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File Number: T 350/90 - 3.2.4
Application No.: 86 302 148.1
Publication No.: 0 197 694
Title of invention: A metal-ceramic combination

Classification: F01D 5/28

DECISION
of 30 April 1993

Applicant: NGK INSULATORS, LTD.

Headword:

EPC Article 56

Keyword: "Inventive step (yes)"



Case Number : T 350/90 - 3.2.4

D E C I S I O N
of the Technical Board of Appeal 3.2.4
of 30 April 1993

Appellant : NGK INSULATORS, LTD.
2-56, Suda-cho, Mizuho-ku
Nagoya-shi, Aichi 467 (JP)

Representative : Paget, Hugh Charles Edward
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Decision under appeal : Decision of the Examining Division of the
European Patent Office dated 19 September 1989
and dispatched on 14 December 1989 refusing
European patent application No. 86 302 148.1
pursuant to Article 97(1) EPC.

Composition of the Board :

Chairman : C.A.J. Andries
Members : P. Petti
M.V.E. Lewenton

Summary of Facts and Submissions

- I. European patent application No. 86 302 148.1, filed on 24 March 1986, was refused by a decision of Examining Division 2.3.01.100 given at the end of the oral proceedings on 19 September 1989, the reasons for the decision being dispatched on 14 December 1989.
- II. The reason for the refusal was that the subject-matter of independent Claim 1 according to the main request as well as that of the independent claims according to auxiliary requests I to III lacked an inventive step having regard to documents
- D1: M.T.Z. Motortechnische Zeitschrift, Vol. 44, 1983/6, pages 225 to 229
D2: DE-A-2 845 716
- and to the common general knowledge of the skilled person.
- III. On 23 February 1990 a notice of appeal was filed by a facsimile copy and the prescribed fee was paid. A written statement setting out the grounds of appeal was filed by a facsimile copy on 20 April 1990. The Appellant submitted with the Statement of Grounds a main request and two auxiliary requests.
- IV. In response to communications of the Board the Appellant filed with his letters of 20 July 1992 and 28 October 1992 amendments concerning the main request. He requested the grant of a patent on the basis of Claim 1 and pages 3, 13 and 14 of the description filed with his letter dated 28 October 1992, together with Claims 2 to 8, pages 1, 2, 4 to 12, 15 to 18 of the description and two sheets of

drawings containing Figures 1 to 4 as filed with the letter of 20 July 1992.

Minor amendments to these documents concerning Claims 2 to 8 and pages 3 and 7 of the description were agreed in a telephone conversation between the Representative and the Rapporteur of the Board on 4 March 1993.

V. Independent Claim 1 of the main request is worded as follows:

"Use as an engine part of a metal-ceramic combination wherein a monobloc ceramic member comprising a base portion (1), a cylindrical protrusion (4) extending from the base and an easement portion having its cross-sectional area gradually increasing towards the base (1) formed on and around the root of the protrusion (4) is combined with a rigid metallic member (2) by fixing the said protrusion (4) in a cylindrical recess or bore of the metallic member, characterized in that the fixing is by force fitting, there is a clearance (L_1) of 0.5 mm or more between the edge (5) of the joint interface and the beginning point (6) of the easement, and the metallic member has at its end facing towards the ceramic member a cylindrical outer surface and a reverse tapered inner surface (16)."

Reasons for the Decision

1. Admissibility of the appeal

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

2. Allowability of amendments (main request)

2.1 The present Claim 1, which is directed to the "use as engine part of a metal-ceramic combination", combines all the features of Claim 1 as originally filed, which was directed to "a metal-ceramic combination", with the following features:

- (a) the protrusion (4) is "cylindrical";
- (b) the metallic member (2) is "rigid";
- (c) the recess or bore of the metallic member is "cylindrical";
- (d) the protrusion is fixed in the recess or bore "by force fitting";
- (e) "the metallic member has at its end facing towards the ceramic member a cylindrical outer surface and a reverse tapered inner surface".

2.2 The change of category of the claim ("Use as an engine part") can be derived from the original Figures 5 to 7 and from the original Claims 4, 7 and 8 which relate to engine parts using the metal-ceramic combination. Moreover, several passages of the original description (page 1, lines 14 to 19; page 1, line 20 to page 2, line 15; and page 21, line 23 to page 22, line 5) clearly refer to "engine parts".

Features (a) and (c) can be derived from the original drawings (Figures 2 and 7) and from the original description (page 7, lines 16 to 23) in so far as it refers to the outside diameter of the protrusion and to the inside diameter of the recess.

Feature (b) can be derived from the original description (page 19, line 26 to page 20, line 2), in so far as it refers to a metallic member made of aluminium-chrome-molybdenum steel having a diameter of 13 mm.

Feature (d) can be derived from the original description (page 6, line 25 to page 7, line 1; page 7, lines 10 to 16; page 19, lines 18 to 20 and page 20, lines 3 to 5).

Feature (e) can be derived from the original drawings (Figure 2) in combination with the original description (page 11, lines 22 to 28).

- 2.3 Apart from the change of category of the claims, the technical features recited in dependent Claims 2 to 8 are the same as in the corresponding original claims.
- 2.4 The amendments of the description essentially concern its adaptation to the new claims and the indication of the background art.

In the paragraph bridging amended pages 13 (line 20) and 14 (line 5) the term "ceramic member" has been changed to "ceramic part" in order to make it clear that the "ceramic part" as defined in this paragraph is distinguished from the "ceramic member" as defined in Claim 1 and thus to avoid an inconsistency between Claim 1 according to which the ceramic member is "monobloc" and the paragraph of the original description (page 15, line 20 to page 16, line 5) according to which the ceramic member was "a two-piece part". Such amendment does not introduce any new information.

- 2.5 Figures 1 to 4 correspond respectively to the original Figures 2, 7, 10 and 11.
- 2.6 There are therefore no objections to the amendments under Article 123(2) EPC.

3. Novelty (main request)

The subject-matter of Claim 1 is novel within the meaning of Article 54 EPC, since there is no document available to the Board which discloses the use as an engine part of the combination of features specified in Claim 1.

4. The closest prior art

Document D1 (Figure 6A) is considered as representing the closest prior art since it discloses the use as an engine part of a metal-ceramic combination by which the protrusion of a ceramic member is fixed in the recess of a metallic member without any intermediate member. This document (see particularly page 228, Figure 6A) discloses all the features specified in the pre-characterising portion of Claim 1. Although the schematic Figure 6A shows a clearance between the edge of the joint interface and the beginning point of the easement, no dimensional information concerning this clearance can be derived from this disclosure.

5. The technical problem (main request)

5.1 The problem to be solved can be seen as being to improve the strength in toto of a metal-ceramic combination used as an engine part, and particularly to prevent large stress concentration from being developed caused by overlapping of stress-concentration formed at the interface between ceramic and metal members of the metal-ceramic combination, with stress concentration in the ceramic member formed by application of a bending load.

5.2 The Board is satisfied that the combination of features specified in Claim 1 solves this technical problem.

The subject-matter of Claim 1 is distinguished from the closest prior art by the following features:

- (a) The protrusion is fixed in the recess by force fitting;
- (b) there is a clearance of 0.5 mm between the edge of the joint interface and the beginning point of the easement;
- (c) the metallic member has at its end a cylindrical outer surface and
- (d) a reverse tapered inner surface.

Feature (a) enables an easy connection between the metallic and the ceramic members. Moreover, according to the original description (page 7, lines 1 to 9) the tolerances in the finished dimension of the protrusion may be larger than in case of expansion fitting and shrink fitting.

Feature (b) permits the reduction of stress concentration.

Features (c) and (d) allow improvement of manufacturing of the metallic member.

Moreover: Feature (d) not only provides for easy entry of the protrusion in the recess but also contributes to reduce the stress concentration. Thanks to the reversed tapered inner surface the clearance between the above mentioned "edge" and "beginning point" can be increased without reducing the length of the metallic member. The reversed tapered inner surface - as pointed out by the Appellant in the statement of grounds - provides a gentle transition between the open end of the metallic and the actual joint between the protrusion and the inner surface of the recess, thereby helping to reduce stress concentration.

6. Inventive step (main request)

6.1 Document D1 discloses (Figure 6) the results of stress level calculations for different rotor designs. According to the accompanying description (page 228, left-hand column, first paragraph) the embodiment according to Figure 6D seems to be the most promising embodiment with respect to limited stress concentrations. A person skilled in the art wanting to decrease stress concentrations would therefore be guided by this document D1 towards the configuration of the embodiment according to Figure 6D rather than to that of Figure 6A.

6.2 Document D2 relates to a metal-ceramic combination wherein the metallic member is provided with a recess and the ceramic member is provided with a cylindrical protrusion extending from the base and with an easement portion having its cross-sectional area formed around the root of the protrusion, said protrusion being fixed in the recess of the metallic member.

Document D2 also shows - for instance in Figure 1 - a clearance between the "edge of the joint interface" and "the beginning point of easement". Moreover the embodiments according to schematic Figures 2 to 6 of this document, which concern a ceramic member fixed in the recess of the metallic member by means of intermediate members, relate to a metallic member which is represented in the above-mentioned figures as having at its end facing toward the ceramic member a cylindrical outer surface and a reverse tapered inner surface.

The embodiment according to Figure 1 of document D2 shows a metallic member having at its end facing toward the ceramic member a reverse conical surface comprising curved

lines which can be considered as being a reverse tapered inner surface.

- 6.2.1 It must be therefore investigated whether the skilled person, by combining the teachings of documents D1 and D2, would arrive at the subject-matter of Claim 1.

Although each of documents D1 and D2 shows a clearance between "edge" and "beginning point", the text of each of these documents does not refer to this clearance. Therefore, neither document D1 nor document D2 contains dimensional information concerning this clearance or teaches its significance. Moreover, there is no evidence that the general knowledge of the skilled person would permit derivation of a relationship between the clearance and the increased strength either from document D1 or from document D2.

Document D2 discloses a metallic member having at its end facing toward the ceramic member a reverse tapered inner surface but only in the drawings. The description of this document does not refer to this feature such that no information concerning the significance of or the technical effects produced by this feature can be derived from document D2.

Although document D2 relates to the problem of reducing stress at the interface region between ceramic and metallic members, it solves this problem in a completely different way, i.e. by means of an elastic connection between ceramic and metallic members.

Therefore, the skilled person would perhaps be guided, in order to prevent large stress concentrations, to such a kind of elastic connection between ceramic and metallic members, but he would not find in, or deduce from,

document D2 any causal relationship of the reduction of stress concentration to the clearance between "edge" and "beginning point" or to the feature concerning the reverse tapered inner surface of the metallic member.

Therefore, a skilled person would not be guided by document D2 to the claimed solution.

- 6.2.2 It must also be considered that neither D1 nor D2 discloses a force fitting between metallic and ceramic members as defined in Claim 1. Indeed, according to Claim 1 the metal-ceramic combination has a rigid metallic member which is fixed in the protrusion of the ceramic member by force fitting. This implies a rigid connection between metallic and ceramic members.

As already stated, document D2 explicitly discloses an elastic connection between ceramic and metallic members which is also defined in Claim 1 of this document ("... ein einerseits mit dem metallischen Bauteil (2) und andererseits mit dem keramischen Bauteil verbindendes, ... federnd elastisches Verbindungsteil"), so that a person skilled in the art using the teaching of document D2, could not be guided to the claimed solution.

- 6.3 The other documents cited in the Search Report are further away from the subject-matter of Claim 1. None of these documents suggests how to reduce the stress concentration by a clearance between the edge of the joint interface between ceramic and metallic members and the beginning point of easement of the ceramic member.

- 6.4 It follows that the subject-matter of Claim 1 according to the main request involves an inventive step within the meaning of Article 56 EPC.

7. The subject-matter as set forth in Claim 1 according to the main request is, therefore, patentable within the meaning of Article 52 EPC, so that a patent may be granted based on this allowable Claim 1, the dependent Claims 2 to 8, which concern particular embodiments of the invention according to Claim 1, the amended description and drawings (Figures 1 to 4).
8. The examination of the auxiliary requests is therefore unnecessary.

Order

For these reasons, it is decided that:

1. The decision under appeal is set aside.
2. The case is remitted back to the Examining Division with the order to grant a patent on the basis of the following documents:

Claims: Claim 1 filed with letter of 28 October 1992;
Claims 2 to 8 filed with letter of 20 July 1992, with the amendments to Claims 2 to 8 agreed by telephone on 4 March 1993.

Description: Pages 1, 2, 4 to 12 and 15 to 18 of the description as filed with letter of 20 July 1992 with the amendments to page 7 as agreed by telephone on 4 March 1993;
pages 3, 13 and 14 of the description as filed with letter of 28 October 1992 with the amendments to page 3 as agreed by telephone on 4 March 1993.

Drawings: Sheets 1 and 2 containing Figures 1 to 4 as filed with the letter of 20 July 1992.

The Registrar:



N. Maslin

The Chairman:



C. Andries

