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**Datasheet for the decision
of 25 June 2019**

Case Number: T 0598/16 - 3.4.03

Application Number: 10180160.3

Publication Number: 2296454

IPC: H01L23/373

Language of the proceedings: EN

Title of invention:
Thermal management system

Patent Proprietor:
NeoGraf Solutions, LLC

Opponent:
SGL Carbon SE

Headword:

Relevant legal provisions:
EPC 1973 Art. 54, 56, 76(1), 100(a)
EPC Art. 123(2)

Keyword:

Amendments - added subject-matter (no)

Inventive step - (yes)

Late-filed ground of opposition - admitted (no)

Decisions cited:

G 0010/91, G 0007/95

Catchword:



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Case Number: T 0598/16 - 3.4.03

D E C I S I O N
of Technical Board of Appeal 3.4.03
of 25 June 2019

Appellant: SGL Carbon SE
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Decision under appeal: **Interlocutory decision of the Opposition
Division of the European Patent Office posted on
5 January 2016 concerning maintenance of the
European Patent No. 2296454 in amended form.**

Composition of the Board:

Chairman G. Eliasson
Members: T. M. Häusser
W. Van der Eijk

Summary of Facts and Submissions

- I. The appeal of the opponent concerns the interlocutory decision of the opposition division maintaining the European patent EP-B-2 296 454 as amended during the opposition proceedings (Article 101(3) (a) EPC).
- II. The opposition had been filed against the patent as a whole. Grounds of opposition were added subject-matter, insufficiency of the disclosure and lack of inventive step.
- III. Reference is made to the following documents:
- E1: US 5,991,155 A,
 - E2: US 3,404,061 A,
 - E3: JP 6-134917 A,
 - E4: JP 8-23183 A,
 - E4a: EP 691 803 A (parallel application of E4).
- IV. At the oral proceedings before the board the appellant (opponent) requested that the decision under appeal be set aside and that the contested patent be revoked.
- The respondent (patent proprietor) requested that the appeal be dismissed and the patent thus be maintained as upheld by the opposition division.
- V. The wording of claims 1, 4, 9, and 10 is as follows (board's labelling "(a)", "(b)", "(c)", "(d)", and "(e)"):
- "1. A thermal management system (10) comprising a heat source having an external surface (100a) and a thermal interface (20) comprising

- (a) an anisotropic flexible graphite sheet formed of compressed particles of exfoliated natural graphite and
 - (b) having a planar area greater than the area of the external surface of the heat source,
- the flexible graphite sheet
- (c) having first and second major planar surfaces and
 - (d) having axes of higher thermal conductivity parallel to said major planar surfaces,
- characterized by
- (e) a first one of said major planar surfaces being in direct operative contact with the heat source."

"4. A thermal management system (10) according to any one of claims 1 to 3 wherein the ratio of thermal conductivity of the anisotropic graphite sheet parallel to one to the major surfaces as compared to transverse to the major surface is at least about 20."

"9. A thermal management system (10) according to any one of claims 1 to 7 further comprising a heat sink (30) which comprises a graphite article shaped so as to provide a heat collection surface and at least one heat dissipation surface, the heat collection surface of the heat sink being in operative contact with a second one of the said major planar surfaces of the flexible graphite sheet."

"10. A thermal management system (10) according to claim 9 wherein the graphite article comprises anisotropic flexible sheets of compressed particles of exfoliated graphite laminated into a unitary article."

VI. The parties argued essentially as follows:

- (i) Amendments

The *appellant* argued that the subject-matter of claims 1, 4, 9, and 10 extended beyond the application and the parent application as filed.

The *respondent* was of the opinion that the subject-matter of these claims had a basis in the application as filed as well as the parent application as filed.

(ii) Novelty

The *appellant* requested to be allowed to discuss lack of novelty of the claimed subject-matter.

The *respondent* objected to this request.

(iii) Inventive step

According to the *appellant* the claimed subject-matter lacked inventive step over document E1 as the closest state of the art, especially in view of document E2.

The *respondent* argued that the claimed subject-matter involved an inventive step over document E1, having regard to documents E2 and E3.

Reasons for the Decision

1. Amendments

- 1.1 In the contested decision the opposition division held that the subject-matter of claims 1, 2, 4, and 7-10 did not extend beyond the application as filed or the parent application as filed (see point 11).

1.2 The appellant argued that the following features had not been disclosed in the original application and parent application:

- claim 1, feature (d): the graphite sheet had "axes of higher thermal conductivity parallel to said major planar surfaces"; it had only been disclosed that the thermal conductivity parallel to the upper and lower surfaces of the graphite sheet was *significantly greater* than in the direction transverse to these surfaces;
- claim 1, feature (e): a major planar surface of the graphite sheet was "in direct operative contact" with the heat source; it had been disclosed that an adhesive could be used to attach the sheet to the heat source; moreover, the claimed expression was open to new undisclosed possibilities;
- claim 4: the ratio of thermal conductivities was at least "about" 20; there was no basis for this vague term;
- claim 9: a heat sink comprising "a graphite article" and having a heat collection surface "in operative contact with a second one of the said major planar surfaces of the flexible graphite sheet"; on page 18, lines 21-28 of the description merely a heat source, a heat collection surface and a heat sink was described;
- claim 10: the graphite article comprising "anisotropic flexible sheets of compressed particles of exfoliated graphite laminated into a unitary article"; this was not disclosed in the description.

1.3 The board notes that it emerges from the description of the application as filed (see for example the respective paragraphs bridging pages 4 and 5 and pages 8 and 9 and page 6, paragraph 2), which is identical to the

description of the parent application, that the flexible graphite sheet of the claimed thermal management system possesses an anisotropic structure due to the compressed particles of exfoliated natural graphite forming the graphite sheet. The graphite particles are aligned with the opposed major surfaces of the graphite sheet. This anisotropic structure implies that many physical properties of the graphite sheet, e. g. the thermal conductivity, are directional, in particular that they have different values parallel and perpendicular to the major surfaces of the graphite sheet.

The board agrees with the appellant in that the graphite sheet is described as having preferably a high degree of anisotropy implying a highly directional thermal conductivity, which may for example be 20 times greater in the direction parallel to the major surfaces of the graphite sheet than in a direction perpendicular to them (see the description of the (parent) application, page 3, third to last paragraph; paragraph bridging pages 4 and 5; page 6, penultimate paragraph). However, throughout the description of the (parent) application (see page 4, paragraph 2; page 8, last paragraph; page 11, second paragraph) and in the original independent claims of the application as filed (claim 1) and of the parent application as filed (claims 1 and 15), the graphite sheet is specified in general terms as being merely "anisotropic" without any indication concerning the degree of anisotropy. In relation to the physical properties this implies a general disclosure of the thermal conductivity having a higher value parallel to the major surfaces of the graphite sheet than perpendicular to them.

Feature (d) of claim 1 is therefore considered to be directly and unambiguously derivable from the applica-

tion as filed as well as from the parent application as filed.

- 1.4 As pointed out in the contested decision (see point 11.1.3) it has been disclosed in original claim 1 of the application as filed that one of the major planar surfaces of the graphite sheet was "in operative contact" with the heat source. A similar disclosure is also contained in original claims 1 and 15 of the parent application.

Hence, it only remains to be considered whether the indication in feature (e) that the surface of the graphite sheet is in "direct" operative contact with the heat source has a basis in the application and the parent application as filed.

In relation to the connection of the heat sink 30, which constitutes a specific embodiment of the invention, and the electronic component 100 the following is stated in the description of the (parent) application as filed (see page 18, last paragraph):

"Heat sink 30 can be mounted to electronic component 100 by conventional means, such as by mounting directly to electronic component 100 using an adhesive, such as a pressure sensitive or thermally activated adhesive (something which the relatively low weight of graphite permits); mounting to thermal interface 20, if present, such as by an adhesive; or mounting to the board or other object on which electronic circuit 100 is mounted, provided heat collection surface 30a of heat sink 30 is operatively connected to external surface 100a of electronic component 100 (directly or through thermal interface 20)."

The heat sink 30 is thus considered "directly" mounted on the electronic component 100 when it is mounted by means of an adhesive to the electronic component 100. This is presented as an alternative to the heat sink 30 being operatively connected to the electric component 100 through the thermal interface 20. In a similar fashion the surface of the graphite sheet is understood to be in "direct" operative contact with the heat source (as indicated in feature (e) of claim 1) if it is mounted, e. g. by means of an adhesive, to the heat source without any intervening layer.

As pointed out by the respondent, it is described in the description of the (parent) application that the surface of the thermal interface 20 (constituted by the graphite sheet) "sits against" the external surface of the electronic component 100, i. e. the heat source, and that the interface 20 is "adhered or mounted to" the external surface of the component 100, e. g. by means of a thermally activated adhesive (see page 11, last full sentence; page 12, paragraph 2). It is therefore considered to be directly and unambiguously derivable from the (parent) application as filed that the surface of the graphite sheet is - within the above meaning - in "direct" operative contact with the heat source.

Hence, feature (e) of claim 1 does not contain subject-matter extending beyond the content of the application or the parent application as filed.

1.5 Concerning the additional feature of dependent claim 4 that the ratio of thermal conductivities is at least "about" 20 the board notes that an identical wording is used in original claim 6 of the application as filed.

There is thus no doubt that this additional feature has a proper basis in the original application documents.

Moreover, in the description of the parent application it is disclosed that the claimed ratio "can approach 20 to one or higher" (see page 6, paragraph 3) implying that the stated value of 20 is merely approximate. This is considered an appropriate basis for the term "about" in claim 4.

Hence, the additional feature of claim 4 is considered to be directly and unambiguously derivable from the application and the parent application as filed.

- 1.6 The additional features of dependent claim 9 are based on claim 12 of the application as filed and on claim 15 (in particular feature (c)) of the parent application as filed. Moreover, the additional features of dependent claim 10 are based on claim 12 of the application as filed and on claim 19 of the parent application as filed. Essentially the same wording is used in present claims 9 and 10 as in the corresponding originally filed claims of the application / parent application mentioned above.

Hence, claims 9 and 10 do not contain subject-matter extending beyond the content of the application or the parent application as filed.

- 1.7 Consequently, the board is satisfied that the amendments effected in relation to claims 1, 4, 9, and 10 comply with the requirements of Article 76(1) EPC 1973 and Article 123(2) EPC.

2. Novelty

2.1 During the oral proceedings before the board the appellant requested for the first time during the appeal proceedings to be allowed to discuss lack of novelty of the claimed subject-matter with respect to the example illustrated in Figure 11 of document E1.

2.2 The ground of opposition under Article 100(a) EPC 1973 in combination with Article 54 EPC 1973 (lack of novelty) was raised by the opponent - present appellant - for the first time after the expiry of the time limit laid down in Article 99(1) EPC (namely with letter dated 30 October 2015), thus constituting a late-filed ground of opposition.

However, this objection was dropped during the oral proceedings before the opposition division (see point 4 of the minutes of these proceedings and point 13.1 of the contested decision). Consequently, the opposition division did not discuss with the parties the admission into the proceedings of this ground of opposition and did not exercise its discretionary power under Article 114(1) and (2) EPC 1973 (decision G 10/91 of the Enlarged Board of Appeal, point 16 of the Reasons) to decide whether or not to admit this ground of opposition into the proceedings for being *prima facie* relevant. The fact that novelty over document E1 is discussed in the contested decision "for completeness" (see point 13.2) is not considered relevant in this respect, as this is merely part of the assessment of inventive step.

2.3 Since the ground of opposition under Article 100(a) EPC 1973 in combination with Article 54 EPC 1973 (lack of novelty) was neither raised and substantiated in the notice of opposition nor introduced into the proceedings by the opposition division in application of

Article 114(1) EPC 1973, this ground of opposition is a *fresh ground* within the meaning of the term intended in the decision G 10/91 (see decision G 7/95, point 5.3 of the Reasons).

The Enlarged Board held in the decision G 10/91 mentioned above that a fresh ground of opposition may in principle not be introduced at the appeal stage and that an exception to this principle is justified only in case the patentee agrees that the fresh ground may be considered: *volenti non fit injuria* (see point 18 of the Reasons).

In the present case the respondent explicitly objected to the introduction of the new ground of opposition into the appeal proceedings. Moreover, the exception provided for in the decision G 7/95 (see headnote, last sentence) does not apply, since the objection of lack of novelty was not based on the closest prior art, which is considered to be the embodiment of Figure 1(a) of document E1 (see point 3 below). Therefore, the board has no power to introduce this ground of opposition into the proceedings for the first time at the appeal stage.

In view of the above, the ground of opposition under Article 100(a) EPC 1973 in combination with Article 54 EPC 1973 (lack of novelty) is not admitted into the appeal proceedings.

3. Inventive step

3.1 Closest state of the art

In the decision under appeal the opposition division considered document E1 the closest state of the art

(see point 14.1). Both parties also argued inventive step taking this document as the starting point.

Indeed, document E1 discloses - as detailed below - subject-matter that is conceived for the same purpose as the claimed invention, namely for providing a thermal management system, and has the most relevant technical features in common with it. This document is therefore regarded as the closest state of the art, in particular the embodiment of Figure 1(a).

3.2 Distinguishing features

3.2.1 Document E1 discloses (see column 1, lines 6-9; column 2, lines 16-23) a heat sink for cooling an exothermic device, such as a microprocessor, utilizing a heat spreader sheet, which is made of a flexible material having high thermal conductivity, such as graphite or graphite composite.

With respect to a reference example shown in Figure 11 document E1 discloses (see column 1, line 29 - column 2, line 13) a heat spreader sheet 4 fixed to an inside wall surface of casing 3 of a portable electronic apparatus and an exothermic device 1, such as a microprocessor, mounted on a circuit board 2.

The first embodiment shown in Figure 1(a) comprises (see column 5, lines 16-37) furthermore an abutting member 6 on the inside wall surface of casing 3 whereby the heat spreader sheet 4 is made to contact a surface of exothermic device 1. By this structure transmission of heat from exothermic device 1 to heat spreader sheet 4 is efficient because the surface of exothermic device 1 contacts the surface of heat spreader sheet 4.

3.2.2 There is consensus between the parties that document E1 discloses - using the wording of claim 1 - in relation to the first embodiment shown in Figure 1(a) a thermal management system comprising a heat source (exothermic device 1) having an external surface and a thermal interface (heat spreader sheet 4) comprising a flexible graphite sheet (heat spreader sheet 4 is made of a flexible material, e. g. graphite or graphite composite) having first and second major planar surfaces (front and back sides of heat spreader sheet 4), a first one of the major planar surfaces of the flexible graphite sheet being in direct operative contact with the heat source (heat spreader sheet 4 is made to contact a surface of exothermic device 1 by means of abutting member 6). The board agrees with this assessment.

3.2.3 The respondent argued that document E1 did not disclose feature (b) of claim 1 that the planar area of the thermal interface was greater than the area of the external surface of the heat source.

However, only the part of the heat spreader sheet 4 that covers the abutting member 6 is in a position to contact the exothermic device 1, but not the part which is fixed to the inside wall surface of the casing 3. Hence, the planar area of the heat spreader sheet 4 is necessarily greater than the area of the external surface of the exothermic device 1. This can also be seen in Figure 1(a) of document E1. Feature (b) is therefore disclosed in this document.

3.2.4 The subject-matter of claim 1 thus differs from the thermal management system of the embodiment of Figure 1(a) in that the flexible graphite sheet

- is anisotropic and formed of compressed particles of exfoliated natural graphite (feature (a)), and
- has axes of higher thermal conductivity parallel to said major planar surfaces (feature (d)).

3.3 Objective technical problem

The appellant argued that it was the objective technical problem of the invention to merely provide an alternative thermal management system.

However, the board agrees with the respondent in that the anisotropy of the thermal interface has the technical effect of reducing the height of peaks in the temperature distribution across the thermal interface, thereby improving the efficiency of the thermal management system.

It is therefore considered to be the objective technical problem of the invention to achieve this effect.

3.4 Obviousness

- 3.4.1 The appellant argued that document E2, which disclosed compressed particles of exfoliated natural graphite, would lead the skilled person to the claimed subject-matter.
- 3.4.2 Document E2 discloses (see column 1, lines 11-28) a new form of graphite, in particular a flexible sheet material which consists essentially of graphite and is free of any binding or bonding material. The flexible graphite sheet material possesses anisotropic or highly directional properties. The flexible graphite sheet material is formed from graphite particles which have

been first appreciably expanded or intumesced and then compressed or compacted together.

However, there is no mention in document E2 that the flexible graphite sheet had the advantage of reducing the height of peaks in the temperature distribution across the sheet. Moreover, only in the context of using the flexible graphite sheet of E2 as a *heat barrier* - i. e. the opposite use compared to that of the invention - the anisotropy of the thermal conductivity of the graphite sheet is mentioned in document E2 (see column 14, lines 70-73):

"In view of the very low thermal conductivity in the c direction of each of the graphite layers, and the use of a highly reflective metal coating, the layers 114 serve as very effective radiant heat barriers."

The skilled person would therefore not consider using the flexible graphite sheet of document E2 in order to solve the posed problem.

- 3.4.3 In relation to the flexible graphite sheet document E1 contains references to documents E3 and E4. However, these documents do not disclose flexible graphite sheets formed of compressed particles of exfoliated natural graphite. Hence, in the board's view, these documents would not lead the skilled person to the claimed subject-matter, either.
- 3.4.4 In view of the above the subject-matter of claim 1 involves an inventive step.

Claims 2 to 10 are dependent on claims 1. Accordingly, the subject-matter of claims 1 to 10 involves an inventive step (Article 52(1) EPC and Article 56 EPC 1973).

4. Conclusion

Since the board is - as indicated above - of the opinion that the patent as upheld by the opposition division and the invention to which it relates meet the requirements of the EPC, the opponent's appeal is to be dismissed (Article 101(3) (a) EPC and Article 111(1) EPC 1973).

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:

The Chairman:



S. Sánchez Chiquero

G. Eliasson

Decision electronically authenticated