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D E C I S I O N
of 23 October 2001

Case Number: T 0174/97 - 3.4.1

Application Number: 88118868.4

Publication Number: 0316015

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Language of the proceedings: EN

Title of invention:
Material for resistor body and non-linear resistor made thereof

Patentee:
MEIDENSHA KABUSHIKI KAISHA

Opponent:
ABB (Schweiz) AG

Headword:
-

Relevant legal provisions:
EPC Art. 56, 123(2)

Keyword:
"Inventive step - no (main request and second auxiliary request)"
"Added subject-matter - yes (first auxiliary request)"

Decisions cited:
G 0009/92, T 0219/93, T 0198/84, T 0279/89

Catchword:
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Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 0174/97 - 3.4.1

D E C I S I O N
of the Technical Board of Appeal 3.4.1
of 23 October 2001

Appellant: (Proprietor of the patent)
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Decision under appeal: **Decision of the Opposition Division of the European Patent Office posted 3 December 1996 revoking European patent No. 0 316 015 pursuant to Article 102(1) EPC.**

Composition of the Board:

Chairman: G. Davies
Members: M. G. L. Rognoni
U. G. O. Himmler

Summary of Facts and Submissions

I. The appellant (patentee) lodged an appeal, received on 12 February 1997, against the decision of the opposition division, despatched on 3 December 1996, revoking the European patent No. 316 015. The fee for the appeal was paid on 12 February 1997 and the statement setting out the grounds of appeal was received on 14 April 1997.

II. The opposition had been filed against the patent as a whole, based on Article 100(a) EPC.

III. In the decision under appeal, the opposition division held, *inter alia*, that a non- linear resistor as specified in claim 6 of the granted patent did not involve an inventive step.

As to the process claim 1, the opposition division concluded that it was not necessary to consider the arguments presented by the opponent against the patentability of this claim, since the rejection of the patent was based on the lack of inventive step of the device claim 6 which had to be regarded as an independent claim despite its formal dependence on claim 1.

IV. The contested decision referred, *inter alia*, to the following documents:

D1: Kingery, W. D. *et al.* "Introductions to Ceramics", second edition, John Wiley & Sons, Inc. (1976), pages 429, 455, 475, 497, 787 to 794, 809 and 811;

D3: E. Sonder *et al.* "ZnO Varistors Made From Powders Produced Using a Urea Process", Ceramic Bulletin, Vol. 65, No.4 (1986), pages 665 to 668;

D4: M. Imataki *et al.* "Advanced Metal Oxide Surge Arrestor For Gas Insulated Switchgear (GIS)", IEEE Transactions on Power Apparatus and Systems, Vol. PAS-103, No. 10, October 1984, pages 2990 to 2998;

D5: US-A-4 180 483;

D6: EP-A-0 097 923;

D7: EP-A-0 241 150.

V. In a communication accompanying a summons to oral proceedings, which both the appellant and the respondent (opponent) had requested, the Board drew the parties' attention, *inter alia*, to the fact that the subject-matter of claim 1 of the patent as granted did not appear to be supported by the application as originally filed and, in conformity with the decisions G 9/91 and G 10/91 (OJ 1993, 408) of the Enlarged Board of Appeal, asked the appellant whether they wished this point to be considered at this stage of the procedure.

VI. By a letter dated 24 September 2001, the appellant's representative informed the Board that the appellant did not consent to the question of Article 123(2) EPC being discussed. Furthermore, the representative submitted that the appellant would not be represented at the oral proceedings, requested that the proceedings be continued in writing and filed two sets of claims by way of auxiliary requests.

VII. Considering the circumstances of the case and the fact that the respondent had not reacted to the appellant's request to continue the appeal procedure in writing, the Board decided to hold oral proceedings as scheduled on 23 October 2001 in the absence of the appellant.

VIII. The appellant requested in writing that the decision of the opposition division be set aside and the patent be maintained on the basis of the following documents:

Main request:
Claims 1 to 13 as granted,
Description and Figures as granted;

First auxiliary request:
Claims 1 to 11 filed with the letter dated 24 September 2001,
Description: revised pages 2 to 5 filed with the letter dated 24 September 2001, with the insert to page 2, lines 40/41, filed with a letter dated 27 September 2001;
Figures as granted.

Second auxiliary request:
Claims 1 to 5 filed with the letter dated 24 September 2001,
Description: pages 2 to 5 filed with the letter dated 24 September 2001, with the insert to page 2, lines 40/41, filed with a letter dated 27 September 2001;
Figures as granted.

The respondent requested that the appeal be dismissed.

IX. **Main request**

The wording of claim 1 according to the **main request** reads as follows:

"1. A process for producing and non-linear resistor comprising the steps of:
preparing composite material by mixing the following components:

Bi_2O_3	0.25 to 1.0 mol%
Sb_2O_3	0.5 to 2.0 mol%
Co_2O_3	0.25 to 1.0 mol%
MnO_2	0.25 to 1.0 mol%
Cr_2O_3	0.1 to 1.0 mol%
NiO_2	0.1 to 1.0 mol%
SiO_2	0.25 to 2.0 mol%, and
ZnO	remainder for 100 mol%

forming the composite material into a desired configuration to form a shaped body;
characterised by
performing firing of said shaped body at a controlled firing temperature, which firing temperature is adjusted to a temperature in the range 1050 to 1100 °C to adjust average particle size of a ZnO crystal growing during the firing process within a range of 7 µm to 9 µm."

The wording of claim 6 according to the **main request** reads as follows:

"6. A non-linear resistor manufactured in accordance with any one of the preceding claims which includes a resistor body formed with a composite material composed of:

Bi_2O_3 0.25 to 1.0 mol%
Sb_2O_3 0.5 to 2.0 mol%
Co_2O_3 0.25 to 1.0 mol%
MnO_2 0.25 to 1.0 mol%
Cr_2O_3 0.1 to 1.0 mol%
NiO_2 0.1 to 1.0 mol%
SiO_2 0.25 to 2.0 mol%, and
ZnO remainder for 100 mol%

characterised in that
said resistor includes a ZnO crystal component, an average particle size of which is adjusted within the range of 7 µm to 9 µm."

Claims 2 to 5 and claims 7 to 13 are dependent on claim 1 and claim 6 , respectively.

First auxiliary request

Claims 1 to 5 according to the **first auxiliary request** correspond to claims 1 to 5 of the main request.

Claim 6 according to the **first auxiliary request** reads as follows:

"6. A non-linear resistor manufactured in accordance with any one of the preceding claims which includes a resistor body formed with a composite material composed of:

Bi_2O_3 0.25 to 1.0 mol%
Sb_2O_3 0.5 to 2.0 mol%
Co_2O_3 0.25 to 1.0 mol%
MnO_2 0.25 to 1.0 mol%
Cr_2O_3 0.1 to 1.0 mol%

NiO_2 0.1 to 1.0 mol%
SiO_2 0.25 to 2.0 mol%, and
ZnO remainder for 100 mol%

characterised in that
said resistor includes a ZnO crystal component, an average particle size of which is adjusted within the range of 7 µm to 9 µm, has a compression strength equal to or higher than 70 kgf/mm^2 and has energy absorption capacity ratio equal to or higher than 1.00."

Claims 7 to 11 are dependent on claim 6.

Second auxiliary request

Claims 1 to 5 according to the **second auxiliary request** correspond to claims 1 to 5 of the granted patent.

X. The appellant's arguments can be summarised as follows:

The opposition division had no objections against claim 1 of the contested patent but found that the subject-matter of claim 6 lacked an inventive step, in particular, because the distinguishing feature of this claim, i.e. an average particle size of the ZnO crystal within the range of 7 µm to 9 µm, did not produce any surprising results and was known from the prior art. However, the conclusion reached by the opposition division, to the effect that claim 6 did not involve the special sintering temperature specified in claim 1, was erroneous, because the statement in claim 1, that firing of the shaped body was performed at a controlled firing temperature, was an explicit feature of the non-linear resistor of claim 6, in the sense that only a resistor made by firing a shaped body at a controlled

firing temperature adjusted to a temperature in the range of 1050°C to 1100°C could infringe claim 6. Hence, this claim met the requirements of patentability in the same way as the process claim 1.

In reaching its decision to revoke the European patent, the opposition division took the view that it had to take a decision on the claims as a whole and that it had to revoke the patent in its entirety, since it did not consider claim 6 to be allowable. However, as the revocation was merely based on the lack of inventive step of claim 6, the decision of the opposition division should be construed as the intent to maintain the patent in amended form, i.e. on the basis of claims 1 to 5. Actually, if the opposition division had clearly pointed out, before taking a decision that its objections were based on claim 6 only, because it did not consider this claim to involve the temperature step of claim 1, the patentee would have filed an auxiliary request seeking maintenance of the patent on the basis of claims 1 to 5 only. As the opponent did not file an appeal against the "effective decision" of the opposition division to allow claims 1 to 5, the decision G 9/92 of the Enlarged Board of Appeal should be followed in the present case and, consequently, the patentability of claims 1 to 5 should no longer be questioned.

The object of the present patent was to provide a material and a process for producing a non-linear resistor which exhibited not only excellent voltage/current characteristics, but also mechanical characteristics, and to provide a non-linear resistor which had satisfactory voltage absorbing ability and sufficiently high mechanical strength. This object was

satisfied essentially by selecting a composition within the claimed range of compositions and by firing a shaped body made of a material of this composition at a controlled firing temperature in the range of 1050°C to 1100°C with the specific aim of obtaining average particle sizes within the range of 7 µm to 9 µm.

Document D6 showed compositions involving MnO and NiO rather than MnO_2 and NiO_2 as claimed in the contested patent. Thus, the composition of the present invention had different oxygen quantities. Since the oxygen content affected the characteristics of non -linear resistor bodies, the resistor of the invention and the resistor known from D6 could not have the same characteristics. Furthermore, D6 was concerned with sintering temperatures in the range of 1100°C to 1350°C and did not mention grain sizes. Accordingly, D6 did not recognise the benefit which could be obtained by sintering in the claimed temperature range and by achieving the claimed grain size, and, in fact, this document was merely concerned with the problem of producing a varistor with a uniform structure.

D4 stated that the performance of MOA (metal oxide surge arrestors) mainly depended on the characteristics of the ZnO elements and was not relevant in the present case because it drew the reader's attention to such elements and away from other considerations.

A combination of D6 with any one of the cited references did not permit a person skilled in the art to reach the important features of the claimed invention and, thus, achieve a non-linear resistor according to claim 6 which showed not only good mechanical characteristics but also excellent

voltage/current characteristics.

Claim 6 of the first auxiliary request comprised a combination of originally granted claims and, therefore, this claim should not give rise to any objection under Article 123 EPC.

The second auxiliary request comprised solely the process claims 1 to 5 as granted which had been considered allowable by the opposition division.

XI. The respondent argued essentially as follows:

D6 represented the closest prior art because it showed compositions equivalent to the ones specified in the present patent. In fact, the only differences between the compositions disclosed in D6 and the ones covered by the present patent concerned nickel (Ni) and manganese (Mn) oxides. According to the general knowledge of the skilled person, NiO_2 represented only a theoretical possibility because it was not stable at high temperatures. The correct form of oxide would be NiO, as shown in the examples of the patent specification. As to MnO_2, this oxide was equivalent to MnO because after treatment of the resistor body at the sintering temperatures the same final product resulted from MnO_2 and MnO.

It was generally known in the art that the electrical properties of a non-linear resistor depended on the average size of the ZnO grains. Hence, it was obvious to the skilled person to choose the average grain size according to the electrical characteristics to be achieved. As to the mechanical characteristics, it was known that the mechanical stability of ceramic bodies

depended on the porosity of the material, in the sense that lower porosity (i.e. larger grains) contributed to mechanical stability. However, it was also known that there was a further competing effect which caused the mechanical stability to diminish with increasing grain sizes. It was obvious to a person skilled in the art that the combination of these known effects would produce a maximum of mechanical stability within a certain range of average particle sizes.

As to the first auxiliary request, the combination of features specified in claim 6 was not admissible under Article 123(2) EPC because it was not disclosed in the application as originally filed.

As to the process claim 1 according to the second auxiliary request, the combination of the claimed temperature and grain size ranges did not have any surprising effect. In fact, the claimed temperature range simply covered the temperatures required by the compositions and sintering time (between 10 and 20 hours) specified in Examples 1 and 2 of the contested patent in order to obtain the claimed range of grain sizes.

Reasons for the Decision

1. The appeal is admissible.

Relevance of G 9/92

2.1 In the appellant's view, the decision of the opposition division to base the revocation of the patent on

objections against the device claim 6 implied an "effective decision" to maintain the patent on the basis of the process claims 1 to 5. Thus, G 9/92 (OJ 1994, 875) should be applied in the present case, and, consequently, the patentability of claims 1 to 5 should no longer be questioned.

2.2 According to the decision G 9/92 of the Enlarged Board of Appeal, neither the board of appeal nor a non-appealing opponent may challenge the maintenance of the patent as amended in accordance with the interlocutory decision of the opposition division. In the present case, the respondent had filed an opposition against the patent **as a whole** and submitted arguments against **all** claims. Though the opposition division observed in the contested decision that the arguments presented by the opponent with respect to the sintering temperature included in claim 1 "need not be gone into further, since the rejection of the patent is based on independent device claim 6" (point 9.4 of the contested decision), there can be no doubt as to the conclusions reached by the opposition division to allow the request of the opponent (respondent) and revoke the patent in its entirety.

2.3 Hence, G 9/92 has no relevance in the present case and the respondent is entitled to argue against the patent as a whole.

Main request

3.1 The claims of the main request, which correspond to the claims of the patent as granted, comprise an independent **process** claim 1 and a **product** claim 6 containing a reference to the manufacturing process

specified in any of preceding claims 1 to 5.

3.2 According to the case law of the Boards of Appeal, claims for products defined as having been made by a particular process are only allowable if the products as such satisfy the requirements of patentability, i.e. only if they are novel and inventive. In particular, according to the decision T 219/93 (not published), product-by-process claims have to be interpreted in an absolute sense, i.e. independently of the process. If their subject-matter as such is new, they still do not involve an inventive step merely because the process for their preparation does so. In order to be patentable, a claim to a product as such has to be a solution to a separate technical problem which is not obvious in the light of the state of the art.

3.3 Therefore, the opposition division was correct in considering claim 6 as an independent device claim which had to comply, *inter alia*, with the requirements of Articles 52 to 56 EPC in order to be allowable.

4. The novelty of the process according to claim 1 or of the non-linear resistor according to claim 6 is not in dispute.

5.1 Document D6, which was considered as the closest prior art by the opposition division, relates to a non-linear resistor which includes a resistor body formed with a composite material composed mainly of ZnO and of oxides of antimony (Sb), bismuth (Bi), cobalt (Co), manganese (Mn), chromium (Cr), nickel (Ni) and silicon (Si), in particular Bi_2O_3, Co_2O_3, MnO, Sb_2O_3, NiO, Cr_2O_3 and SiO_2. Several examples shown in Table 1 (page 9) comprise percentages of such oxides which fall within the ranges

specified in claim 6 of the main request.

5.2 The subject-matter of claim 6 differs from the non-linear resistors disclosed in D6 essentially in that:

(a) it is manufactured according to the process specified in claims 1 to 5;

(b) it comprises NiO_2 and MnO_2 instead of NiO and MnO;

(c) the average particle size of a zinc oxide crystal component is adjusted within the range of 7 µm to 9 µm.

5.3 As to (a), it is observed that according to the case law of the boards of appeal (cf. T 205/83 (OJ 1985, 363)), if novelty of a product could not be defined by structural characteristics but only by its method of manufacture, novelty could be established only if evidence was provided that modification of the process parameters resulted in other products. In the present case, the characteristics of the resistor of the invention are defined essentially as a function of the **average particle size** of ZnO crystal (cf. Figures 8 to 10 of the patent specification) and the sintering temperature range specified in the process claims appears to be merely dictated by the requirement to obtain resistor bodies falling within the claimed range of average particle sizes when the sintering process is carried out for the sintering time referred to in the description. Since there is no evidence in the contested patent that the choice of the particular sintering temperatures specified in the process claims might further influence the properties of a non-linear resistor and thus distinguish the resistors of the

invention from products which have the same average particle sizes but are obtained by means of different sintering temperatures and times, the reference to the process claims in the product claim has no limiting effect on the subject-matter covered by the latter.

5.4 As to (b), the respondent has essentially argued that the reference to NiO_2 in claim 6 of the contested patent cannot be correct because it is known in the art that only NiO is stable and finds practical application (cf. Holleman-Wiberg, "Lehrbuch der Anorganischen Chemie", 81.-90. edition, Walter de Gruyter, Berlin-New York 1976, pages 942 and 943). The respondent's submissions appear to be confirmed by the examples given in the description of the patent as granted (and of the application as originally filed) which refer only to NiO (cf. published patent specification: page 4, line 27, table and line 47; page 5, line 11).

Furthermore, the respondent has argued that MnO and MnO_2 are equivalent as starting components for a non-linear resistor because the end product after the heat treatment would be the same. The fact that MnO and MnO_2 can be considered interchangeable for the preparation of sintered resistor bodies appears to be supported by D7, which discloses non-linear resistors comprising the oxides of Bi, Co, Sb, Cr, Si and Zn recited in claim 6 together with NiO an MnO_2 (D7, page 5, Table 1(a)). A further example of the use of MnO_2 instead of MnO for the preparation of non-linear resistor bodies is given in D5 (column 5, Table 2).

Hence, the Board shares the respondent's view that the skilled person would be aware of the possibility of replacing MnO with MnO_2 in the composite material for

the non-linear resistor body known from D6, and that, therefore, this difference between the present invention and the closest prior art does not contribute to the inventive step of the claimed subject-matter.

5.5 As to feature (c), D6 does not disclose any specific average particle size for the ZnO crystal. With regard to the structure of the sintered resistor bodies, this document teaches that "the zinc oxide which is the main component usually constitutes the component of relatively large grain bodies as much as several micrometers to several tens of micrometers, and metallic oxide which is the additive component constitutes the component of thin grain boundary layers which interpose among contact surfaces of the zinc oxide grain bodies in the state of wrapping them" (page 2, second paragraph).

6.1 Hence, starting from document D6, the problem addressed in the present patent could be defined as determining the appropriate average particle size for the zinc oxide crystal component.

6.2 According to the respondent, it is generally known in the art that the average grain size of ZnO affects the voltage-current characteristics of a non-linear resistor and that, therefore, the choice of the appropriate grain size is primarily dictated by the electrical characteristics to be achieved.

6.3 The respondent's argument and the fact that the claimed range of average particle sizes covers values which are typical for a non-linear resistor find support in D3 which shows samples having average grain sizes ranging from 1.4 µm to 9.3 µm, and teaches that the breakdown

voltage **decreases** with **increasing** sintering temperature, i.e. with increasing grain sizes.

6.4 The link between electrical characteristics and grain sizes is further confirmed in D5 which relates to a method for forming ZnO containing ceramic bodies with non-linear electrical characteristics. According to this document, the "major advantage of the present process is the ability to closely control the grain size and diffusion during annealing. Similarly, as non-linear electrical characteristics appear only after annealing, the value of á and C can be tailored to the requirements of the device when adjusting the annealing temperature and time to control the grain size and diffusion distance", whereby á is the coefficient of non-linearity and C is the non-linear resistance (column 5, lines 2 to 7).

As shown in D5 (cf. Table 1), a ceramic including 80% ZnO and 20% mixed oxide glass according to Table 2 shows non-linear behaviour starting from an average grain size of 5.9 µm. The samples referred to in this document have an average grain size ranging from 5.9 to 10.6 µm, whereby with increasing grain size the non-linear coefficient increases whereas the non-linear resistance decreases.

6.5 The electrical properties of metal oxide surge arrestors based on ZnO elements is further investigated in document D4. As acknowledged by the appellant (cf. letter dated 24 September 2001, page 6), Figures 2(a) and 2(b) of this document compare the voltage gradient ratio ç with the microstructure of the ZnO crystal. These figures indicate values of 1.05 and 2 for this parameter. Figure 4 of D4 shows the relationship

between energy absorption capability per unit volume and voltage gradient ratio ç. From Figure 2 it can be concluded that the grain size is 10 µm, when ç is 1.05, and 5 µm, when ç is 2.0, whereas, according to Figure 4 the energy absorption capability is around 1.0 for values of ç between 1.05 and 2.0. In other words, the samples considered in D4 have similar energy absorption capability as the resistors according to the present invention when the average particle size ranges from 5 µm to 10 µm.

7.1 According to the appellant, however, the contested patent shows that the range of grain sizes from 7 µm to 9 µm provides the unexpected result of ensuring not only excellent voltage/current characteristics but also improved mechanical characteristics. The recognition of the benefit which can be achieved with the claimed range would thus justify the presence of a "selection invention".

7.2 According to the established case law of the boards of appeal (cf. T 198/84 (OJ 1985, 209) and T 279/89), a selection of a sub-range of numerical values from a broader range is new when **each** of the following criteria is satisfied:

(a) the selected sub-range should be narrow;

(b) the selected sub-range should be sufficiently far removed from the preferred part of the known range (as illustrated for instance in the examples given in the prior art);

(c) the selected sub-range should not be an arbitrarily chosen specimen from the prior art, i.e. not merely one way of carrying out the prior art teaching, but must provide a new invention (purposive selection).

7.3 As it appears from the teaching of D3, D4 and D5, the claimed range of 7 µm to 9 µm does not meet the criteria (a) and (b) because it cannot be regarded as narrow with respect to the ranges disclosed in these documents and, moreover, it covers some of their typical values. This should suffice to arrive at the conclusion that the claimed range cannot be considered as new.

7.4 As to the "special effect" of improved mechanical properties which can be obtained with an average particle size between 7 µm and 9 µm, the patent specification shows that the compression strength of two specimens of non-linear resistors according to the present invention reaches a maximum within the claimed range of average particle sizes.

In the opinion of the Board, this effect would be easily recognized by the skilled person carrying out routine measurements on non-linear resistors within the typical range of 5 µm to 10 µm. Moreover, it could also be expected since it is generally known that the mechanical stability of a ceramic body is the result of two competing effects (i.e. porosity and surface cracks) which are dependent on the average grain size (cf. D1).

8.1 In summary, the Board finds that the range of average particle sizes specified in claim 6 cannot be

considered new with respect to the ranges known from the prior art (e.g. D4), and that it would have been obvious to a skilled person starting from D6 to develop a non-linear resistor with average particle sizes within known ranges. In doing so, the skilled person would have arrived at a resistor falling within the terms of claim 6 without the exercise of any inventive skills.

8.2 Hence, the subject-matter of claim 6 of the main request does not involve an inventive step within the meaning of Article 56 EPC.

First auxiliarily request

9.1 Claim 6 of the first auxiliary request is based on claims 6, 8 and 9 of the patent as granted. In the application as originally filed, the values of compression strength and energy absorption capacity ratio which are now associated with a range of average particle sizes of 7 µm to 9 µm are defined in connection with a range of 5 µm to 10 µm. In particular, in the application as originally filed independent claim 3 defines a range of average particle sizes of 5 µm to 10 µm, and dependent claims 4 and 5 specify a compression strength "approximately and higher than 70 kgf/mm^2 and an energy absorption capacity ratio "approximately or higher than 1.00", respectively. On the other hand, claim 9, dependent on claim 3, recites a range of 7 µm to 9 µm, whereas claims 10 and 11, dependent on claim 9 specify a compression strength "approximately and higher than 80 kgf/mm^2 and an energy absorption capacity ratio "approximately or higher than 1.10", respectively.

Furthermore, claim 6 covers the possibility of achieving a compression ratio "equal" to 70 kgf/mm^2 and an energy absorption capacity ratio "equal" to 1.00 within the range of average particle sizes of 7 µm to 9 µm, though this is in contradiction with the data shown in Figures 8 and 9 of the patent specification.

9.2 As claim 6 contains subject-matter which extends beyond the content of the application as originally filed, the first auxiliary request in not admissible under Article 123(2) EPC.

Second auxiliary request

10.1 As pointed out above in connection with the main request, the Board considers that it does not involve an inventive step to arrive at a non-linear resistor comprising a shaped body made of a material selected within the claimed range of compositions and having an average particle size falling within the claimed range.

Similarly, a process consisting in mixing the claimed components, forming the resulting composite material into a shaped resistor body and adjusting the average particle size of ZnO growing during the firing process within a range of 7 µm to 9 µm cannot be regarded as inventive.

Claim 1 according to the second auxiliary request, however, specifies a process for producing a non-linear resistor which links the firing temperature range with the range of average particle sizes of the ZnO crystal growing during the firing process.

Hence, the essential question to be considered now is

whether the particular selection of a sintering temperature and an average particle size falling within the claimed ranges involves any inventive activity on the part of the skilled person.

10.2 According to the appellant, the prior art does not recognise the benefit of selecting a composition within the claimed range of compositions and of firing a shaped body made from such a composition at a firing temperature in the range of 1050°C to 1100°C with the specific aim of obtaining average particle sizes within the range of 7 µm to 9 µm. In fact, in the appellant's view, the particular combination of temperature range and average particle size range specified in the process claim 1 has an effect on the electrical and mechanical characteristics of the non-linear resistor which could not be expected by the person skilled in the art. Such "special effect" would justify the presence of a selection invention.

10.3 Document D6 relates to a process for producing a non-linear resistor comprising the step of firing the shaped resistor body at a temperature in the range of 1100°C to 1350°C. According to a specific embodiment (page 8, lines 16 to 18), the composite body was "sintered at 1300 °C for 2 hours".

D3 refers to three ZnO varistors produced by sintering at 1100°C or 1200°C for 45 minutes, the resulting average grain size being 5.1 µm and 9.3 µm, respectively (cf. D3, page 665, left-hand column, lines 1 and 2, and page 667, Table II). Furthermore, it is pointed out in D3 that higher temperatures result in larger grain sizes "as it might be expected" (page 666, right-hand column, second paragraph).

According to D5, the annealing step in a process for producing non-linear resistors "comprises heating in the absence of pressure to a temperature suitably in the range of 1000°C to 1300°C for a time on the order of 1 to 2 hours", and, furthermore, "as non-linear electrical characteristics appear only after annealing, the value of á and C can be tailored to the requirements of the device when adjusting the annealing temperature and time to control the grain size and diffusion distance" (D5, column 4, line 68 to column 5, line 8). The specific samples listed in Table I have grain sizes of 5.9 µm, 7.3 µm, 8.6 µm and 10.6 µm, and are obtained by annealing for one hour at temperatures of 1150°C, 1200°C, 250°C and 1300°C, respectively.

In D7 sintering is carried out "preferably at 1150 - 1250 °C" for 2 to 7 hours (page 4, line 30).

10.4 Hence, the general teaching of the prior art concerning the sintering step in a process for producing non-linear resistors can be summarized as follows:

- typical sintering temperatures range from 1000°C to 1300°C;

- the average grain size is a function of **both** sintering temperature and time;

- the electrical characteristics of the sintered body depend on the average grain size and can be controlled by adjusting both sintering temperature and sintering time.

10.5 The non-linear resistors according to "Example 1" and "Example 2" of the contested patent were produced by

firing at a temperature in a range of 1050°C to 1250°C for ten to twenty hours (published patent: page 4, lines 51 and 52; page 5, lines 11 to 12). Figure 7 shows the linear dependance of the average grain size on the firing temperature **and** on the composition of the resistor body.

The compression strength of samples produced "by varying the firing temperature and thereby varying the average particle size of ZnO crystal" is shown in Figure 8 as a function of the average particle size (cf. patent as published: page 5, lines 24 to 26).

Similarly, the dependance of the energy absorption ratio as a function of grain size is shown in Figure 9.

10.6 In summary, the contested patent teaches that:

- for a particular composition and a given firing time the average particle size of ZnO crystal is a function of the firing temperature;

- the mechanical and electrical properties are a function of average particle size;

- by adjusting the firing temperature, and consequently the average particle size, it is possible to control the mechanical and electrical properties of a non-linear resistor;

- by appropriately selecting the average particle size it is possible to maximize some electrical and mechanical characteristics of the resistor.

10.7 As to the selection of the firing temperature, the

teaching of the contested patent does not go beyond what is already known from the prior art. In particular, as the mechanical and electrical properties of the non-linear resistors according to the present invention are merely presented as functions of the average particle size and not attributable to particular firing temperatures (cf. point 5.3 above), the patent specification does not disclose or imply any additional effect that may be achieved by growing ZnO crystal grains under the disclosed firing conditions (i.e. at lower temperatures for longer firing times).

10.8 In the absence of any documented effect, beyond the growth of ZnO crystal of certain sizes, produced by the claimed temperatures on the structure or characteristics of a non-linear ZnO resistor, the combination of firing temperatures falling within the claimed range and of firing times within the range indicated in the examples of the contested patent has to be regarded as one of the possible options available to the skilled person wishing to obtain a non-linear resistor with an average particle size within the claimed range.

10.9 Since the combination of the process steps specified in claim 1 of the second auxiliary request appears obvious in the light of D6 and of the skilled person's general knowledge, the subject-matter of this claim does not involve an inventive step within the meaning of Article 56 EPC.

11. In summary, the Board finds that none of the appellant's requests is allowable and that, therefore, there is no basis for the maintenance of the patent.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

R. Schumacher G. Davies