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Bezeichnung der Erfindung: Metal Oxide Varistor
Title of invention:
Titre de l'invention :

Klassifikation / Classification / Classement : H01C 7/10

ENTSCHEIDUNG / DECISION

vom / of / du 19 September 1990

Anmelder / Applicant / Demandeur :

Patentinhaber / Proprietor of the patent /
Titulaire du brevet : Kabushiki Kaisha Toshiba

Einsprechender / Opponent / Opposant : Asea Brown Boveri AG

Stichwort / Headword / Référence :

EPÜ / EPC / CBE Article 56

Schlagwort / Keyword / Mot clé : "Problem-invention - no" -
"Inventive step - no" -
"Process steps in product-claims"

Leitsatz / Headnote / Sommaire

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Case Number : T 549/89 - 3.4.1

D E C I S I O N
of the Technical Board of Appeal
of 19 September 1990

Appellant : (Proprietor of the patent)	Kabushiki Kaisha Toshiba 72, Horikawa-cho Saiwai-ku Kawasaki-shi Kanagawa-ken 210 (JP)
Representative :	Lehn, Werner, Dipl.-Ing. Hoffmann, Eitle & Partner Patentanwälte Arabellastrasse 4 D-8000 München 81 (FRG)
Respondent : (Opponent)	Asea Brown Boveri AG Haslerstr. 16 Postfach CH-5401 Baden
Representative :	-
Decision under appeal :	Decision of the Opposition Division of the European Patent Office dated 4 August 1989 revoking European patent No. 70 468 pursuant to Article 102(1) EPC.

Composition of the Board :

Chairman : K. Lederer

Members : R. Shukla

L. Mancini

Summary of Facts and Submissions

I. European patent No. 70 468 was granted in respect of European patent application No. 82 106 123.1.

II. The Respondent filed an opposition requesting revocation of the patent on the grounds that its subject-matter was not patentable within the terms of Articles 52, 54 and 56 EPC having regard to the following prior art documents:

D1 - DE-A-2 834 461
D2 - DE-A-3 026 200
D3 - US-A-4 045 374
D4 - DE-A-2 642 567.

III. The Opposition division revoked the patent. The reason given was that the subject-matter of Claim 1 lacked inventive step in view of the prior art known from D1 to D3.

IV. The Patentee lodged an appeal and along with a written statement of grounds he also filed a Declaration made by one of the inventors, Motomasa Imai, which contains results of a comparative test carried out by him.

V. In his response, the Respondent argued that the subject-matter of Claim 1 did not involve an inventive step having regard to the prior art disclosed in D1 to D3.

VI. Oral proceedings were held, at the end of which the Appellant maintained his request to set aside the decision of the Opposition Division and maintain the patent as granted, whereas the Respondent requested that the Appeal be dismissed.

VII. The valid Claim 1 reads as follows:

"A metal oxide varistor which comprises; a sintered body containing a) ZnO as a principal component, and (b), as auxiliary components, Bi, Co and Mn in amounts of 0.05 to 2 mole %, 0.05 to 2 mole % and 0.05 to 2 mole %, when calculated in terms of Bi_2O_3, CO_2O_3 and MnO_2, respectively, and at least one selected from Al, In and Ga in amounts of 1×10^{-4} to 3×10^{-2} mole %, when calculated in terms of Al_2O_3, In_2O_3 and Ga_2O_3, respectively; said sintered body having been reheated at a temperature of 650 to 900°C after sintering; and a non-diffusable electrode provided on said sintered body after reheating of said sintered body."

Claims 2 to 8 are dependent claims.

VIII. The Appellant argued essentially as follows:

The present invention is clearly distinguished over the closest prior art disclosed in D1 in that a non-diffusible electrode is provided after reheating of the sintered varistor body, whereas in D1 the electrodes are applied after sintering but before the step of reheating. As apparent from the results of comparative tests described on page 7, lines 11 to 31 of the patent specification and in the Declaration, the specific sequence of steps according to the present invention results in improved voltage build-up ratio. Although in D2 the electrodes are applied after a heat treatment, the composition of the varistor is quite different from that of the present invention and there is no suggestion in D2 that this particular sequence of steps has any advantageous effects on the voltage build-up ratio. In D3, there is no teaching regarding the heat treatment. Thus, while one may derive individual features of the invention from the cited prior

art, an expert in the field had no incentive to combine these features. The decision T 2/83 supports the above line of argumentation.

IX. The Respondent argued in effect as follows:

The varistor composition according to the present invention differs from the one disclosed in D2 only in that it contains traces of at least one of Al_2O_3 , In_2O_3 and Ga_2O_3 . Since the known varistor is subjected to a heat treatment after sintering as in the present invention, it has improved non-linearity coefficient. In the field of varistor technology, it is generally known that the composition of the varistor plays a decisive role in its electrical properties and an expert concerned with improving electrical properties such as non-linearity and surge resistance would learn from D3 that the above properties are improved by incorporation of a small amount of at least one of Al_2O_3 , In_2O_3 and Ga_2O_3 and thus arrive at the claimed subject-matter in an obvious manner.

As regards the Declaration filed by the Appellant, the conditions under which the comparative sample No. 31 was tested were not clear since the aluminum electrode would melt and even be oxidised during the heat treatment carried out at a temperature of 700°C, a temperature well above the melting point of aluminum.

Reasons for the Decision

1. The appeal is admissible.

2. **Interpretation of Claim 1**

Although the wording of the claim relates to a varistor,

that is, a product, it also includes, besides product features, process steps of (i) reheating the sintered varistor body at a temperature of 650 to 900°C and (ii) providing an electrode after the step of reheating so that the electrode material does not diffuse in the sintered body. In the Board's opinion, in referring to process features in a product claim, protection is sought for observable technical effects which result from such process features and not for the process features per se so that novelty and inventive step are to be assessed having regard to these technical effects. Referring to the description on page 3, lines 13 to 26; page 4, lines 1 to 22 and Figures 1 and 2 of the patent specification, the Board is satisfied that the process feature (i) in combination with the claimed varistor composition improves pulse response, that is, voltage build-up ratio (R) as shown in Figures 1 to 5. As regards the process feature (ii), the Board agrees with the Respondent that the test conditions described in the Declaration, for the comparative sample 31 are not clear so that the results of the comparative test cannot be taken into consideration. Nonetheless, in the opinion of the Board, the results of the comparative test described on page 7, lines 11 to 31 of the patent specification clearly demonstrate that the process feature (ii) does not cause diffusion of the electrode material and thereby deterioration in voltage build-up ratio (R).

3. **Novelty**

3.1 In D1 there is described a zinc oxide based varistor comprising 95.7% ZnO, 0.5% of each of Bi_2O_3, CO_2O_3 and MnO_2 and 0.003% of aluminum nitrate (cf. page 8) and reference to page 13, last paragraph and Claims 7 and 8 makes it clear that the above composition is to be understood as expressed in mole percent. As pointed out by

the Respondent, and this was not disputed by the Appellant, since the above starting composition is sintered at a temperature of 1250°C, aluminum nitrate must have been converted to aluminum oxide in the final product.

After the step of sintering, the prior art varistor is subjected to a heat treatment between 480 and 880°C (see, in particular, Claim 1; the description on page 11 and Figure 2). As regards the application of the electrodes to the sintered body, whereas in the example described on page 8, lines 20 and 21 it is stated that electrodes 12 are applied after sintering, on page 10, lines 23 to 25 it is disclosed that heat treatment follows sintering so that in the Board's opinion, the sequence of steps following sintering is not clear. Also, the description on page 11 of D1, cited by the Appellant, does not lead to any other conclusion. The Appellant's submission that in D1 the electrodes are applied after sintering but before the heat treatment cannot, therefore, be followed. Nonetheless, it is admitted that D1 attaches no significance to the order in which the heat treatment and the application of electrodes are carried out and there is no disclosure that the electrodes are non-diffusible.

As discussed under paragraph 2 above, in the present invention the heat treatment between 650 and 900°C in combination with the inclusion of Al_2O_3 is responsible for improved pulse response as shown in Figures 1 to 3 of the patent specification, and the pulse response does not deteriorate on account of the fact that the electrode material does not diffuse in the varistor body. It follows, therefore, that although some of the embodiments in D1, which are heated above the lower limit of 650°C of the claimed temperature range, must have the same pulse response after the heat treatment as some of the embodiments of the claimed varistor, it is not clear that

in these prior art embodiments the pulse response has not deteriorated on account of the diffusion of the electrode material.

In view of the above, the varistor according to Claim 1 of the patent in suit differs from the varistor known from D1 in that (a) the ranges of the amounts of the varistor components are given, whereas in D1 only one varistor composition falling within the claimed range is disclosed and (b) the electrode material has not diffused in the varistor body to the detriment of the pulse response.

3.2 The varistor known from D2 does not include any of Al, Ga and In as an oxide.

3.3 The varistor compositions described in D3 fall within the composition ranges claimed in the present invention. However, the known compositions are not subjected to any heat treatment after sintering as in the present invention so that in D3 there is no disclosure that the known varistor has the pulse response obtained as a result of the heat treatment, of the invention (cf. curve 4 of Figure 1).

3.4 The varistor composition known from D4 does not include any of Al, Ga and In.

3.5 For the foregoing reasons, the varistor according to Claim 1 is not comprised in the state of the art and is new within the meaning of Article 54 EPC.

4. **Inventive Step**

4.1 In the opinion of the Board, the prior art coming closest to the invention is disclosed in D1. In relation to this prior art, the objective problem addressed by the present invention can be seen in providing a range of varistor

compositions which have a sufficiently high non-linearity and improved pulse response (see, for example, page 2, lines 42 to 44 of the patent specification).

Although D1 deals with the problem of leakage currents and does not mention the non-linear current-voltage characteristic of the varistor, from the disclosures in D2, D3 and D4 it is evident that the basic operation of a varistor relies on the non-linear voltage-current characteristic so that in D1 the expert would, as a matter of routine, be concerned with having sufficiently high non-linearity. Also, as acknowledged in the patent specification on page 2, lines 39 to 41, in the prior art attempts have been made to improve pulse response of varistors so that there is no inventive merit also in the formulation of this aspect of the above mentioned problem.

4.2 In the varistor technology, it is common general knowledge that electrical properties, such as non-linearity, are essentially determined by the type and the amount of additives employed so that the skilled person would carry out routine experiments to find out optimum amounts of the varistor components disclosed in D1. As a result, the distinguishing feature (a) [see 3.1, last paragraph] of the invention must be regarded as lying within the competence of the skilled man.

As mentioned earlier under 3.1, there is no clear teaching in D1 regarding the application of electrodes so that the skilled person would turn to the other prior art documents to fill this gap in the teaching of D1 and would learn from the disclosure in D2 that electrodes can be formed by spray metallisation of aluminum after thermal treatment of a ZnO based varistor containing Bi_2O_3, CO_2O_3 and MnO_2.

The Board is also of the view that not only in the field of varistors but electrical devices in general, electrodes are usually applied, with the exception of any final passivation of the device, at the end of the manufacturing process. Thus, not only the skilled person had only two options, that is, providing the electrodes before or after the heat treatment, before he could test the varistor for non-linearity and pulse response and such testing forming part of his normal activity, but of the two options the one employed in the present invention was the one commonly employed so that the skilled person would, as a matter of routine, consider applying the electrode after the heat treatment. Also within his normal activity of testing he would establish that the pulse response does not deteriorate when the electrodes are applied after the heat treatment.

The Board, therefore, considers that there is no inventive step in applying the electrode after the heat treatment, that is, in using a non-diffusible electrode (see feature (b) at the very end of 3.1).

4.3 The Appellant has stressed that in the prior art there is no teaching that the electrodes should be applied after the heat treatment with a view to preventing deterioration in the pulse response and has submitted that following the decision T 2/83 (published OJ EPO 1984, 265), an inventive step is to be seen in the discovery of an unrecognised problem in spite of the fact that the claimed solution was retrospectively trivial.

In this respect, the Board would like to point out that the situation was quite different in the cited case. Whereas in that case the claimed invention went against a general trend in the art (cf. point 4 of the reasons), which was to avoid barriers in tablets, in the present case the alleged invention just does all that is generally

done when applying electrodes to the body of an electronic component. Moreover, the above decision also refers to circumstances under which an unforeseen effect should not be considered as decisive for patentability, and cites the decision T 21/81 (published OJ EPO 1983, 15). The Board considers that the findings of this latter decision are indeed applicable in the present case where a measure is not only known but is commonly employed in the art in general so that it would be obvious in itself despite the fact that it produces an unexpected effect.

4.4 The Board, therefore, comes to the conclusion that the subject-matter of the present Claim 1 does not involve an inventive step (Articles 52(1) and 56 EPC).

4.5 Claims 2 to 8 are not allowable in view of their dependence on Claim 1.

Order

For these reasons, it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

P. Martorana K. Lederer