1, lines 30-34 of the rejected application. According to doc. (3) it is essential, if such destruction is to be avoided, that a protective oxide coating continues to be regenerated as it peels off. This is achieved, according to doc. (3), by ensuring that the atmosphere in the casing consists essentially of oxygen.

This is brought about by evacuating the casing or flushing it with oxygen to remove most of the nitrogen and then sealing in oxygen gas or mixing with the magnesia filling one of a number of chemical oxidising agents which generate oxygen on heating in an amount such that the casing can support the oxygen pressure at the operating temperature.

7.5 In the Board's opinion the skilled person confronted with the problem as explained in doc. (3) would recognise that it could alternatively be tackled by replacing the Fe-Cr-Al alloy resistance element with one made of a material of similar electrical characteristics but exhibiting a greater resistance to the peeling off (or spalling) of its protective oxide, which is what ultimately leads to exhaustion of the oxygen from the air in the casing, were such a material available. As the refused application itself recognises, doc. (4) discloses yttrium containing alloys as defined in the characterising part of Claim 1 of the application and indicates their good oxidation resistance in relation to otherwise similar alloys free of yttrium, and their particular suitability for forming heating elements, which the skilled person would, of course, understand to mean electrical heating elements. The benefit of the inclusion of yttrium in the alloys is demonstrated by comparative tests conducted in moist air. The oxidation resistance of Fe-Cr-Al alloys has been generally attributed to their ability to form adherent layers of aluminium oxide which serve to retard further oxidation, see e.g. doc..... page 515. As indicated above by doc. (3) it is the spalling of the protective layer which causes oxidation to proceed further. Yttrium-containing alloys however show a resistance to spalling which generally attributed to

the presence of the yttrium, see doc. (8), pages 428 and 431. Doc. (9) also refers - at column 2, lines 14-18 - to non-spalling (oxide) film formed on yttrium-containing alloys of the type under consideration.

Consequently, the skilled person seeking a cure for spallation in the circumstances depicted in document (3), to provide an increase in lifetime before the oxygen content of the housing is exhausted, would realise that the use of the yttrium-containing alloy disclosed in document (4) might serve his purpose. Experiments of an entirely routine nature would confirm this.

7.6 The skilled person who had already availed himself of the teaching of document (3) and resorted to filling the housing with oxygen gas would also appreciate that oxygen itself ultimately erodes the resistor element if spallation occurs, and that substitution for the conventional FeCrAl alloy of the yttrium-containing alloy would slow down the process of oxidation and lead to a further improvement in lifetime were this to be required. In such an arrangement, as opposed to one in which solid oxygen-releasing additives are included it cannot be argued that the resistor element is not embedded in an insulating material of MgO.

In the circumstances the Board is satisfied that the replacement of the FeCrAl alloy resistor element of the heating element which as set forth in the preamble of Claim 1 by an element/additionally contains yttrium in an amount within the limits

specified in the characterising part of that claim does not involve an inventive step in the sênse of Article 56 EPC.

Claim 1 is, therefore, not allowable (Article 52 EPC).

8. Claims 2 and 3 are both dependent on the unallowable Claim 1 and therefore fall with it. Moreover, their reformulation to independent claims would not save them since alloys having percentages by weight of the quoted component elements within the ranges stipulated in these claims are disclosed in document (4) so that no inventive step is to be found in them.

9. The contention of the Appellant, that the explanation of the destruction of the resistor wire given in document (3) is now known to be incorrect, is unsupported by documentary evidence as to the state of the art at the priority date and there is nothing in the other available documents that would lead the skilled man away from taking this document at its face value, both with regard to the protective effect of the oxide and the phenomenon of spallation. He would therefore have no cause to perform calculations such as that made by the Appellant which might cause him to question that any oxide layer would reach a sufficient thickness.

As to the calculation itself it is observed firstly that no evidence has been brought to show that an oxide of the calculated thickness would not have a protective effect and secondly that not all heating elements are of the dimensions given. Indeed it is not clear why a wire diameter of 0.8mm should have been chosen as a basis for the calculation when in Example 1 of the application itself a wire having a diameter of 0.4mm and hence 1/4 of the volume per

unit length is used. It is also noted that if the nitrogen has been largely removed as proposed in document (3) the nitrogen pressure promoting diffusion will be substantially reduced.

10. The fact that in practice the protective layer actually formed is of spinel rather than alumina does not invalidate the arguments on which the Board has based its decision. If the spinel layer is, in fact, produced its formation occurs independently of whether the skilled person expects it or not and no special conditions have to be met to ensure its formation, which simply arises in the course of use.

There is a certain conflict within the information supplied by the Appellant concerning this layer. Thus, page 1, lines 25-28 of the specification and the supporting priority document refer to formation of a protective layer of aluminium oxide. On the other hand, in Appendix 2 to the letter filed on 2 February 1984,the allegedly ineffective protective layer on DSD is shown to be of MgO. A12 03 (i.e. spinel). This rather suggests that the formation of a spinel is a recent discovery of the Appellant and not something the normal skilled person was aware of at the priority date, i.e. the time at which the Applicant himself still spoke of an alumina layer.

It is, of course, the state of knowledge at that date rather than the present state of knowledge on which consideration of inventive step has to be based.

ORDER

For these reasons,

it is decided that:

The appeal is dismissed.

The Registrar

J. Rückerl

The Chairman

O. Huber