

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SAMSUNG ELECTRONICS CO., LTD.; AND
SAMSUNG ELECTRONICS AMERICA, INC.,
Petitioner,

v.

REDSTONE LOGICS LLC,
Patent Owner.

Case No. IPR2024-00974
Patent No. 9,253,925

**PETITION FOR *INTER PARTES* REVIEW OF CLAIMS 3 AND 15–16
OF U.S. PATENT NO. 9,253,925 UNDER 35 U.S.C. §§ 311–319
AND 37 C.F.R. § 42.100 *et seq.***

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1001	U.S. Patent No. 9,253,925
1002	Certified File History for U.S. Patent No. 9,253,925
1003	Declaration of Leland Spangler, Ph.D.
1004	U.S. Patent No. 7,180,173 (Kuo)
1005	U.S. Patent Application Publication No. 2011/0133236 A1 (Nozaki)
1006	U.S. Patent Application Publication No. 2005/0039879 A1 (Hanai)
1007	Plaintiff Redstone Logics LLC’s Preliminary Disclosure of Asserted Claims and Infringement Contentions, <i>Redstone Logics LLC v. Samsung Electronics Co., Ltd., et al.</i> , No. 2:23-cv-00485 (E.D. Tex. Mar. 25, 2024)
1008	Claim Chart for U.S. Patent No. 9,253,925 accompanying Plaintiff Redstone Logics LLC’s Preliminary Disclosure of Asserted Claims and Infringement Contentions, <i>Redstone Logics LLC v. Samsung Electronics Co., Ltd., et al.</i> , No. 2:23-cv-00485 (E.D. Tex. Mar. 25, 2024)
1009	U.S. Patent Application Publication No. 2012/0206882 A1 (Mohammed)
1010	First Amended Scheduling Order, <i>Redstone Logics LLC v. Samsung Electronics Co., Ltd., et al.</i> , No. 2:23-cv-00485 (E.D. Tex. Apr. 23, 2024)
1011	Hugh O. Pierson, <i>Handbook of carbon, graphite, diamond, and fullerenes : properties, processing, and applications</i> (1993)
1012	Jishan Wu, Wojciech Pisula, & Klaus Müllen, <i>Graphenes as a Potential Material for Electronics</i> , 107 Chem Review 718-747 (2007)
1013	Thermacore, <i>Introduction to Aluminum and Magnesium Annealed Pyrolytic Graphite (k-Core)</i> , MEPTEC Thermal Management Symposium, March 19, 2012, San Jose, CA.
1014	L. C. F. Blackman & A. R. Ubbelohde, <i>Stress Recrystallization of Graphite</i> , A266 Proceedings of the Royal Society of London 20-32 (1962)
1015	Xingcum Colin Tong, <i>Advanced Materials for Thermal Management of Electronic Packaging</i> (2011)
1016	Excerpt of <i>The Heat is On 2012: Revolutionary and Evolutionary Innovations in Thermal Management</i> , MEPTEC Symposium Proceedings Number 47, San Jose, CA, March 19, 2012
1017	Richard Lemak, <i>Pyrolytic Graphite Heat Spreader Options for High Performance Embedded Components and Systems</i> , IMAPS Advanced

Exhibit No.	Description
	Technology Workshop on Thermal Management, Palo Alto, CA, Sept. 11-13, 2006
1018	U.S. Patent No. 568,323 (Acheson)
1019	D.D.L. Chung and Yoshihiro Takizawa, <i>Performance of Isotropic and Anisotropic Heat Spreaders</i> , 41 J. Elec. Materials 2580-2587 (June 28, 2012)
1020	Julian Norley et al., <i>The Development of a Natural Graphite Heat-Spreader</i> , Seventeenth Annual IEEE Semiconductor Thermal Measurement and Management Symposium, Cat. No.01CH37189, pp. 107-110 (2001)
1021	Gary Shives et. al., <i>Comparative Thermal Performance Evaluation of Graphite/Epoxy Fin Heat Sinks</i> , Ninth Intersociety Conference on Thermal and Thermomechanical Phenomena in Electronic Systems, Las Vegas, NV, June 1-4, 2004
1022	Nikhil Lakhkar et al., <i>Multi-Objective Optimization of Graphite Heat Spreader for Portable Systems Applications</i> , Proceedings of the ASME 2009 InterPACK Conference, San Francisco, CA, July 19-23, 2009
1023	Freescall, <i>i.MX 6 Series Thermal Management Guidelines</i> , Doc. No. AN4579, Rev. 0, Nov 2012
1024	Martin D. Smalc, <i>Innovations in Flexible Graphite for Thermal Management Applications</i> , MEPTEC Symposium Proceedings, No. 47, San Jose CA, March 19, 2012
1025	U.S. Patent No. 5,224,030 (Banks)
1026	U.S. Patent No. 5,902,762 (Mercuri)
1027	U.S. Patent No. 5,991,155 (Kobayashi)
1028	U.S. Patent No. 7,292,441 (Smalc)
1029	U.S. Patent No. 6,404,070 (Higashi)
1030	U.S. Patent No. 4,849,858 (Grapes)
1031	Walter Galan, <i>Blackberry Playbook Teardown</i> , iFixit (Apr. 19, 2011), https://www.ifixit.com/Teardown/BlackBerry+PlayBook+Teardown/5265
1032	Michael Chen et al., <i>TI OMAP4xxx POP SMT Design Guideline</i> , https://www.ti.com/lit/an/swpa182c/swpa182c.pdf?ts=1713417178496 (last visited May 30, 2024)
1033	SanDisk, <i>eMMC 4.41 I/F: Preliminary Data Sheet</i> , 80-36-03433 (Feb. 2010)
1034	Texas Instruments, <i>Fully Integrated Power Management with Switch Mode Charger</i> , TWL6030 Data Sheet (rev. July 2011)

Exhibit No.	Description
1035	<i>Epotek H20E Technical Datasheet</i> , Epoxy Technology (July 7, 2007)
1036	Masahiro Inoue et al., <i>Physical Factors Determining Thermal Conductivities of Isotropic Conductive Adhesives</i> , 38 J. Elec. Materials 430-437 (2008)
1037	Ravi Kandasamy & A.S. Mujumdar, <i>Interface thermal characteristics of flip chip packages – A Numerical Study</i> , 20 Applied Thermal Eng'g 822-829 (2009)
1038	Charles Arthur, <i>RIM to Release Blackberry PlayBook in US and Canada on 19 April, [2011] Starting at \$499; Some Features Put It Ahead of The iPad</i> , The Guardian (Mar. 22, 2011), https://www.theguardian.com/technology/2011/mar/22/blackberry-playbook-launch-date-price-specs
1039	Ravi Prasher, <i>Thermal Interface Materials: Historical Perspective, Status, and Future Directions</i> , 94 Proceedings of the IEEE 1571-1586 (Aug. 2006)

I. INTRODUCTION

Samsung Electronics Co., Ltd. and Samsung Electronics America, Inc. (collectively, “Petitioner”) petition for inter partes review (“IPR”), seeking cancellation of claims 3 and 15–16 of U.S. Patent No. 9,253,925 (“the ’925 patent”) (the “Challenged Claims”).

The ’925 patent claims an enclosure for one or more heat-generating electronic devices, such as integrated circuits (ICs), mounted on a substrate. The enclosure is defined by the substrate on the bottom, sidewalls, and a heat-spreading panel over the top of the electronic devices, as was disclosed in the prior art. The heat-spreading panel, as was known, conducts heat generated by the electronic devices within the enclosure to the sidewalls, where the heat can be dissipated. Such an arrangement may be advantageous in devices like mobile phones or laptop computers, where it is desirable to avoid “hot spots” in areas where a user may interact with the device, such as a keyboard or a screen, and where it is difficult to insert heat-sinking structures among tightly-packed components.

The purported advance claimed in the Challenged Claims of the ’925 patent is that the heat-spreading panel is made from a material that conducts heat anisotropically; that is, the material conducts heat many times more efficiently along the plane of the material than in the direction perpendicular to the material.

During prosecution, the examiner did not have a reference showing that such an anisotropic heat-spreading material was known and had been used for enclosures for semiconductor devices. However, as explained below, this material—and this use for it—was known in the prior art before the priority date of the '925 patent, so it would have been obvious to use it with the existing, known enclosure as claimed. The Challenged Claims therefore should be cancelled as unpatentable.

II. STANDING, MANDATORY NOTICES AND FEE AUTHORIZATION

Grounds for Standing: Pursuant to 37 C.F.R. § 42.104(a), Petitioner certifies that the '925 patent is available for IPR and that Petitioner is not barred or estopped from requesting an IPR challenging the '925 patent on the grounds identified in this petition.

Real Party-in-Interest: Petitioner identifies Samsung Electronics Co., Ltd. and Samsung Electronics America, Inc. as real parties-in-interest.

Related Matters: Patent Owner Redstone Logics LLC has asserted the '925 patent in litigation against Petitioner in *Redstone Logics LLC v. Samsung Electronics Co., Ltd., et al.*, Case No. 2:23-cv-00485 (E.D. Tex.).

Lead and Back-Up Counsel: Petitioner designates Scott C. Weidenfeller (Reg. No. 54,531, sweidenfeller@cov.com) as lead counsel, of Covington & Burling LLP, 850 Tenth Street, NW, Washington, DC 20001 (postal and hand delivery), telephone: (202) 662-5923, facsimile: (202) 778-5923.

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Service Information: Service information is provided in the designation of counsel above. Petitioner consents to service of all documents via electronic mail at the email addresses above and at Samsung-Redstone-IPR@cov.com.

Fee Authorization: The Office is authorized to charge all fees due in connection with this proceeding to Deposit Account No. 60-3160.

III. SUMMARY OF CHALLENGE

Petitioner requests IPR of claims 3 and 15–16 of the '925 patent based on the following grounds:

- Ground I: Claims 3 and 15–16 Would Have Been Obvious Over a Combination of Kuo and Nozaki.
- Ground II: Claims 3 and 15–16 Would Have Been Obvious Over a Combination of Kuo and Hanai.

The '925 patent claims priority to an application filed on January 11, 2013. Petitioner's challenge is based on the following references, which are available as prior art under 35 U.S.C. § 102 (pre-AIA)* as shown in the following table:

Exhibit	Reference	Date(s)	Availability as Prior Art
Ex. 1004 (Kuo)	U.S. Patent No. 7,180,173	Issued Feb. 20, 2007	At least §102(b)
Ex. 1005 (Nozaki)	U.S. Patent Application Publication No. 2011/0133236 A1	Published June 9, 2011	At least §102(b)
Ex. 1006 (Hanai)	U.S. Patent Application Publication No. 2005/0039879 A1	Published Feb. 24, 2005	At least §102(b)

None of these prior art references was cited or considered by the Examiner during prosecution of the '925 patent. The Spangler Declaration (Ex. 1003) also was not before the Examiner. Accordingly, the prior art and arguments in this Petition are not the same (or substantially the same) as those previously presented to the Office under 35 U.S.C. §325(d).

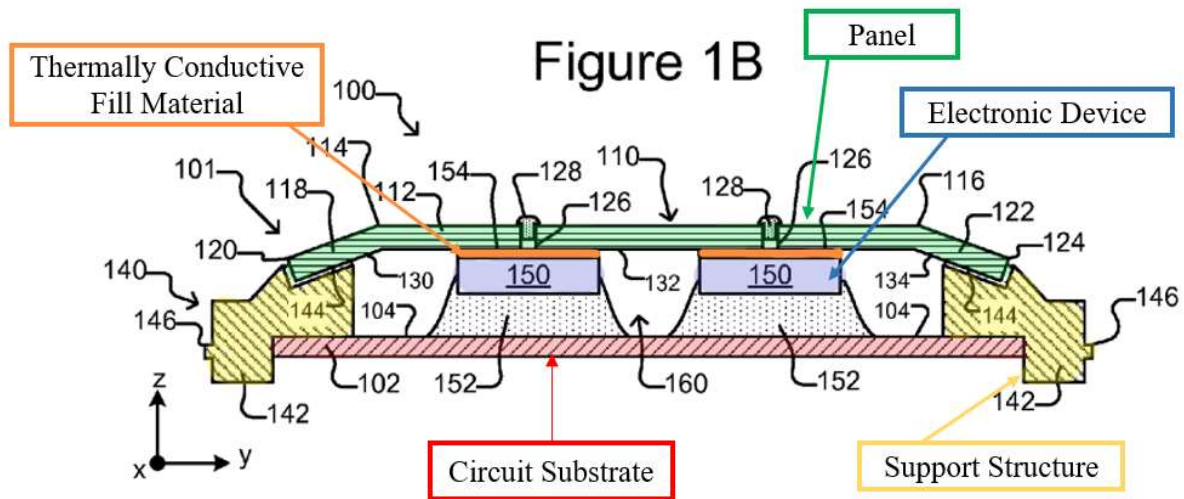
* Because the application for the '925 patent was filed prior to March 16, 2013, the pre-AIA conditions for patentability apply.

IV. OVERVIEW OF THE '925 PATENT

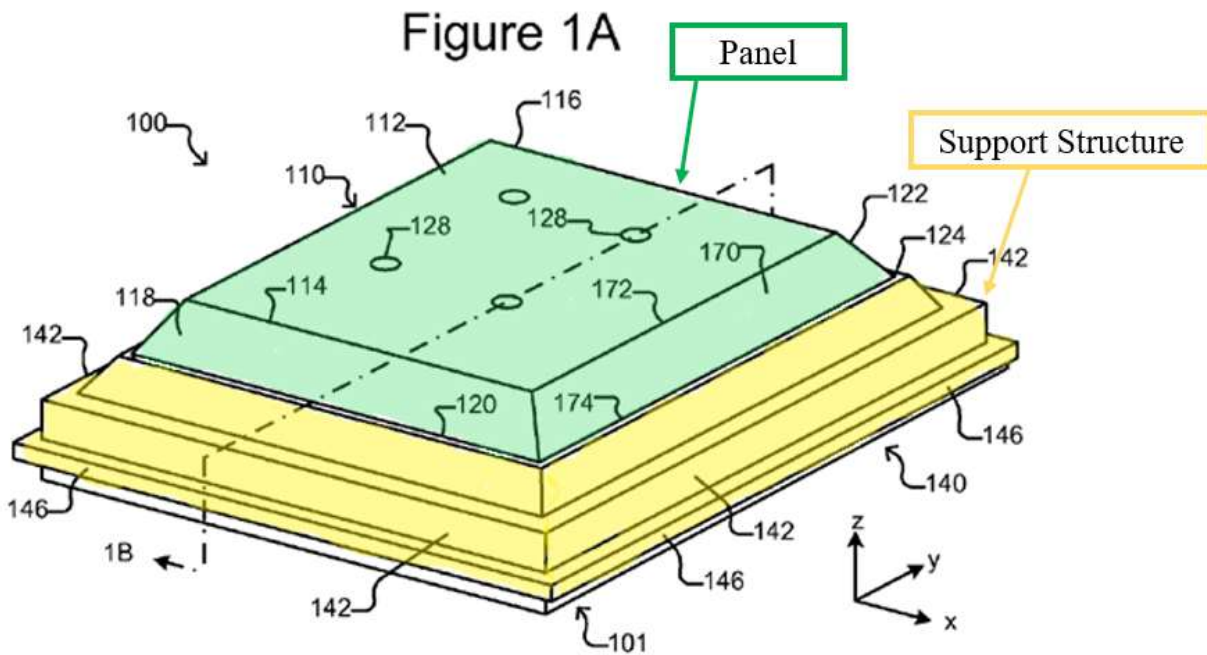
The '925 patent was originally assigned to L-3 Communications Corp. Ex. 1002, 196. Redstone Logics LLC now purports to own the patent.

A. Written Description

The '925 patent is directed to an electronic packaging assembly including a “composite material panel” that is “configured to provide highly conductive thermal paths” that remove heat from electronic devices in the assembly. (Ex. 1001, Abstract, 6:26–46). In Figure 1B, the inner surface of panel 110 (highlighted in green) of electronic assembly 100 is attached to one end of support structure 140 (yellow). Support structure 140 is comprised of walls 142 (Fig. 1A) that enclose an interior space 160. Support structure 140 may include heat radiating elements 146. Ex. 1001, 3:46–49. Circuit substrate 102 (red) is attached to another end of the support structure. One or more electronic devices 150 (blue) are mounted to the mounting surface with adhesive material 152. A thermally conductive fill material 154 (orange) is disposed between and physically contacts electronic devices 150 and the inner surface of panel 110. Ex. 1001, 2:53–4:30.



Ex. 1001, Fig. 1B (annotated)



Ex. 1001, Fig. 1A (annotated)

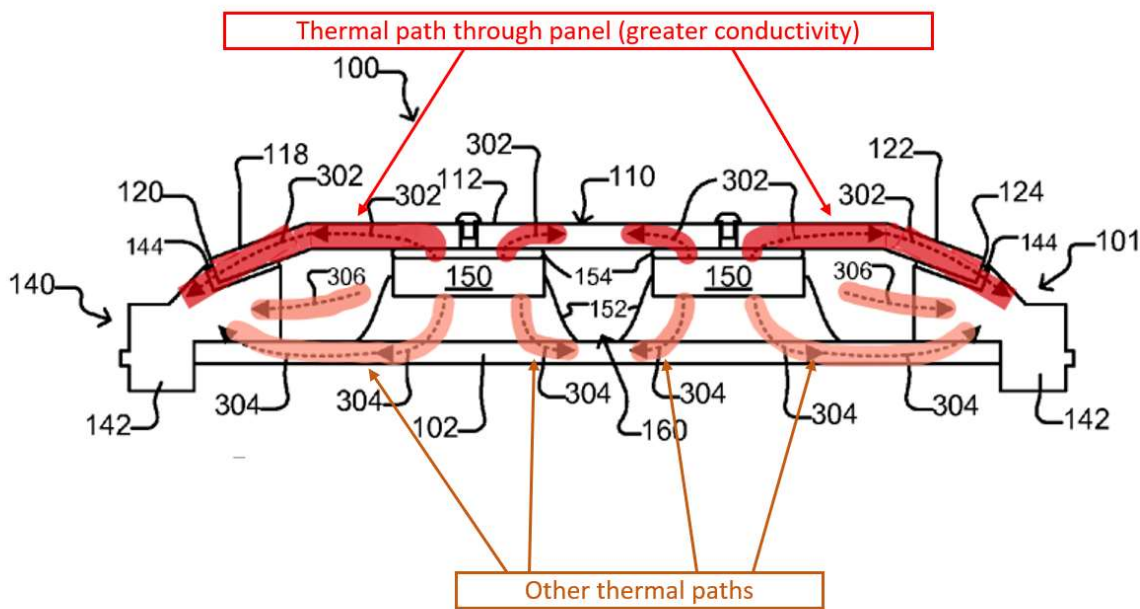
Electronic devices 150 “can be any type of electronic apparatus, component, circuit element, and/or the like” including, for example, “a semiconductor die comprising one or more integrated electronic circuits, an electronic component (e.g.,

a resistor, capacitor, inductor, transistor or the like), a diode, or the like.” Ex. 1001, 3:30–36.

Panel 110 “can comprise substantially parallel, contiguous sections 112, 118, 122 one or more of which can be angled with respect to each other and/or the mounting surface 104 of the circuit substrate 102.” Ex. 1001, 4:31–34. Three such sections 112, 118, 122 are shown in FIGS. 1A and 1B. However, the panel may “have more or fewer than the three substantially parallel, contiguous sections 112, 118, 122 shown, and those sections can be oriented (e.g., angled) differently than shown.” Ex. 1001, 4:35–41. The specification states further that “the invention is not limited to use of a panel with any particular number of sections or orientation of sections.” Ex. 1001, 4:46–48. Although the specification describes that “one or more of sections 112, 118, 122 can be angled with respect to each other and/or the mounting surface 104 of the circuit substrate 102,” Ex. 1001, 5:24–26, it attributes no critical significance to the particular angles of the sections relative to the mounting surface. These angles can vary up to forty-five degrees. Ex. 1001, 5:33–44.

Panel 110 comprises a “composite material” in which “the thermal conductivity is significantly greater” in a first direction that is substantially parallel to the inner surfaces of the sections than it is in a second direction that is substantially perpendicular to the inner surfaces. Ex. 1001, 5:45–55. This difference in thermal

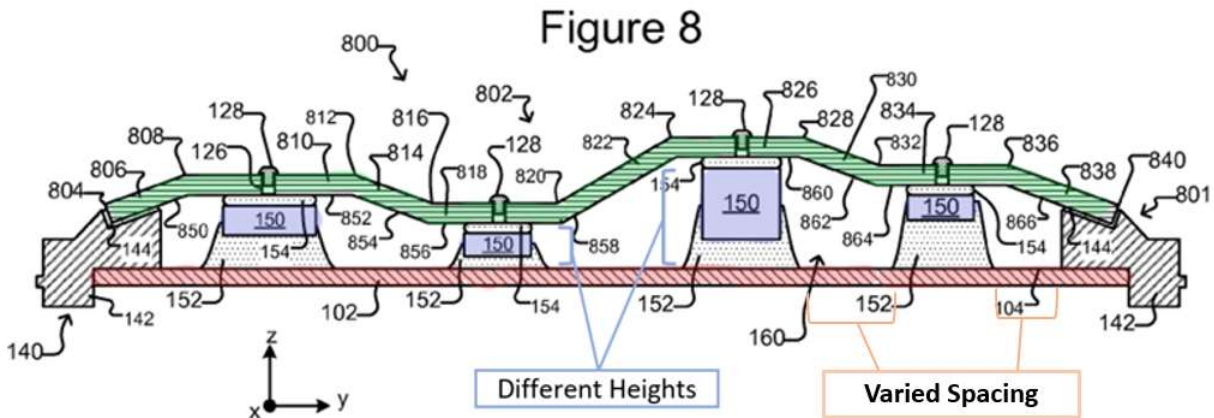
conductivity can vary by up to several hundred-fold. Ex. 1001, 5:55–67. As a result, the panel 110 can be configured to provide highly-conductive thermal paths that are substantially parallel with the inner surfaces of the contiguous sections. These paths direct heat escaping from the top of the IC devices toward sidewalls 142 of electronic package assembly 100, as illustrated by dashed arrows 302 in Fig. 3:



Ex. 1001, Fig. 3 (annotated)

According to the specification, the thermal paths 302 through the panel to the outside of the electronic assembly “have a greater thermal conductivity” than any of the other thermal paths to the outside of the electronic assembly, such as the thermal paths depicted by arrows 304, 306. Ex. 1001, 6:63–7:3.

Figure 8 discloses an embodiment which contemplates a plurality of electronic devices 150 of varying heights and with varying spacing between the devices.



Ex. 1001, Fig. 8 (annotated)

The '925 patent explains that the geometry of the heat-spreading panel 802 can “be customized to different sized electronic devices” and that the angles between panel sections and a plane parallel to the mounting surface, as well as the angles between sections, may vary. Ex. 1001, 9:66–10:3.

B. Prosecution History

During prosecution of the '925 patent, application claims 1–8 and 10–20 were rejected as anticipated and/or obvious in view of Mohammed. Ex. 1009. At that time, claim 1 was the only independent claim in the application. It recited:

We claim:

1. An electronic assembly comprising:
 - a support structure comprising walls enclosing a space;
 - a circuit substrate coupled to a first portion of said support structure, said circuit substrate comprising a mounting surface;
 - an electronic device attached to said mounting surface and disposed within said space;
 - and
 - a panel coupled to a second portion of said support structure, said panel comprising contiguous sections, each said section comprising an inner surface facing said mounting surface of said circuit substrate and oriented within twenty-five degrees of parallel to said mounting surface,
 - wherein each said section has a first thermal conductivity substantially parallel to the inner surface of said section and a second thermal conductivity substantially perpendicular to the inner surface of said section, and
 - wherein said first thermal conductivity is greater than said second thermal conductivity.

Ex. 1002, 184

The examiner determined that Fig. 1A of Mohammed (as shown below) included a panel with at least three contiguous sections parallel to the mounting surface of the circuit substrate. Specifically, the examiner determined that panel 40 of Mohammed, which comprised a flat, planar surface, “includes at least three contiguous sections parallel to the mounting surface; where a 1st section corresponds to the substrate to the left of the device, a 2nd section constitutes a portion that abuts the device, and a 3rd section corresponds to the substrate to the right of the device.” Ex. 1002, 136. The examiner further found that the “sections are not differentiated by any particular structural attributes.” *Id.* In addition, the examiner noted that “as

claimed, each section being within 25 [degrees] of parallel also includes all parallel sections.” *Id.*

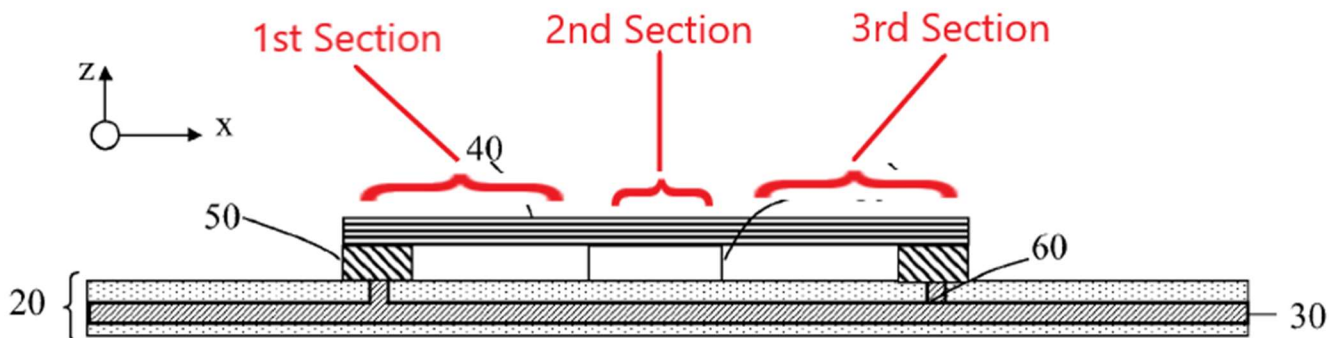


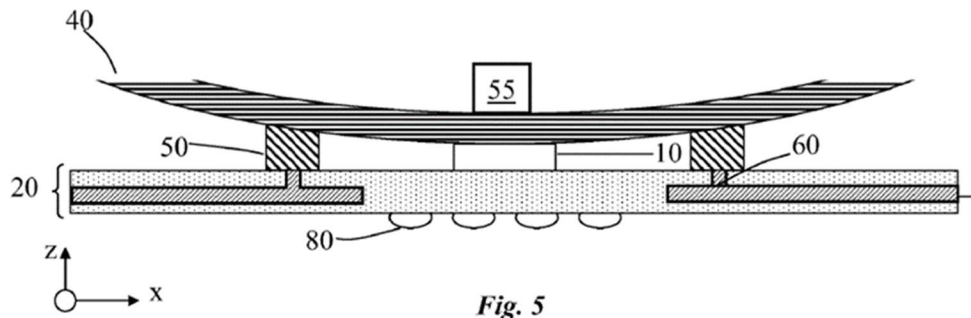
Fig. 1A

Ex. 1009, Fig. 1A (annotated to show sections identified by examiner)

In its response, the applicant did not dispute the examiner’s finding that Mohammed’s flat, planar panel contained a plurality of parallel contiguous sections that satisfied the limitation in application claim 1 that such contiguous sections be “oriented within twenty-five degrees of parallel.” Instead, the applicant amended claim 1 to add limitations reciting that the sections be contiguous to one another and the angle between sections must be “greater than or equal to five degrees.” Ex. 1002, 119. In remarks accompanying the amendment, the applicant argued that Mohammed “fails to teach or render obvious *the requirement now recited in claim 1 of an angle* between the inner surfaces of contiguous sections of the panel of claim 1.” Ex. 1002, 126 (emphasis added).

In the next Office action, the examiner finally rejected application claim 1 again as anticipated by Mohammed. This time, the examiner relied on Fig. 5 of

Mohammed, which shows an embodiment of a heat sinking panel having a curved profile 40. Ex. 1009, [0054]-[0055]. The examiner asserted that this embodiment of Mohammed disclosed “at least two contiguous sections within 25° of parallel to the mounting surface” wherein the angle between said sections was “at least 5°.” Ex. 1002, 99–100.



Ex. 1009, Fig. 5

However, in the same Office action, the examiner indicated that dependent application claim 3 (which depended from application claim 1) contained allowable subject matter: wherein “said first thermal conductivity is at least one-hundred times greater than said second thermal conductivity.” Ex. 1002, 104. In addition, the examiner indicated that dependent application claim 16 (which also depended from application claim 1 through other dependent claims) was allowable due to the presence of “a thermally conductive adhesive coupling said outer edge of said outer one of said sections to said support structure.” *Id.*

In its next response, the applicant again did not contest the examiner’s interpretation of Mohammed. Rather, the applicant made further amendments to

avoid the rejection. Insofar as relevant to the Challenged Claims, the applicant rewrote application claims 3 and 16, which included the allowable subject matter relating to thermal conductivities and a thermally adhesive coupling, respectively, as independent claims which contained the limitations of originally-presented application claim 1 (but did not include the added limitations relating to the angle between two contiguous sections being greater than or equal to five degrees):

Claim 3 (Currently amended): ~~The electronic assembly of claim 1~~ An electronic assembly comprising:
a support structure comprising walls enclosing a space;
a circuit substrate coupled to a first portion of said support structure, said circuit substrate comprising a mounting surface;
an electronic device attached to said mounting surface and disposed within said space;
and
a panel coupled to a second portion of said support structure, said panel comprising contiguous sections, each said section comprising an inner surface facing said mounting surface of said circuit substrate and oriented within twenty-five degrees of parallel to said mounting surface,
wherein each said section has a first thermal conductivity substantially parallel to the inner surface of said section and a second thermal conductivity substantially perpendicular to the inner surface of said section,
wherein for each said section, said first thermal conductivity is at least one-hundred times greater than said second thermal conductivity.

Ex. 1002, 74

Claim 16 (Currently amended): ~~The electronic assembly of claim 15 further comprising~~ An electronic assembly comprising:

- a support structure comprising walls enclosing a space;
- a circuit substrate coupled to a first portion of said support structure, said circuit substrate comprising a mounting surface;
- an electronic device attached to said mounting surface and disposed within said space;
- and
- a panel coupled to a second portion of said support structure, said panel comprising contiguous sections, each said section comprising an inner surface facing said mounting surface of said circuit substrate and oriented within twenty-five degrees of parallel to said mounting surface,
- wherein each said section has a first thermal conductivity substantially parallel to the inner surface of said section and a second thermal conductivity substantially perpendicular to the inner surface of said section,
- wherein said first thermal conductivity is greater than said second thermal conductivity,
- wherein a thermally conductive path from said space enclosed by said walls of said support structure out of said electronic assembly that has a greatest thermal conductivity comprises a thermal path through contiguous ones of said sections of said panel to an outer edge of an outer one of said sections of said panel, and
- wherein said electronic assembly further comprises a thermally conductive adhesive coupling said outer edge of said outer one of said sections to said support structure.

Ex. 1002, 78

In remarks accompanying the amendment, the applicant explained that claim 3 had been “rewritten in independent form” and that although it did “not include all features of [its] base claim and/or intervening claims,” claim 3 recited the subject matter the examiner had identified as patentable: “for each said section, said first thermal conductivity is at least one-hundred times greater than said second thermal conductivity.” Ex. 1002, 80. As so amended, application claim 3 became claim 3 of the ’925 patent.

Similarly, the applicant explained that application claim 16 had been re-written to include the thermally adhesive coupling limitation identified as allowable subject matter by the examiner, and thus claim 16 and its dependent claim 17 were allowable. Ex. 1002, 81. As so amended, application claims 16–17 were renumbered as claims 15–16 when the '925 patent issued. Ex. 1002, 6.

V. LEVEL OF ORDINARY SKILL

The person of ordinary skill in the art (“POSA”) for purposes of the art relevant to this Petition would have (1) a bachelor’s degree in electrical or mechanical engineering or an equivalent degree; (2) a minimum of two to five years of experience in the design of electronic packages and assembly processes; and (3) general knowledge of engineering that would include an understanding of electronic products including portable electronics. Ex. 1003, ¶¶ 45–47.

VI. CLAIM CONSTRUCTION

Claims in an IPR are construed in accordance with the ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and the prosecution history. 37 C.F.R. § 42.100(b); *see Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (en banc). Petitioner does not believe that any specialized constructions are necessary for this petition.

VII. OVERVIEW OF PRIOR ART

Petitioner’s expert, Dr. Leland Spangler, has nearly forty years of experience in the design of electronic components, including packaging enclosures for such

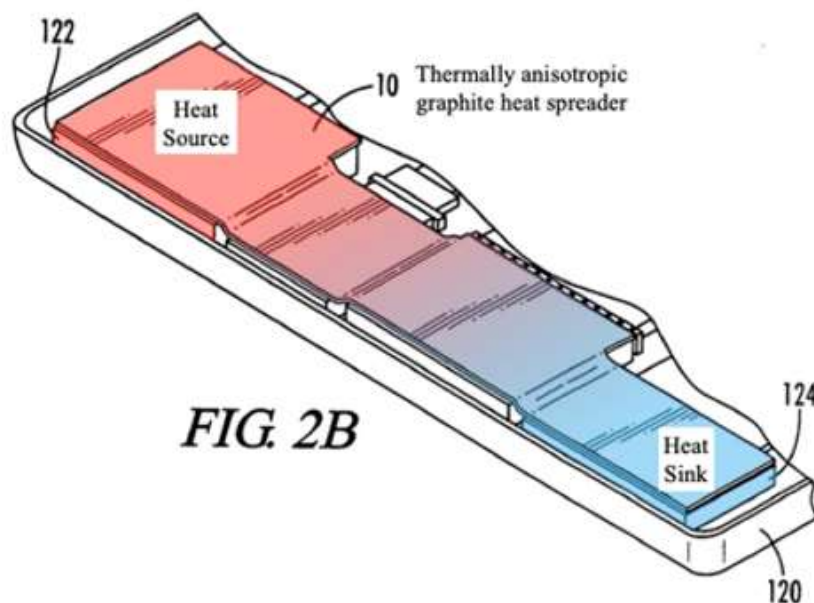
components. Ex. 1003, ¶¶ 7–31. As Dr. Spangler explains, it was well known before the January 11, 2013, priority date of the '925 patent that as electronic components in devices such as laptop computers and cellphones became smaller, more powerful, and more closely packed together in the device, heat management became more and more of a critical design issue. In particular, when components such as CPUs, memory chips and other electronic devices were closely packed together, it became difficult to insert heat sinking structures near the components to dissipate heat. In addition, such components could create “hot spots” in areas where a user would interact with the device, such as a keyboard or display. It was therefore known that movement of heat from the locations of the devices that generated it to locations where heat sinking structures could be placed and where the user was less likely to touch the device, was an important design consideration. Ex. 1003, ¶¶ 82–86, Fig. 6.

In addition, graphite films or sheets existed prior to 2013 that had anisotropic heat-spreading properties. That is, the sheet would conduct heat more efficiently along the plane of the sheet than perpendicular to it. One of the most important uses of thermally anisotropic graphite was in heat spreaders for mobile electronic devices such as cell phones and laptop computers that had thermal management challenges. The ability to form graphite into thin sheets of various forms with low mosaicity (a term that crystallographers use to describe the distribution of crystal plane

orientations in graphite), and a high degree of crystalline alignment resulted in the availability of heat spreaders that had extremely high thermal anisotropy with extremely high thermal conductivity in the plane of the sheet. For example, in 2006, one supplier, Minteq, offered a “Pyrolitic Graphite” product with a thermal conductivity in the in-plane “ab-direction” of greater than 1900 W/mK, compared with 7 W/mK in the perpendicular “c-direction.” This corresponds to a thermal anisotropy of approximately 275 (that is, the heat conductivity in the in-plane direction was 275 times the heat conductivity in the perpendicular direction). Ex. 1017. In 2012, another supplier, ThermaCore, provided heat spreaders with a thermal anisotropy of 170. Exs. 1013, 1016. The physical structure of such materials was well-characterized and understood, as were techniques to form the material into flexible sheets for various applications in packaging electronic devices. Ex. 1003, ¶¶ 70–76, 84–89.

When placed over the top of a heat-generating electronic device, a sheet made from such a material would spread the heat laterally away from the electronic device toward the side edges of the graphite sheet. In mobile devices such as laptops or cellphones, this allowed heat to be moved to the side of the device where heat sinking structures could be located and away from where “hot spots” would bother the user. Ex. 1003, ¶¶ 82–89.

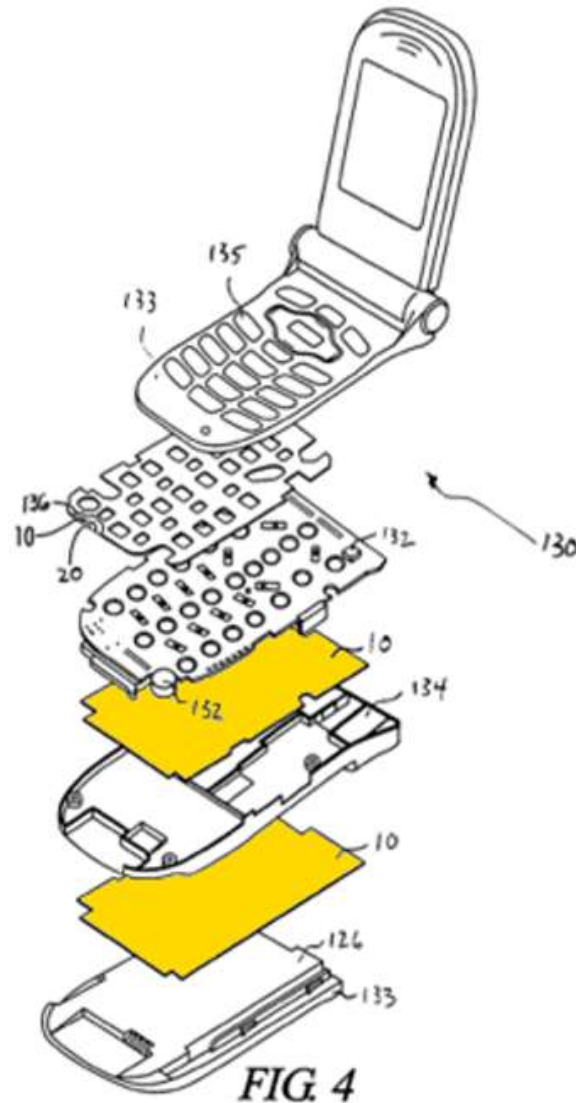
For example, Smalc (U.S. Patent 7,292,441) disclosed the use of a sheet of compressed particles of exfoliated graphite 10 placed in contact with a heat source inside a laptop computer and oriented to spread heat from the source to heat sink 124 located inside the computer, but spaced away from the heat source, because space constraints would not allow the heat sink to be located closer to the heat-generating components. In addition, the graphite sheet shielded and thus prevented the environment near the heat-generating elements from overheating. Ex. 1028, 14:58–15:11.



Ex. 1028, Fig. 2B (annotated)

Smalc further taught that a similar solution could be employed inside a mobile phone for the same purposes: (1) to spread heat away from the heat-generating components

to a heat sinking structure (not shown) located elsewhere in the device and (2) to shield the environment (that is, the user and other components such as the keypad) from excessive heat. Ex. 1028, 15:18–50. *See* Ex. 1003, ¶ 89, Fig. 9.

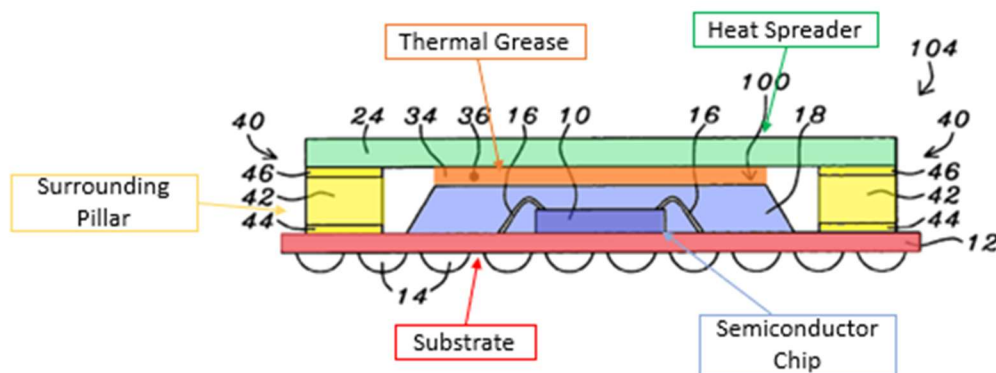


Ex. 1028, Fig. 4 (annotated)

The specific prior art references upon which the Grounds are based are discussed below.

A. U.S. Patent No. 7,180,173 (“Kuo”) (Ex. 1004)

Kuo discloses an enclosure for a semiconductor IC device with a metal heat-spreading cover that is very similar to the enclosure of the '925 patent. Kuo discloses that such IC products produce “lots of heat” which require, *inter alia*, the use of “heat spreaders ... in order to dissipate the extra heat.” Ex. 1004, 1:16–19. Kuo sought to “provide an improved heat spreader” package design. Ex. 1004, 1:59–61.



Ex. 1004, Fig. 2B (annotated)

As shown in Fig. 2B, Kuo’s design includes heat spreader ball grid array package 104 comprising “surrounding pillar” 40 (highlighted in yellow) formed around, and spaced apart from, semiconductor chip 10 (blue). The pillar is described as a “square ring” that surrounds the space occupied by chip 10. Ex. 1004, 4:47–49. Pillar 40 comprises stiffener portion 42 fixed to substrate 12 below (red) by epoxy

adhesive 44. Stiffener portion 42 is preferably comprised of a metal material, preferably copper. Ex. 1004, 4:49–55.

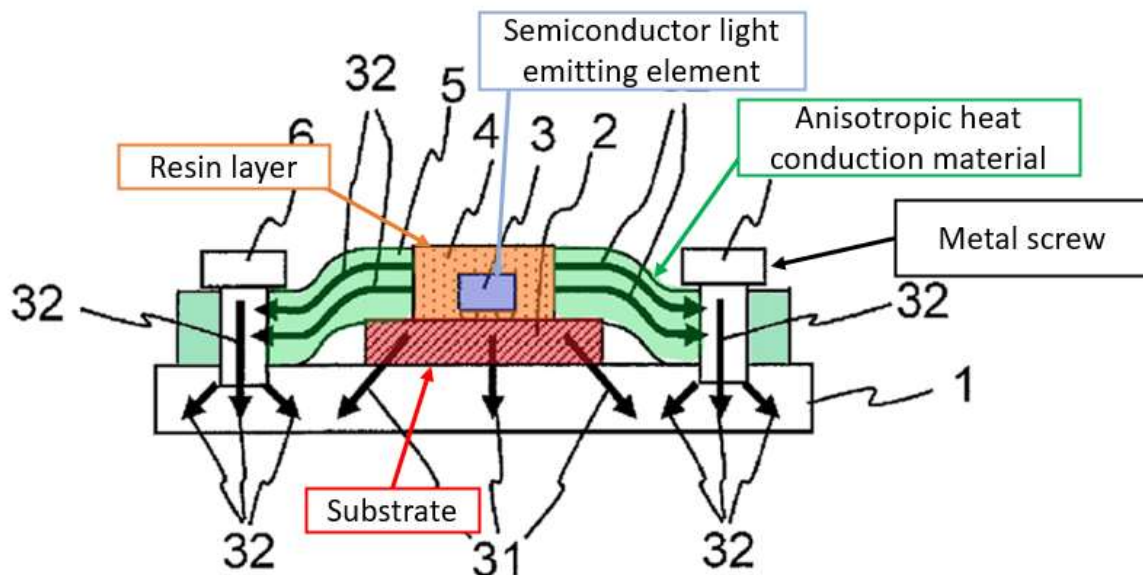
Heat spreader 24 (green) is fixed to the upper end of pillar 40 by epoxy adhesive 46 so that heat spreader 24 is located over and above chip 10, leaving a gap 34 between the molding compound 18 that encases the semiconductor chip 10 and heat spreader 24. Heat spreader 24 is made from the same metal materials as stiffener portion 42 of surrounding pillar 40. Ex. 1004, 4:56–64. “Thermal grease” 36 (orange) is inserted into gap 34 at least between heat spreader 24 and molding compound 18. Ex. 1004, 5:4–12. Thermal grease 36 is described as a “silicon[e] rubber” substance “containing heat-conducting particles such as zinc oxide, aluminum oxide, aluminum nitride, boron nitride or ceramic fillers or other materials which have the properties of heat conduction.” Ex. 1004, 5:13–17. The purpose of thermal grease 36 is to transmit heat from the molding compound encapsulating the semiconductor chip to heat spreader 24 to remove heat from the semiconductor chip and to reduce heat stress in the heat spreader. Ex. 1004, 5:29–34.

B. U.S. Patent App. Pub. No. 2011/0133236 (“Nozaki”) (Ex. 1005)

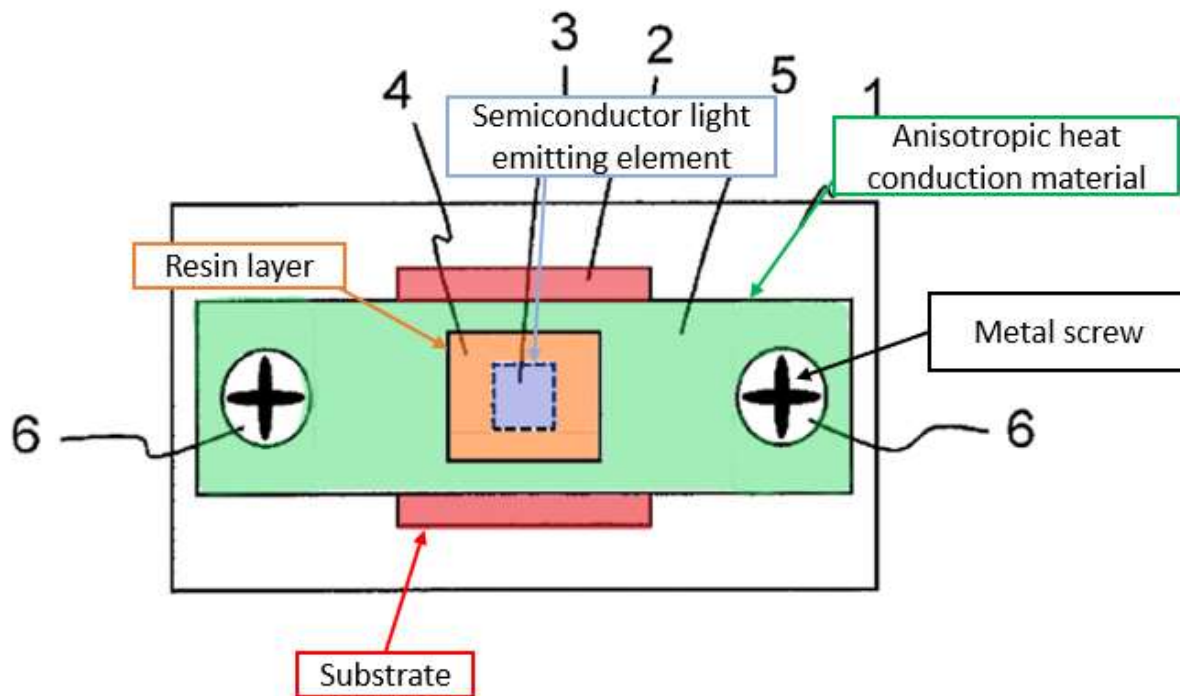
Nozaki discloses a package for a semiconductor device (an LED) that uses a heat-spreading material comprised of laminated graphite sheets that conduct heat in a highly anisotropic manner along the plane of the heat-spreading material. Nozaki’s package shows “superior heat radiation characteristics.” Ex. 1005, [0001]. Nozaki

notes that higher temperatures have deleterious effects on semiconductor light-emitting elements and thus, as the temperature increases, luminous efficiency of the elements decreases. Nozaki thus desires “to increase heat radiation efficiency” from the devices. Ex. 1005, [0002].

In one embodiment shown in Fig. 3, Nozaki discloses semiconductor light-emitting element 3 (highlighted in blue) mounted on insulating substrate material 2 (red), which in turn is mounted upon metal substrate 1. Light emitting element 3 is surrounded by fluorescent substance-containing resin layer 4 (orange) which, as shown in Fig. 1(a), resides in a square-shaped cut-out in a “sheet” of “anisotropic heat conduction material 5” (green) attached to substrate 1 by metal screws 6. Ex. 1005, Fig. 1(a) & [0040].



Ex. 1005, Fig. 3 (annotated)

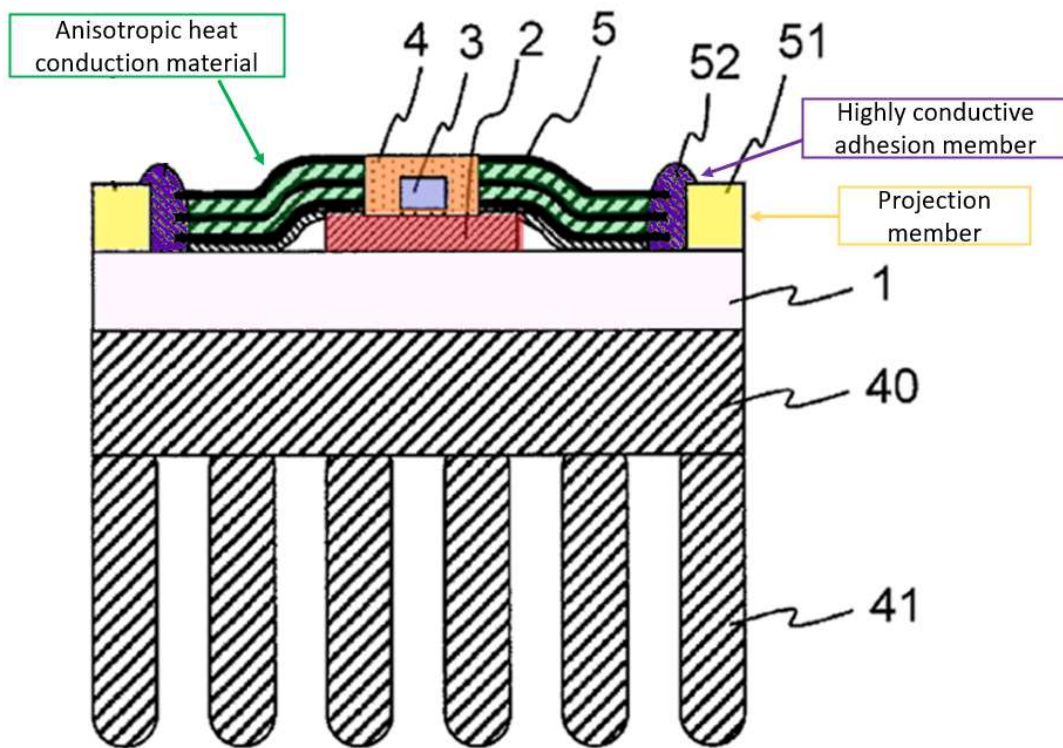


Ex. 1005, Fig. 1(a) (annotated)

Nozaki explains that anisotropic heat conduction material 5 has heat conductivity in the main plane direction that is larger than the heat conductivity in the thickness direction. *Id.*, [0040]. Anisotropic heat conduction material 5 conducts heat 32 along the main plane direction and radiates it to the metal substrate 1 as shown by the arrows in Fig. 3. *Id.*, [0045, 0051]. More specifically, Nozaki teaches that the heat conduction material may be composed of “three layers each of graphite sheets . . . [where] [h]eat conductivity of one sheet of the graphite sheet . . . was 4 to 6 w/mk for the thickness direction, or 1200 w/mk for the plane direction.” *Id.*,

[0090]. That is, it specifies that the thermal conductivity is from 200 (1200/6) to 300 (1200/4) times greater in the in-plane direction.

In another embodiment shown in Fig. 5, Nozaki teaches use of “highly conductive adhesion member 52” (purple) for coupling the outer edge of the anisotropic heat conduction material to “projection member 51.” Adhesion member 52 may be “a cured heat conductive paste containing a highly heat conductive metal filler.” *Id.*, [0058]. Projection member 51 is formed from the same material as metal substrate 1 and is used for structural support and to conduct heat received from the anisotropic heat conduction material through the adhesion member to substrate 1 and heat sink 40 having fins 41. *Id.*, [0058]; *see id.*, [0049].



Ex. 1005, Fig. 5

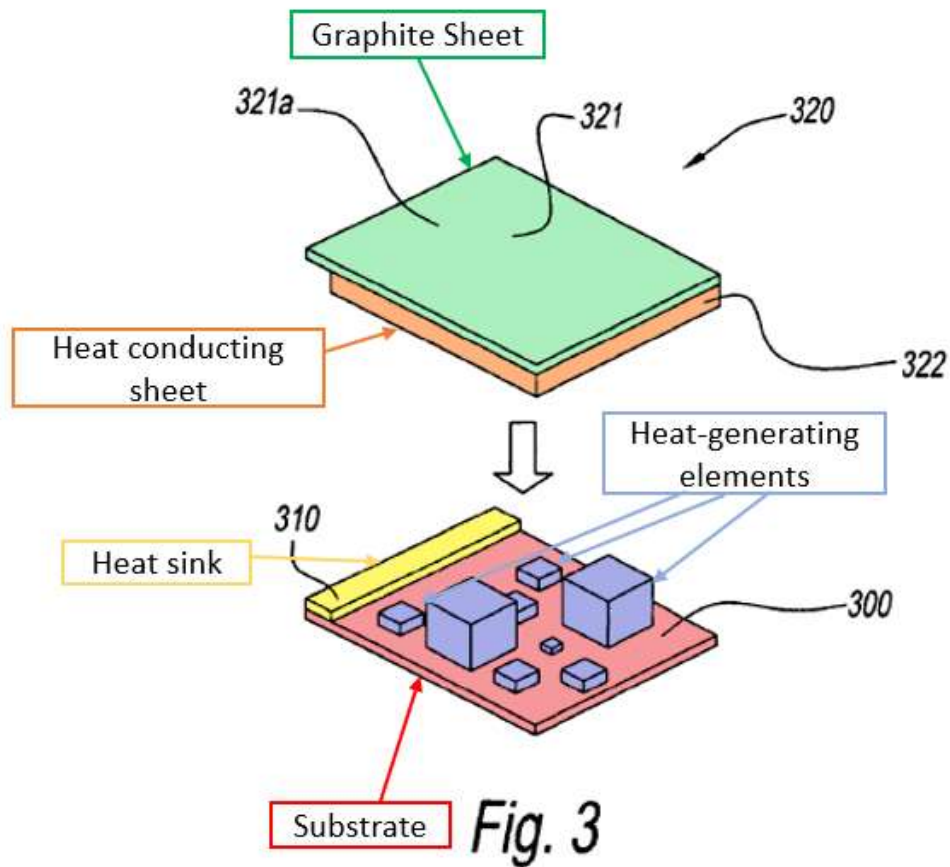
Nozaki explains that heat from resin layer 4 “is highly efficiently conducted along the main plane direction.” Ex. 1005, [0059]. Thereafter, the heat is further conducted from the end of anisotropic heat conduction material 5 to the projection member 51 via highly heat conductive adhesive member 52, and conducted from adhesive member 52 and projection member 51 to substrate 1. In this way, “the heat of the semiconductor light emitting element 3 and the fluorescent substance-containing resin layer 4 can be radiated to the substrate 1 at a position remote from the region of the substrate 1 to which the heat is conducted via the insulating

substrate 2 (directly under the insulating substrate 2), and free from fear of heat saturation.” *Id.*

C. U.S. Patent App. Pub. No. 2005/0039879 (“Hanai”) (Ex. 1006)

Hanai discloses a pliable, anisotropically heat-conducting graphite sheet used for “the cooling of heat-generating elements” arranged on a circuit substrate, in particular for “the cooling of multiple heat-generating elements of different shapes.” Ex. 1006, [0001]. Hanai’s invention “efficiently cools heat-generating elements when many heat-generating elements of different shapes are mounted at high density.” *Id.*, [0007].

As shown in Figure 3, Hanai discloses printed circuit board 300 with aluminum heat sink 310 located at one side. Mounted on printed circuit board 300 are a plurality of “heat generating elements” of different heights, shapes and spacings. Ex. 1006, [0005], [0019].



Ex. 1006, Fig. 3

“Heat transmission member” 320 comprised of pliable graphite sheet 321 and flexible heat conducting sheet 322 is superimposed over the top of and adheres closely to heat generating elements 300a, 300b, 300c, 300d, 300e, as seen in the exemplary configuration shown in Figure 4, Ex. 1006, [0021].

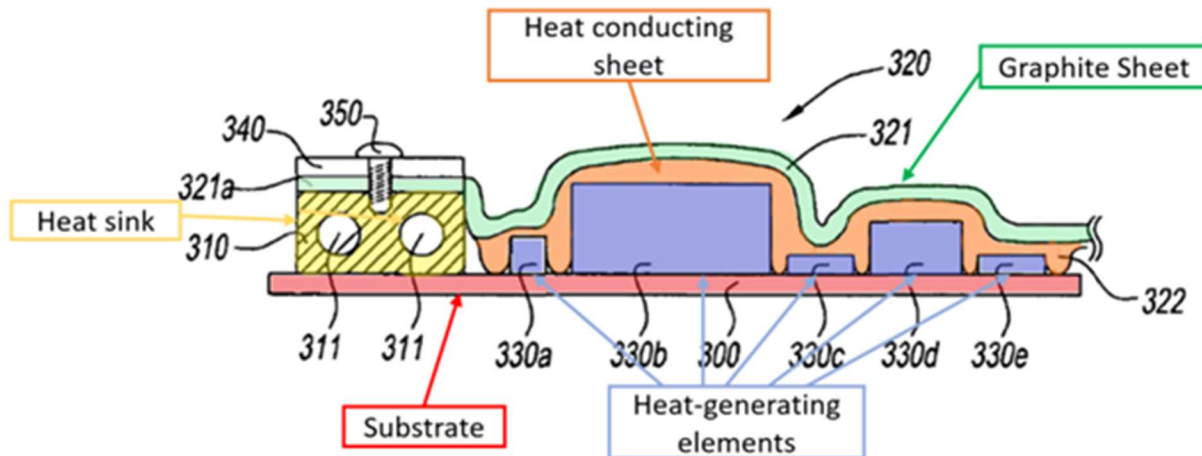


Fig. 4

Ex. 1006, Fig. 4 (annotated)

The heat-generating elements (highlighted in blue) mounted on the printed circuit board substrate (red) are of inconsistent sizes, but graphite sheet 321 (green) and heat conducting sheet 322 (orange) are flexible enough to fit over the top of the heat-generating elements. Ex. 1006, [0020]. Graphite sheet 321 conducts heat anisotropically. The heat conductivity of the graphite sheet is approximately 5 W/mK to approximately 20 W/mK in the direction of its thickness and approximately 200 W/mK to approximately 800 W/mK in the direction of the plane of the surface. Heat conducting sheet 322, in contrast, conducts heat isotropically; that is, at approximately the same rate in all directions. Ex. 1006, [0019].

Graphite sheet 321 is thermally joined to heat sink 310 and “quickly transmit[s] the heat that has been transmitted from heat-conducting sheet 322 to heat sink 310.” Ex. 1006, [0021]. As a result, “heat transmission member 320 can

efficiently cool these heat-generating elements when many heat-generating elements of different shapes are mounted at high density.” *Id.* Hanai teaches that heat conducting sheet 322 is “flexible” enough and graphite sheet 321 is “pliable” enough that this arrangement “can be used as is, even if the placement of heat-generating elements 330 a, etc. changes. As a result, economics and development efficiency are improved when compared to the prior art.” *Id.*

VIII. APPLICATION OF PRIOR ART TO THE CHALLENGED CLAIMS

A. Ground I: Claims 3, 15, and 16 Would Have Been Obvious Over a Combination of Kuo and Nozaki

The POSA would have found it obvious to combine the teachings of Kuo and Nozaki to arrive at the alleged inventions defined by claims 3, 15, and 16. Kuo discloses the basic electronic packaging structure claimed, including a heat-spreading panel, but not one that conducts heat anisotropically. It also discloses an adhesive coupling the outer edge of the heat-spreading panel to the heat-conducting support structure, although it does not expressly state that the adhesive is thermally conductive (claim 15). The POSA would have found it obvious to use Nozaki’s anisotropic heat-spreading material for the panel of Kuo and to employ thermally conductive adhesive as claimed.

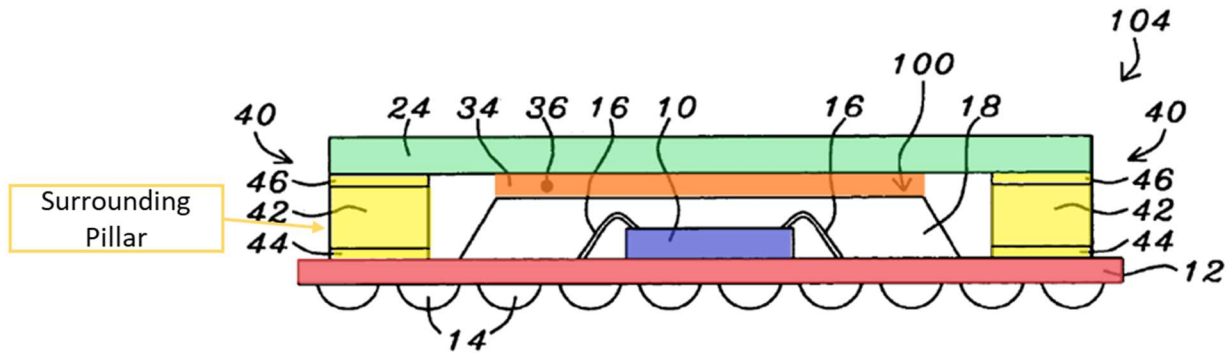
1. Independent Claim 3

a. Preamble: An electronic assembly comprising:

To the extent the preamble is limiting, Kuo discloses this limitation. Kuo discloses in Fig. 2B an embodiment of heat spreader ball grid array package 104 intended to house IC chip 10, which is expected to generate “lots of heat” that must be dissipated from the package. Ex. 1004, 1:13–18; 4:42–45; Fig. 2B. Ex. 1003, ¶ 160.

b. Limitation 3[a]: a support structure comprising walls enclosing a space;

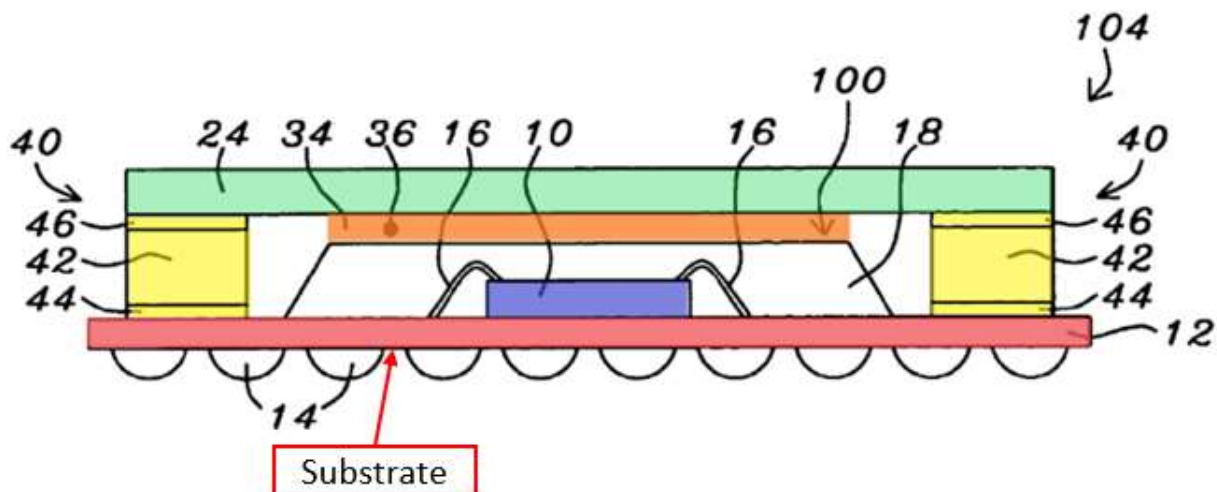
Kuo discloses this limitation. Kuo illustrates in Fig. 2B “surrounding pillar” 40 in the shape of a “square ring” mounted on substrate 12. Pillar 40 comprises metal “stiffener portion 42” that is fixed to substrate 12 and provides structural support for package 104. The POSA would understand from this description that the square-ring-shaped pillar forms a support structure having four “walls” enclosing a space that includes within it semiconductor IC 10 encased in molding material 18 as well as gap 34, which includes thermal grease 36 located over molding material 18. Ex. 1004, 4:42–64; 5:4–12; Fig. 2B; Ex. 1003, ¶¶ 161–62.



Ex. 1004, Fig. 2B (annotated)

- c. **Limitation 3[b]: a circuit substrate coupled to a first portion of said support structure, said circuit substrate comprising a mounting surface;**

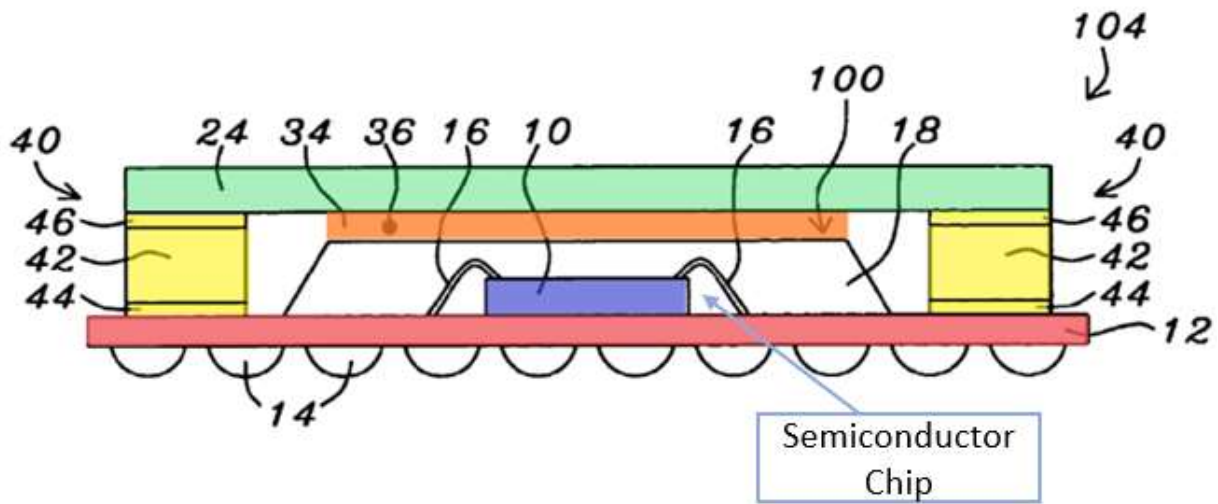
Kuo discloses this limitation. Kuo discloses that “ball grid array (BGA) chip 100 includes semiconductor chip 10 mounted onto a substrate 12 and is electrically connected to substrate 12 by, for example, lead wires 16. Substrate 12 includes balls 14 mounted on its surface opposite the silicon semiconductor chip 10.” Ex. 1004, 2:42–46. Surrounding pillar 40 is coupled to substrate 12 via epoxy adhesive 44. *Id.*, 4:47–49. The POSA would understand from this description that substrate 12 is a “circuit substrate” that comprises a mounting surface for semiconductor chip 10 and is coupled to a first portion of a support structure (pillar 40) via epoxy adhesive 44. Ex. 1003, ¶ 163.



Ex. 1004, Fig. 2B (annotated)

d. Limitation 3[c]: an electronic device attached to said mounting surface and disposed within said space; and

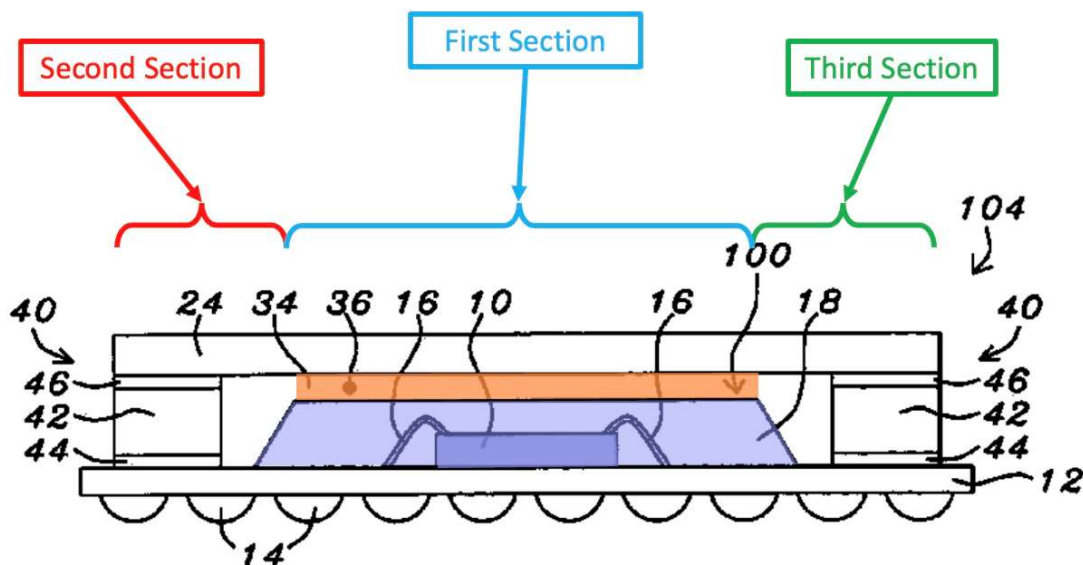
Kuo discloses this limitation. The '925 patent specification describes an exemplary “electronic device” as “any type of electronic apparatus, component, circuit element, and/or the like” including, for example, “a semiconductor die comprising one or more integrated electronic circuits, an electronic component (e.g., a resistors, capacitor, inductor, transistor or the like), a diode, or the like.” Ex. 1001, 3:30–36. The POSA would understand from Kuo’s description that semiconductor chip 10 is an “electronic device” as contemplated by the '925 patent. Ex. 1003, ¶ 164.



Ex. 1004 at Fig. 2B (annotated)

- e. **Limitation 3[d]: a panel coupled to a second portion of said support structure, said panel comprising contiguous sections, each said section comprising an inner surface facing said mounting surface of said circuit substrate and oriented within twenty-five degrees of parallel to said mounting surface,**

Kuo discloses this limitation. Kuo discloses that heat spreader 24 is coupled to a second portion (top portion) of surrounding pillar 40 (the support structure) via epoxy adhesive 46 so as to be located over and above ball grid array chip 100 (which includes semiconductor chip 10). Ex. 1004, 4:56–59.



Ex. 1004, Fig. 2B (annotated)

The POSA would consider these portions to be different but contiguous sections of the heat spreader. The first section of the heat spreader, as understood by the POSA, is that portion of heat spreader 24 located directly above semiconductor chip 10 and its molding compound 18. This is the location where thermal grease 36 (orange) is placed to provide a thermally conductive interface between heat spreader 24 and molding compound 18. Ex. 1004, 5:18–21. This first section of heat spreader 24 absorbs the heat transferred from semiconductor chip 10 and molding compound 18 via thermal grease 36. Ex. 1003, ¶¶ 165–167.

The POSA would have understood that the portions of the heat spreader located contiguously but to the sides of the first section (identified as the second and third sections), do not have thermal grease under them, for mechanical reasons. As the thermal grease increases in temperature, it expands in volume. Because the

portions of gap 34 under the second and third sections have no thermal grease, the volume under those sections can accommodate the expansion of the thermal grease under the first section. Ex. 1004, 5:6–9. The heat absorbed into the first section through thermal grease 36 is spread away, in part, through the second and third sections of heat spreader 24 to pillar 40. The POSA would thus have a logical and technical reason to regard the first section of the panel directly above the thermal grease in Kuo as a separate and distinct section of the panel from the sections of the panel that are not located directly above the thermal grease. Ex. 1003, ¶ 168.

In addition, the patent applicant's behavior during prosecution shows that the applicant acquiesced to the examiner's view that Fig. 1A of Mohammed, which shows a heat spreader configured similarly to Kuo's, comprised at least three contiguous sections. As explained in the "Prosecution History" section above, the examiner determined that the flat heat-spreading panel shown in Fig. 1A of Mohammed included a panel with at least three contiguous sections parallel to the mounting surface of the circuit substrate. Ex. 1002, 136. The examiner further found that the "sections are not differentiated by any particular structural attributes" and that flat "parallel sections" met the requirement that each section be oriented "within 25 degrees of parallel" as claimed. *Id.*

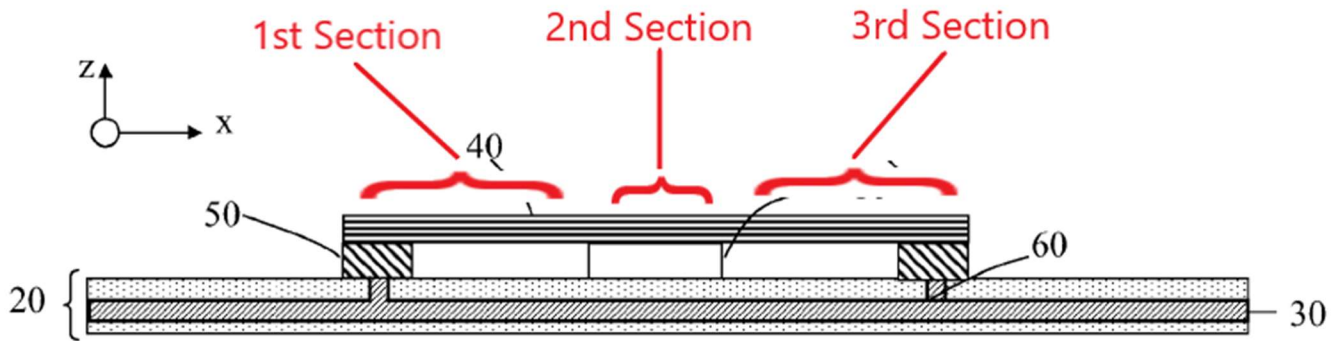


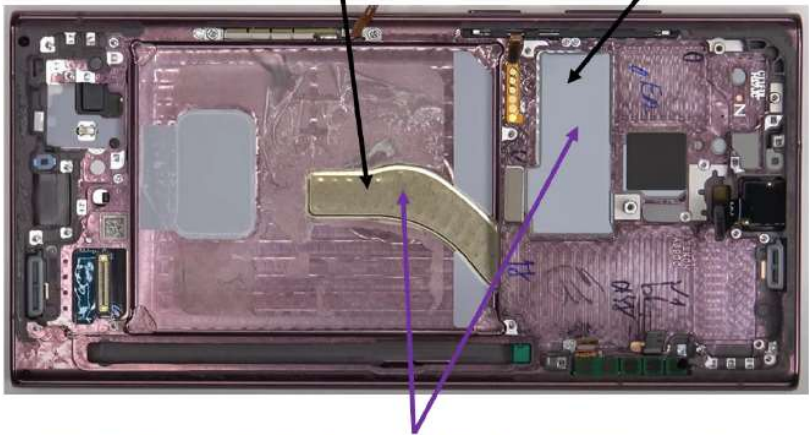
Fig. 1A

Ex, 1009, Fig. 1A (annotated)

The examiner’s interpretation of Mohammed, which the patent applicant did not dispute, is equally applicable to the similar heat spreader of Kuo. The prosecution history thus supports the position that a flat, planar panel such as shown in Kuo or Mohammed meets this limitation.

In addition, Patent Owner has recently taken the same view as the examiner and the original patent applicant as to what constitutes a contiguous section. In its infringement contentions served in the parallel district court litigation against Petitioner, Patent Owner contends that a flat graphite sheet contained in Petitioner’s accused smartphones is a “panel comprising contiguous sections, each said section ... oriented within twenty-five degrees of parallel to the mounting surface.” Ex. 1007; Ex. 1008, 8–10:

[3d] a panel coupled to a second portion of said support structure, said panel comprising contiguous sections, each said section comprising an inner surface facing said mounting surface of said circuit substrate and oriented within twenty-five	Each Accused Product comprises a panel coupled to a second portion of said support structure, said panel comprising contiguous sections, each said section comprising an inner surface facing said mounting surface of said circuit substrate and oriented within twenty-five degrees of parallel to said mounting surface. For example, the Galaxy S22 Ultra contains a vapor chamber and a graphite sheet, each of which has an inner surface facing the mounting substrate and substantially parallel to it. <i>See, e.g.:</i>
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Claim 3	Accused Products
degrees of parallel to said mounting surface,	Vapor Chamber Graphite  a panel coupled to a second portion of said support structure, said panel comprising contiguous sections, each said section comprising an inner surface facing said mounting surface of said circuit substrate and oriented within twenty-five degrees of parallel to said mounting surface (the graphite film, vapor chamber and boards are all oriented parallel to the plane of the frame flat surface – and likely within 1 degree of parallel to the mounting surface. The graphite is visible through holes in the flat surface of the frame and covers a larger area on the opposite side of the frame)) Annotated photograph of Galaxy S22 Ultra.

Claim 3	Accused Products
	Graphite  Vapor Chamber (graphite film has been peeled back)  (these are views from the opposite side of the frame – to better see how the vapor chamber and graphite film have contiguous sections) Annotated photographs of Galaxy S22 Ultra.

Excerpts from Ex. 1008

Patent Owner is thus on record that a flat, planar panel comprised of heat conducting material can be regarded as having plural contiguous sections oriented within twenty-five degrees of parallel to the mounting surface, as the examiner interpreted Mohammed and as shown by Kuo. Kuo therefore meets this limitation. Ex. 1003, ¶¶ 169–172.

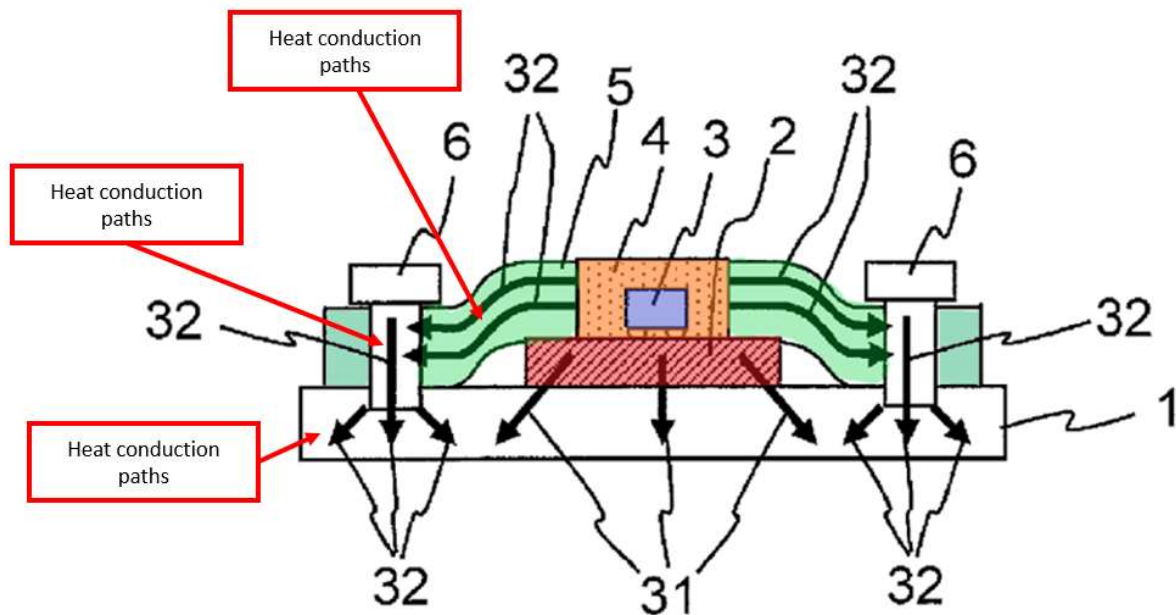
f. Limitation 3[e]: wherein each said section has a first thermal conductivity substantially parallel to the inner surface of said section and a second thermal conductivity substantially perpendicular to the inner surface of said section,

This limitation would be satisfied by Kuo as modified to use the anisotropic heat-spreading material of Nozaki. Ex. 1003, ¶ 173. Kuo’s heat-spreading panel 24 is constructed from a metal material, most preferably copper. Ex. 1004, 4:61–64. Such a material spreads heat isotropically; that is, approximately equally in all directions. Ex. 1003, ¶ 141. The POSA would have been motivated to combine the teachings of Kuo and Nozaki by substituting Nozaki’s anisotropic heat-spreading composite graphite material for Kuo’s metal heat-spreading panel 24 to achieve the advantage of more efficient dissipation of heat from the semiconductor device, through the plane of the heat-spreading panel, and into the surrounding support structure of Kuo. Ex. 1003, ¶ 146.

Nozaki, like Kuo, is directed to a packaging assembly for semiconductor devices, where dissipation of heat generated by the semiconductor device is an

important consideration. Kuo recognizes that advanced IC products such as those used in Kuo “produce lots of heat which require the use of heat spreaders.” Ex. 1004, 1:16–19. Nozaki also addresses the “desire[] to increase heat radiation efficiency” from heat-producing semiconductor elements. Ex. 1005, [0002]. These references are therefore in the same field and closely related to one another, and the POSA looking to solve the problem of managing heat in a semiconductor package would have been likely to consult both references. Ex. 1003, ¶ 147.

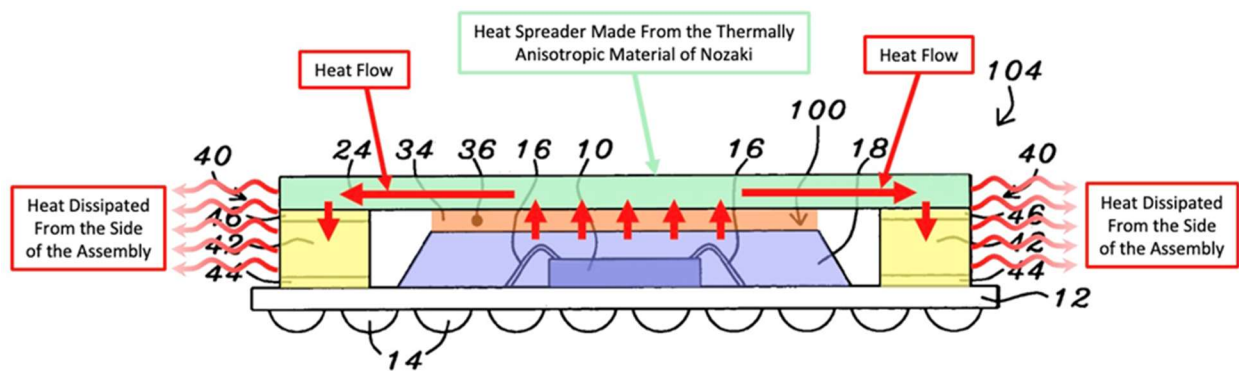
Nozaki teaches that an anisotropic heat-spreading material should be used to increase the heat radiation efficiency from a semiconductor device. The anisotropic heat-spreading material disclosed by Nozaki is a composite material constructed in alternating layers of graphite sheets and acrylic adhesive. This material conducts substantially more heat along the plane of the sheet than it does through the thickness of the sheet. The exemplary material described in Nozaki has a thermal conductivity of “4 to 6 w/mk for the thickness direction” and “1200 w/mk for the plane direction.” Ex. 1005, [0090]; Ex. 1003, ¶¶ 136, 175. Employing such a material allows heat to be conducted from the semiconductor device along the plane of the heat spreader to the outside frame members of the package assembly, as Nozaki illustrates with arrows in Fig. 3. Ex. 1005, [0051]; Ex. 1003, ¶ 148.



Ex. 1005, Fig. 3 (annotated)

By using a thermally anisotropic heat spreader in the assembly of Kuo, the thermal energy from the heat source is more efficiently transferred away from the semiconductor element, as illustrated below. In Nozaki, the anisotropic heat spreader conducts heat from element 3 to screw 6 and metal substrate 1, each of which is preferably made of copper or aluminum. Similarly for Kuo, as illustrated below, the heat from the anisotropic heat spreader would couple into element 42, which is preferably comprised of copper, in addition to being dissipated from the side of the anisotropic heat conducting material. The anisotropic heat conducting material, with its very high heat conductivity (on the order of 1200 W/mK), helps move the heat from the source to the copper surrounding pillar, which also has a high heat

conductivity (on the order of 400 W/mK). This would allow the semiconductor element in Kuo to have better performance by keeping it at a lower temperature, while also eliminating hot spots above the semiconductor element. Ex. 1003, ¶ 149.



Ex. 1004, Fig. 2B (annotated)

As Dr. Spangler notes, in Nozaki’s preferred embodiments, heat enters into the *edge* of the anisotropic heat conduction material 5 from the light emitting semiconductor device. In the combination with Kuo, the POSA would have understood that heat would enter the anisotropic heat conducting material from the *bottom side* of the anisotropic heat spreader through thermal grease 36, whose purpose is to facilitate the heat transfer from the encapsulated heat-generating IC device into the heat-spreading panel. *See* Ex. 1004, 5:18–21 (thermal grease creates “thermally conductive interface between the heat spreader...and the molding compound 18”). Ex. 1003, ¶¶ 150-51. This design was common. Ex. 1003, ¶ 158.

Although the thermal conductivity of the graphite material is relatively low in the c-direction, the thermal grease forms an intimate contact with the surface of the

graphite heat spreader and minimizes interface gaps, which allows thermal energy to be transferred from the heat generating elements. This is because the thermal energy needs to propagate only a short distance from the surface to enter the plane of the heat spreader. Once the thermal energy is in the graphite heat spreader, the high thermal conductivity in the in-plane direction allows the thermal energy to be shunted to the outside of the package and into support pillar 40, which is preferably comprised of copper. Because the thermal conductivity in the plane of the graphite heat spreader is much greater than in the thickness direction, the heat flow, as shown by the lateral red arrows in the above figure, results in the thermal energy being drawn away from the electronic device. Ex. 1003, ¶ 152.

The POSA would understand that heat also would be transferred in the perpendicular direction from the anisotropic heat spreading panel into metal support pillar 42. The POSA would appreciate that the layer 46 of epoxy between the heat-spreading panel and the metal pillar would be very thin, on the order of 0.001 inch (25 microns), and also be made of a thermally conductive epoxy. Alternatively, the POSA would have known that, if necessary to meet design specifications for heat dissipation, the electronic assembly could be designed such that the edge of anisotropic heat spreader 24 abuts support structure wall 42 in Kuo to facilitate heat transfer, similar to how composite heat spreading material 5 abuts screws 6 in Nozaki. Ex. 1003, ¶ 153.

The POSA would have understood that transferring heat from the source of the thermal energy and spreading it to the side of the package as taught by both Kuo and Nozaki is desirable. This approach to thermal management keeps the heat-generating components inside the package cooler, which generally improves their performance. The sides of the package typically have more area than the central portion of the package, so the thermal energy is spread over a larger area, which results in lower overall temperature of the component inside the package as well as the package itself. Ex. 1003, ¶ 154.

The POSA would have appreciated the advantages of this approach, particularly in portable electronics such as cell phones or laptops, because it reduces undesired “hot spots”; that is, portions of the device that are noticeably hotter than the rest of the device. Not only are hot spots undesired by the user, hot spots can also cause localized mechanical stress due to the hot components expanding more than cooler components, based on their coefficients of thermal expansion (CTE). Different materials used in the electronic device have different CTEs and thus expand a different amount for a given temperature change. This may lead to stress gradients developing inside the device that can cause functional and reliability failures. Transferring heat with an anisotropic heat spreader to the sides of the package enables further heat dissipation when the sides of the package are placed in

contact with other parts of the electronic device or subject to airflow. Ex. 1003, ¶¶ 154-55.

The POSA also would have appreciated another advantage of spreading heat to the support structure where other electronic components that are placed over or near the heat-generating component must be protected from heat. The anisotropic heat spreader causes the heat to be transferred to the support structure, so the temperature directly above or near the heat-generating components does not increase to the point of degrading the performance of the component above or nearby. POSAs had been using this approach in portable devices for many years prior to 2013 as a way to protect, for example, the display portion of the device from having a localized “hot spot” that could adversely affect the display characteristics over the hot spot. Ex. 1003, ¶ 155.

In modifying Kuo to use a thermally anisotropic heat spreader as taught in Nozaki, the POSA would have reasonably expected success in achieving an electronic packaging assembly having a heat-spreading panel in which the contiguous sections thereof have “a first thermal conductivity substantially parallel to the inner surface of said section and a second thermal conductivity substantially perpendicular to the inner surface of said section” as claimed. The design and manufacture of such a structure would have been straightforward; the POSA simply would have replaced the flat heat-spreading panel 24 of Kuo with a flat heat-

spreading panel made from Nozaki's composite graphite material. The pillar structure, including the frame and epoxy adhesive holding the heat spreader to the frame, would not have to change. Ex. 1003, ¶ 156.

As discussed above in Section VII, the anisotropic heat-spreading graphite material taught by Nozaki was well-known before the priority date of the '925 patent, and the POSA would not have faced problems in making the combination that the POSA would not have been able to address through routine experimentation or design choices. Ex. 1003, ¶ 157.

g. Limitation 3[f]: wherein for each said section, said first thermal conductivity is at least one-hundred times greater than said second thermal conductivity,

This limitation would be satisfied by Kuo as modified to use the anisotropic heat-spreading material of Nozaki. As explained above, the exemplary anisotropic heat-spreading material disclosed by Nozaki has a thermal conductivity in the plane direction of 1200 W/mK and a thermal conductivity in the thickness direction of 4 to 6 W/mK. Ex. 1005, [0090]. Nozaki thus discloses a material whose thermal conductivity in the in-plane direction is from 200 (i.e., $1200/6$) to 300 (i.e., $1200/4$) times the thermal conductivity in the thickness direction. Ex. 1003, ¶¶ 175-76. Thus, the “first thermal conductivity” of the material in Nozaki is “at least one-hundred times greater” than the second thermal conductivity, as required by this claim limitation.

2. Independent Claim 15

a. Preamble: An electronic assembly comprising:

To the extent the preamble is limiting, Kuo discloses this limitation as explained with respect to Claim 3 Preamble above.

b. Element 15[a]: a support structure comprising walls enclosing a space;

Kuo discloses this limitation as explained with respect to Limitation 3[a] above.

c. Element 15[b]: a circuit substrate coupled to a first portion of said support structure, said circuit substrate comprising a mounting surface;

Kuo discloses this limitation as explained with respect to Limitation 3[b] above.

d. Element 15[c]: an electronic device attached to said mounting surface and disposed within said space; and

Kuo discloses this limitation as explained with respect to Limitation 3[c] above.

e. Element 15[d]: a panel coupled to a second portion of said support structure, said panel comprising contiguous sections, each said section comprising an inner surface facing said mounting surface of said circuit substrate and oriented within twenty-five degrees of parallel to said mounting surface,

Kuo discloses this limitation as explained with respect to Limitation 3[d] above.

- f. Element 15[e]: wherein each said section has a first thermal conductivity substantially parallel to the inner surface of said section and a second thermal conductivity substantially perpendicular to the inner surface of said section,**

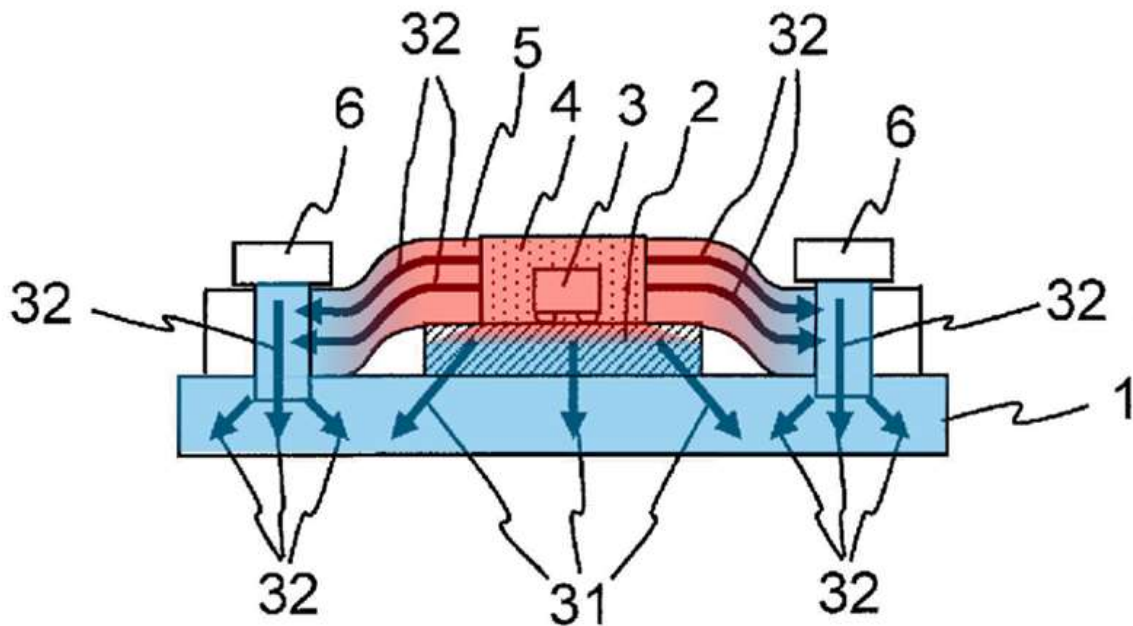
Kuo in combination with Nozaki satisfies this limitation as explained with respect to Limitation 3[e] above.

- g. Element 15[f]: wherein said first thermal conductivity is greater than said second thermal conductivity,**

This limitation would be satisfied by Kuo as modified to use the anisotropic heat-spreading material of Nozaki. As explained with respect to Limitation 3[e], the composite graphite material used by Nozaki conducts heat anisotropically; that is, the material conducts substantially more heat along the plane of the sheet than it does through the thickness of the sheet. The exemplary material described in Nozaki has a thermal conductivity in the in-plane direction of 1200 W/mK and a thermal conductivity in the thickness direction of 4 to 6 W/mK. Ex. 1005, [0090]. The combination of Kuo and Nozaki thus would result in an electronic package assembly where in each contiguous section, the “first thermal conductivity” in the in-plane direction is greater than “said second thermal conductivity” in the perpendicular direction, as claimed. Ex. 1003, ¶¶ 136, 147–49, 152–57, 175, 183.

- h. Element 15[g]: wherein a thermally conductive path from said space enclosed by said walls of said support structure out of said electronic assembly that has a greatest thermal conductivity comprises a thermal path through contiguous ones of said sections of said panel to an outer edge of an outer one of said sections of said panel, and**

This limitation would be satisfied by Kuo as modified to use the anisotropic heat-spreading material of Nozaki. Nozaki describes the thermal path through which heat escapes from the interior of the electronic assembly through its anisotropic heat-spreading material, and illustrates that path in Fig. 3. As shown by arrows 32, heat passes through the anisotropic heat-spreading composite graphite material 5 to metal screws 6 (in Nozaki's first embodiment) and then to metal substrate 1. Ex. 1005, [0049]. Additionally, some amount of heat passes through substrate 2 to metal substrate 1 below, as shown by arrows 31. *Id.*

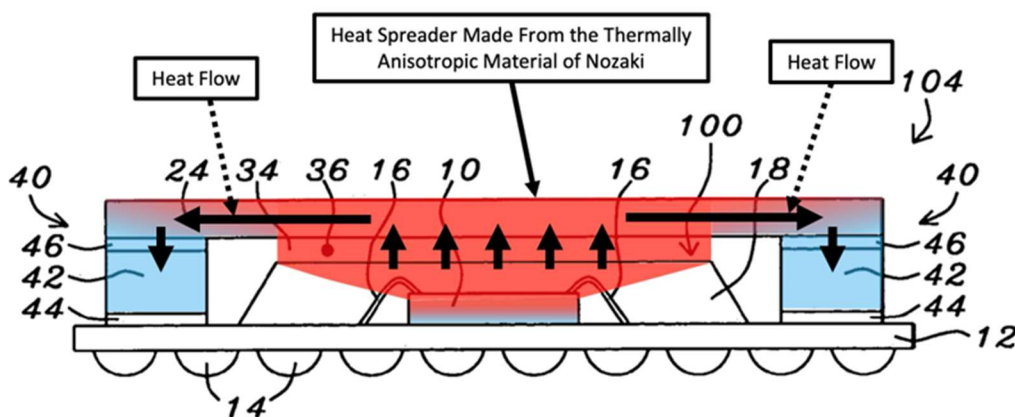


Ex. 1005, Fig. 3 (annotated)

Ex. 1003, ¶ 184. As Dr. Spangler explains, the thermal conductivity of the heat conductive path through the contiguous sections is the path through the graphite material having a thermal conductivity in the in-plane direction of 1200 W/mK and further into the metal screws and metal substrate, which are preferably copper, which has a thermal conductivity of approximately 400 W/mK. This path is shown by arrows 32. The POSA would have understood that the heat conductivity of substrate 2, which is described for example as a ceramic material such as aluminum nitride, is less than the heat conductivity of the anisotropic heat-spreading composite graphite material in the in-plane direction. Aluminum nitride has a thermal conductivity on the order of 170 W/mK. Ex. 1003, ¶ 185. Thus, the POSA would have understood

that the thermally conductive path shown by arrows 32 is the path with greatest thermal conductivity in Nozaki's assembly. Ex. 1003, ¶ 186.

When replacing the copper heat spreader of Kuo with the thermally anisotropic heat spreader of Nozaki, a thermal path that meets this claim limitation is also formed. The heat from the semiconductor chip 10 and mold 18 is transferred through the thermal grease to the thermally anisotropic lid. Due to the anisotropy of the graphite material, the heat is then transferred laterally and from there, the thermal energy couples into the pillar structure 40. Kuo, like Nozaki desires to transfer heat efficiently from the space enclosed by the assembly.



Ex. 1004, Fig. 2B (annotated)

While Kuo does not expressly identify the material from which its substrate 12 is formed, the POSA would have appreciated that it was known that BGAs use insulating materials for the substrate such as printed circuit board (PCB) made of laminated organic (FR4, BT resins, etc.) or ceramic materials because these insulating materials allow for electrically conductive traces to be formed on top of,

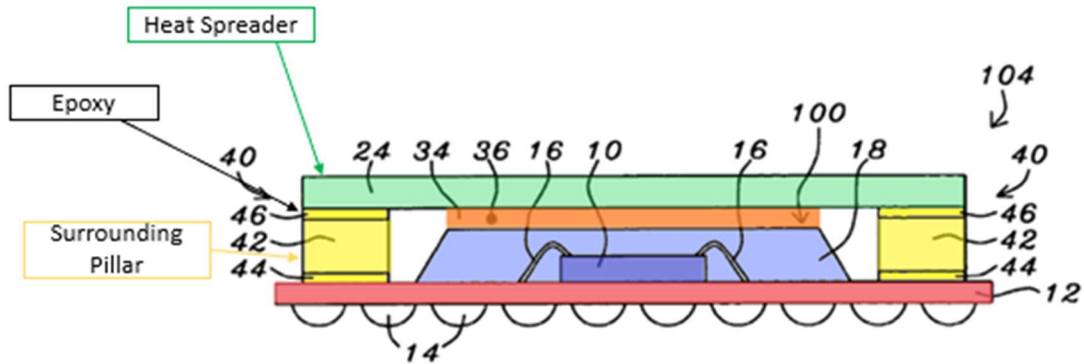
on the underside of and inside the substrate. The thermal conductivity of PCB substrates is typically in the range of 0.5 to 0.3 W/mK. Ex. 1003, ¶ 188.

The POSA would have appreciated that, in implementing the combination of Kuo and Nozaki using the anisotropic graphite heat spreading material for the panel and an insulating material for the substrate, the thermal path from the space enclosed by the walls of the support structure out of said electronic assembly that has the greatest thermal conductivity would be the thermal path through the contiguous sections of the anisotropic heat-spreading panel to the outer edges, just as is the case with Nozaki, because other possible paths by which heat would escape would go through the insulating material of the substrate which has a much lower thermal conductivity. The path having the greatest thermal conductivity thus comprises a thermal path through contiguous ones of said sections of said panel to an outer edge of an outer one of said sections of said panel, as claimed. Ex. 1003, ¶¶ 187-89.

- i. Element 15[h]: wherein said electronic assembly further comprises a thermally conductive adhesive coupling said outer edge of said outer one of said sections to said support structure.**

This limitation would be satisfied by Kuo as modified to use the anisotropic heat-spreading material of Nozaki for two reasons.

First, this limitation is at least strongly suggested by Kuo itself. In Kuo, metal heat-spreading panel 24 is fixed to the upper end of metal pillar 40 by epoxy adhesive 46 as shown. Ex. 1004, 4:56–64.



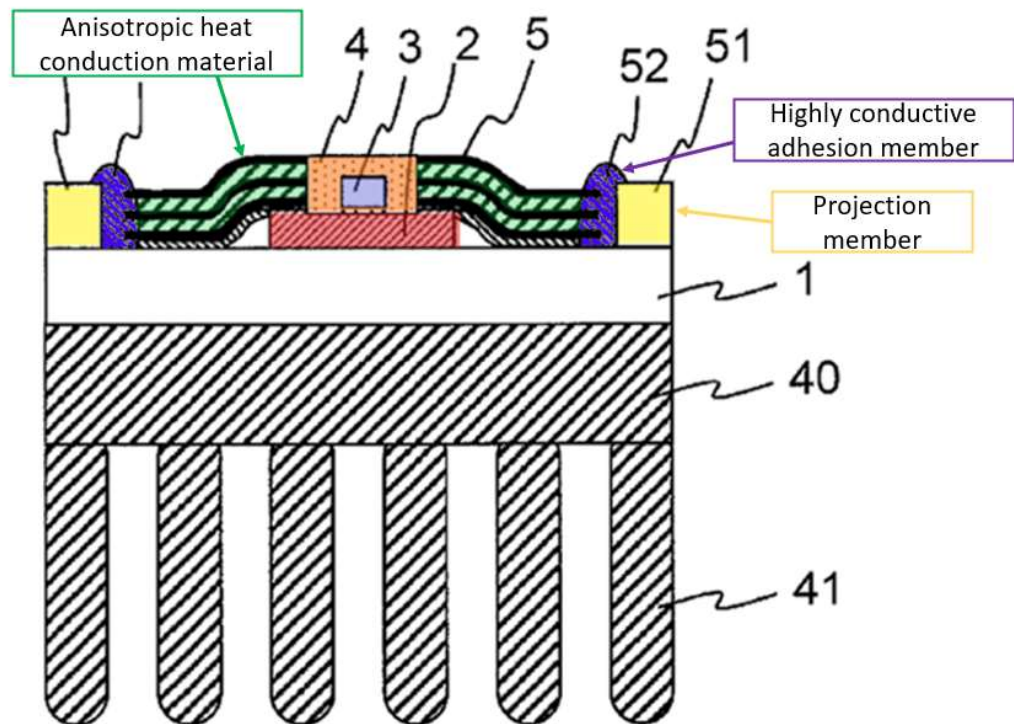
Ex. 1004, Fig. 2B (annotated)

Kuo does not describe the thermal properties of the epoxy. However, as Dr. Spangler explains, the POSA would have understood that epoxy materials used to connect heat-conducting structures were typically spread in very thin layers and filled with a heat-conducting material such as silver or other metal. Ex. 1003, ¶ 190. This is likely to be the case in Kuo because Kuo's ball grid array package is designed to conduct heat away from the semiconductor device primarily through thermal grease 36 to heat spreader 24 and the POSA would have understood that some heat was also intended to flow to support structure 42, which is made of the same material as heat spreader 24. The POSA therefore would have understood that the epoxy material 46 that attaches heat spreader 24 to support structure 42 was likely to have some thermally conductive properties in order to enable this heat transfer. Ex. 1003, ¶ 190.

The POSA further would have been motivated to use a thermally conductive epoxy in Kuo, particularly when Kuo is modified to use the anisotropic heat-spreading material of Nozaki. As discussed above with respect to Limitation 3[e], Nozaki's heat-spreading material allows heat to be conducted from the semiconductor device along the plane of the heat spreader to the outside frame members of Nozaki's package assembly. When modifying Kuo's assembly to use the anisotropic heat-spreading material of Nozaki, the POSA would likewise have been motivated to ensure that heat would be conducted to the outside frame members of the assembly—*e.g.*, copper support structure 42. Doing so would avoid both (1) hot spots that might be annoying to the user or detrimental to adjacent components and (2) concentration of heat in a confined space where components are located in close proximity to one another. Given that it was well-known to use heat-conducting epoxy to join two heat-conducting members, the POSA would have readily employed such a material, regardless of whether the panel was made of copper (as in Kuo) or the thermally anisotropic graphite of Nozaki. Ex. 1003, ¶¶ 191–92.

Second, Nozaki specifically teaches the use of thermally conductive adhesive for connecting its anisotropic heat-spreading material to the outside frame members of its package assembly. As shown below, Nozaki illustrates a second embodiment of his invention in Figure 5, which includes “highly heat conductive adhesion

member 52” in between anisotropic heat-spreading composite graphite material 5 and outer projection member 51. Ex. 1005, [0058].



Ex. 1005, Fig. 5 (annotated)

Projection member 51 is not made of metal (unlike the metal screw 6 in Nozaki’s first embodiment). Nevertheless, projection member 51 has heat conductivity greater than the conductivity of the composite graphite material in the perpendicular direction. Ex. 1005, [0058]. To further facilitate heat transfer in this embodiment, Nozaki teaches to interpose “highly heat conductive adhesion member 52” (indicated in purple in the annotated figure above) between the outer edge of anisotropic heat-spreading composite graphite material 5 and projection member 51, which have a heat conductivity comparable to or higher than that of the substrate 1.

Ex. 1005, [0058]. Heat conductive adhesion member 52 may be a “cured heat conductive paste containing a highly heat conductive metal filler such as those of tungsten, carbon, copper, aluminum, silver and gold.” Ex. 1005, [0058]. These thermally conductive epoxy materials were well-known prior to 2013. Ex. 1003, ¶¶ 191–93.

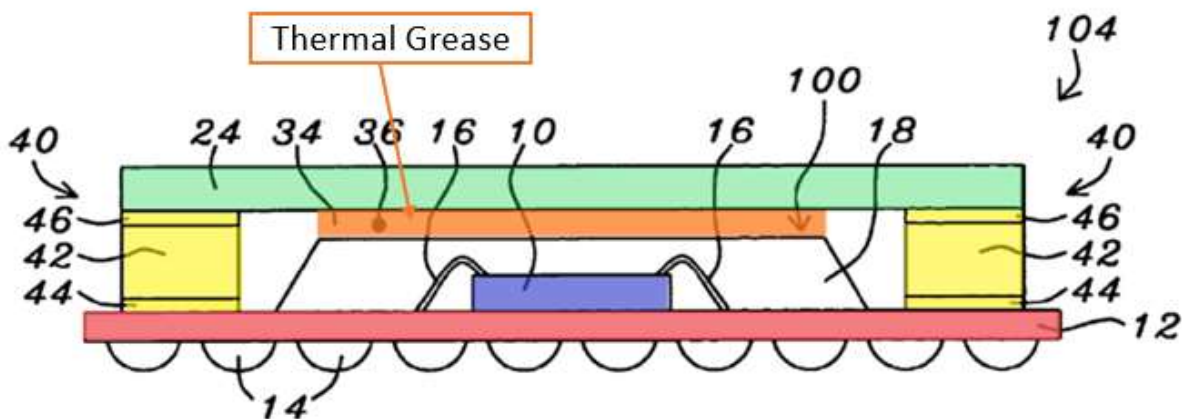
In implementing the combination of Kuo and Nozaki, the POSA would have been motivated to include such a thermally conductive adhesive (as taught by Nozaki) between the anisotropic heat-spreading composite graphite panel and the support structure to further efficiently conduct heat generated by the electronic device from the anisotropic heat-spreading composite graphite panel to the sidewalls of the electronic assembly where the heat can be further dissipated, as taught by Nozaki. Ex. 1003, ¶¶ 194–95.

3. Dependent Claim 16

- a. The electronic assembly of claim 15 further comprising a thermally conductive material disposed between and in physical contact with said electronic device and the inner surface of one of said contiguous ones of said sections of said panel.**

Kuo satisfies this limitation. Kuo teaches the insertion of thermally conductive material in the space between epoxy-encapsulated electronic device 100 and metal heat spreader 24 in the form of thermal grease 36. Thermal grease 36 is described as silicone rubber “containing heat-conducting particles such as zinc oxide, aluminum

oxide, aluminum nitride, boron nitride or ceramic fillers or other materials which have the properties of heat conduction.” Ex. 1004, 5:13–17. The POSA would have understood that additional heat dissipation efficiency would be achieved from the presence of the thermal grease between the epoxy-encapsulated electronic device and the heat-spreading composite graphite panel in Kuo as modified by Nozaki. Ex. 1003, ¶¶ 196–97.



Ex. 1004, Fig. 2B (annotated)

B. Ground II: Claims 3, 15, and 16 Would Have Been Obvious Over a Combination of Kuo and Hanai.

The POSA would have found it obvious to combine the teachings of Kuo and Hanai to arrive at the alleged invention defined by claims 3, 15, and 16. As discussed for Ground I above, Kuo discloses the basic electronic packaging structure with a heat-spreading panel. Kuo’s heat-spreading panel does not conduct heat anisotropically. The POSA would have found it obvious to replace Kuo’s heat-spreading panel with Hanai’s pliable anisotropic heat-spreading graphite sheet that

follows the topology of multiple electronic devices mounted on a substrate to maximize heat transfer from all of the devices.

58aki would also result in a heat-spreading panel with contiguous sections having different angular configurations. Thus, to the extent that the Board does not accept that Kuo's planar panel comprises "contiguous sections," this claim requirement would nevertheless be satisfied by Kuo as modified to use Hanai's pliable graphite sheet.

1. Independent Claim 3

a. Preamble: An electronic assembly comprising:

To the extent the preamble is limiting, Kuo discloses this limitation as explained with respect to Ground I above.

b. Limitation 3[a]: a support structure comprising walls enclosing a space;

Kuo discloses this limitation for the reasons explained with respect to this limitation in Ground I above.

c. Limitation 3[b]: a circuit substrate coupled to a first portion of said support structure, said circuit substrate comprising a mounting surface;

Kuo discloses this limitation for the reasons explained with respect to this limitation in Ground I above.

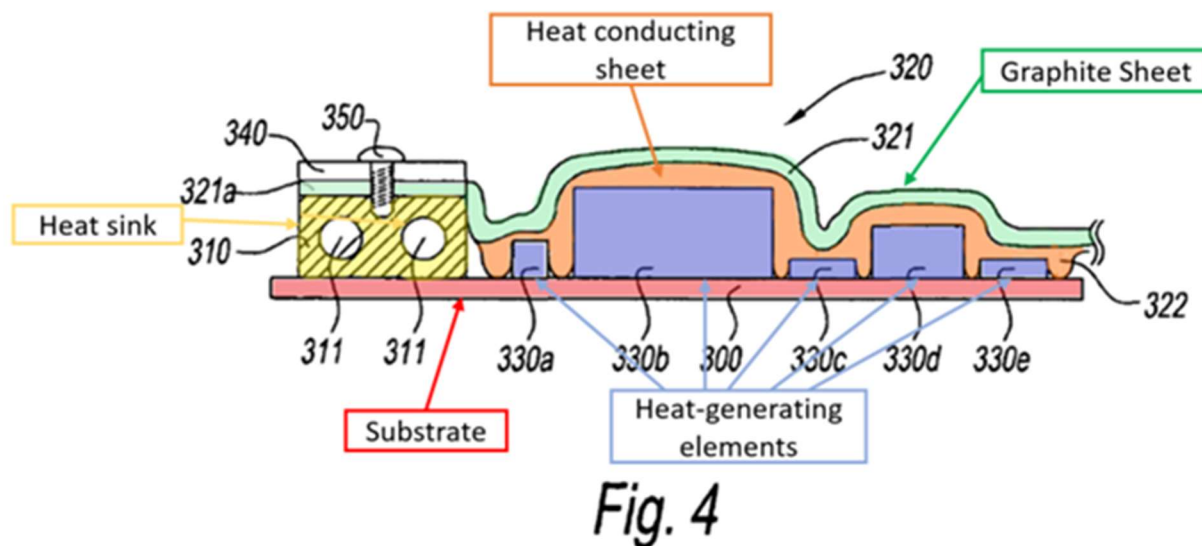
d. Limitation 3[c]: an electronic device attached to said mounting surface and disposed within said space; and

Kuo discloses this limitation for the reasons explained with respect to this limitation in Ground I above. The use of the article “an” in this limitation includes one or more such electronic devices. *See Baldwin Graphic Systems, Inc. v. Siebert, Inc.*, 512 F.3d 1338, 1342–43 (Fed. Cir. 2008).

e. Limitation 3[d]: a panel coupled to a second portion of said support structure, said panel comprising contiguous sections, each said section comprising an inner surface facing said mounting surface of said circuit substrate and oriented within twenty-five degrees of parallel to said mounting surface,

As explained for Ground I, this limitation is met by Kuo because the flat, planar heat-spreading panel of Kuo can be viewed as having separate contiguous oriented within 25° parallel to the substrate, particularly as different sections of the heat-spreading panel are exposed to different amounts of heat in different areas. This understanding was adopted by the examiner during prosecution, accepted by the original applicant, and further adopted by the Patent Owner in recent litigation, as discussed above with respect to Ground I. However, to the extent the Board does not accept that Kuo’s planar panel meets this limitation, the limitation is met additionally by Kuo as modified in view of the teachings of Hanai to use an anisotropic heat-spreading composite graphite panel that follows the topology of multiple electronic devices mounted on a substrate. Ex. 1003, ¶¶ 201-02.

The POSA, when confronted with the problem of enclosing multiple devices of different heights, would have been motivated to combine the teachings of Kuo and Hanai by substituting Hanai's anisotropic, pliable graphite sheet material for the metal material of Kuo's heat-spreading panel 24. This modification would enable the POSA to achieve efficient dissipation of heat from multiple semiconductor devices by designing the sheet material to follow the topology of the devices, as shown in Hanai Figure 4. Ex. 1003, ¶¶ 203-09:



Ex. 1006, Fig. 4 (annotated)

Hanai, like Kuo, is directed to efficiently cooling heat-generating elements mounted on an electronic circuit board substrate. Hanai is specifically directed to an assembly of a plurality of such heat-generating elements having different shapes and heights that are mounted on a substrate. Ex. 1006, [0007]. Ex. 1003, ¶¶ 139, 141–42, 238. Configurations in which such substrates contain multiple electronic devices

having variable shapes, sizes, heights and spacing were common in, for example, portable electronic devices such as cell phones and laptop computers that use ICs enclosed in packages. These packages have different sizes, heights, and shapes due to the specifics of each IC and how it is made. Ex. 1003, ¶¶ 101, 222.

In addition, the spacings between ICs and among other components are important design criteria. Components that must communicate with each other using high frequency signals, such as a microprocessor and a memory IC, are often located close to each other to preserve the integrity of the communication. In contrast, RF IC's are usually located away from the microprocessor or memory ICs so that the RF communication signals do not interfere with the high frequency communication between the microprocessor and the memory. Ex. 1003, ¶ 207.

Hanai teaches that to achieve efficient cooling of multiple electronic devices mounted on a substrate having variable shapes, sizes, heights and spacing, it is important that the heat-spreading element located above the devices be pliable, so that it can closely follow the topology of the devices. Ex. 1003, ¶¶ 201, 203, 209. Hanai further teaches that it is advantageous to employ a material that spreads heat anisotropically. This way, the heat can be effectively transferred to the side of the device. Ex. 1003, ¶¶ 210–14.

Hanai teaches that the pliable, anisotropic heat-spreading graphite sheet “adhere[s] closely to heat-generating elements 330a, etc.,” Ex. 1006, [0021], and

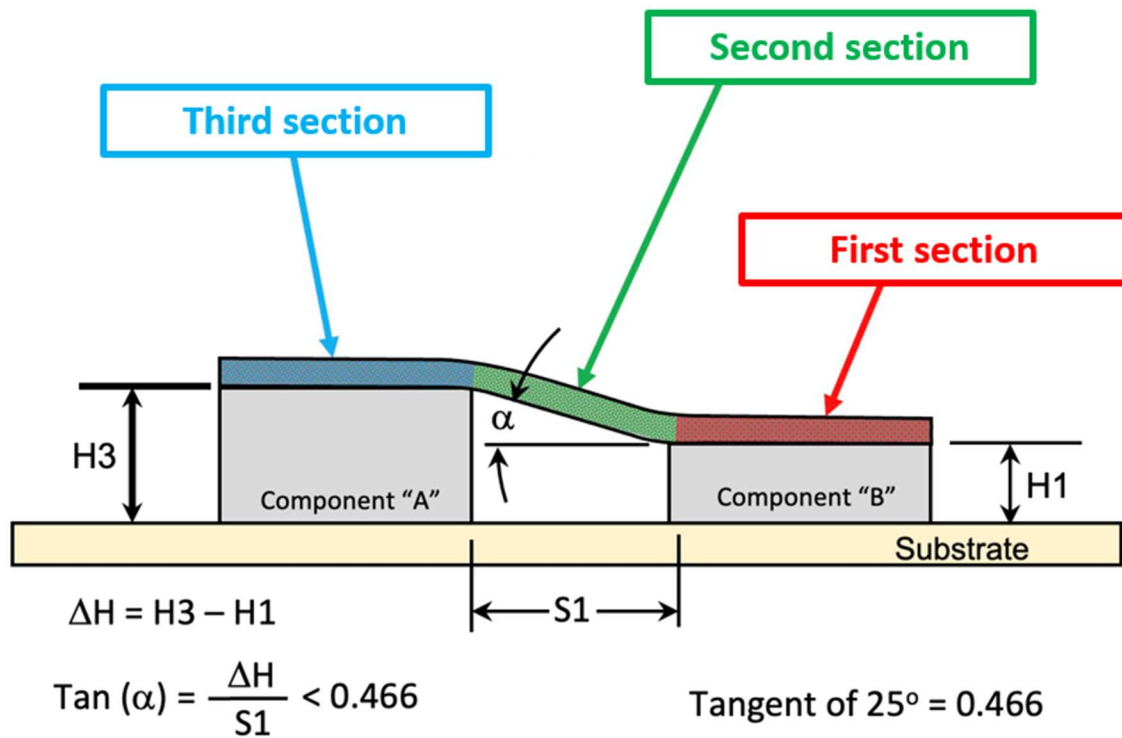
thus conforms to the topology of the plurality of semiconductor devices on the substrate. This teaching mirrors the '925 patent specification's statement that, in the case of multiple devices, the heat-spreading panel can "be customized to different sized electronic devices." Ex. 1001, 9:66-10:3, Fig. 8; Ex. 1003, ¶ 238.

By combining these teachings of Kuo and Hanai, the POSA would have achieved the advantage of conducting heat through the plane of the heat-spreading panel, and into the support structure. Spreading heat to the side of the package has many advantages as explained in Ground I with respect to Limitation 3[e]. For example, spreading heat to the side of the package assembly avoids localized hot spots that not only may be annoying to the user, but also may be detrimental to other adjacent components and contribute to localized mechanical stress due to the hot components expanding more than cooler components based on their CTEs. Ex. 1003, ¶ 212.

The POSA would have appreciated that Hanai's teachings are applicable to a variety of configurations of substrate-mounted semiconductor devices with different shapes, sizes, heights and spacing. The POSA would have appreciated that the exact configuration of the panel would depend on the particular semiconductor device topology being followed by the pliable, anisotropic heat-spreading graphite sheet. Thus, the POSA readily would have appreciated that, for certain combinations of substrate-mounted semiconductor devices, the various sections of the graphite sheet

heat-spreading element would necessarily be oriented within twenty-five degrees of parallel to the mounting surface, as claimed. Ex. 1003, ¶ 236.

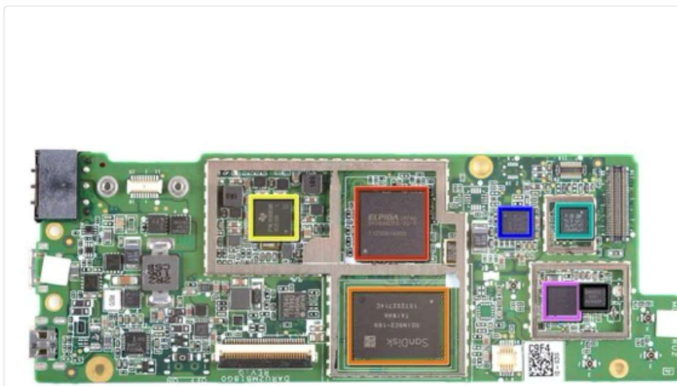
For example, in the case of the geometry set out in the figure below, the POSA would have understood that, if the ratio of the difference in heights between two adjacent electronic devices on the substrate (ΔH) to the distance between the devices (S1) is less than 0.466 (the tangent of 25°) then the angle α between two contiguous sections of the pliable anisotropic heat conducting sheet is necessarily less than 25 degrees. One skilled in the art would understand that this condition is met where design considerations for the end-use device requires devices having such sizes and spacing. Ex. 1003, ¶ 222.



Exemplary Application of Hanai

For example, one such device that existed in the timeframe before 2013 was the BlackBerry PlayBook, which included a pliable graphite heat-spreading sheet used to cover and cool various electronic devices, as documented in the below illustrations from contemporaneous presentations:

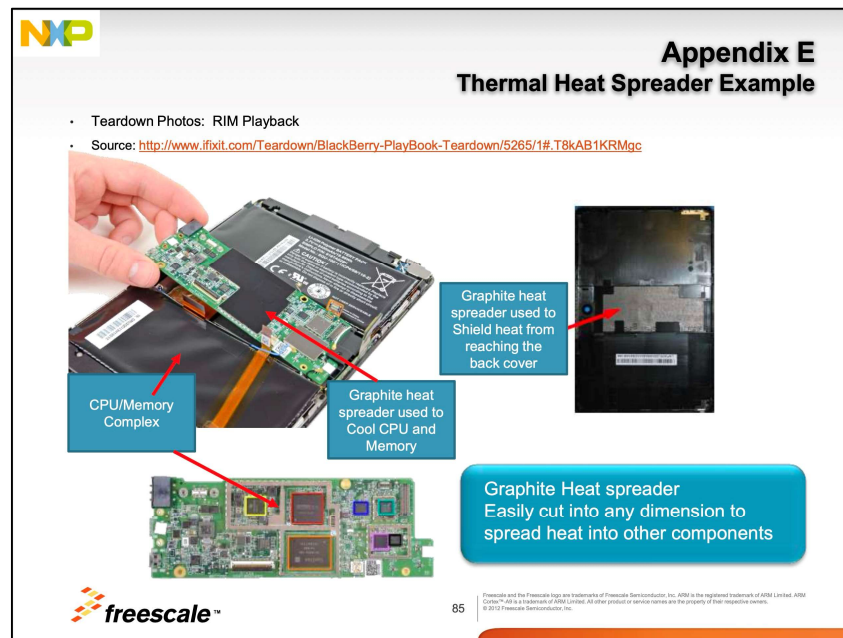
Step 7



- Front view of the motherboard. If you want the super-huge version of the motherboard, [click here](#).

- Elpida B8064B2PB-8D-F 1GB DRAM & the TI OMAP4430 1GHz dual-core processor
- SanDisk SDIN5C2-16G 16 GB NAND Flash
- Texas Instruments TWL6030 Power Management
- STMicroelectronics XTV0987 5 MP mobile imaging processor
- Wolfson WM8994E audio codec
- Texas Instruments WL1283 GPS/WLAN/Bluetooth/FM
- TriQuint Semiconductor TQP6M9002 802.11a/b/g/n + BT front-end module

Illustration of Main Circuit Board of Blackberry Playbook



Illustrations from Tear Down of Blackberry Playbook

As explained in Dr. Spangler's declaration, approximate angles for the contiguous sections of the pliable graphite heat-spreading sheet were determined from specification sheets providing the dimensions of the electronic devices, and

measurements of the device spacing based on the locations shown in these photographs. Given the geometry of this product, the resulting angles of the contiguous sections relative to the substrate would have been on the order of approximately 6 to 11.3°, well within twenty-five degrees of parallel to said mounting surface. Ex. 1003, ¶¶ 223-36.

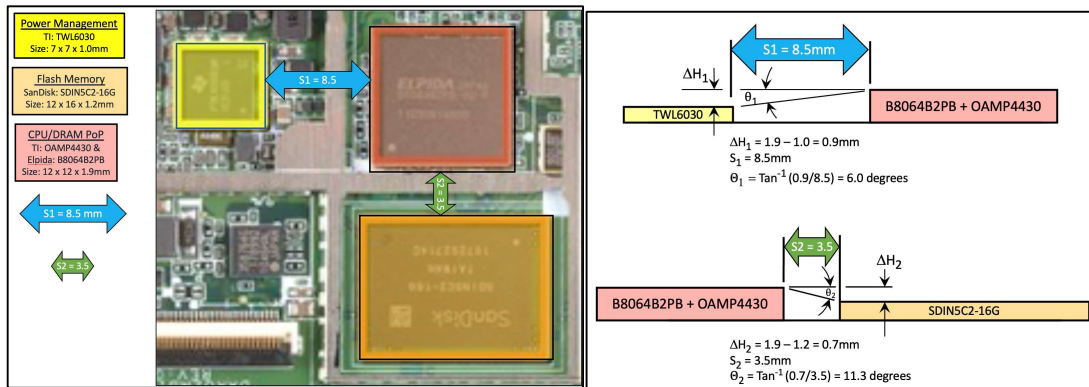


Illustration of Application of Hanai to BlackBerry Playbook

In addition, it bears noting that the '925 patent specification does not ascribe any particular significance to the number of contiguous sections or the exact values of the angles between the inner surfaces of the contiguous sections of the claimed panel, both with respect to one another and with respect to the mounting surface. Ex. 1003, ¶ 237. *See Ormco Corp. v. Align Tech., Inc.*, 463 F.3d 1299, 1311 (Fed. Cir. 2006) (presumption of obviousness applies where range of values in prior art overlaps claimed range and no criticality is ascribed to claimed values). The '925 specification states that the panel may “have more or fewer than the three substantially parallel, contiguous sections 112, 118, 122 shown, and those sections

can be oriented (e.g., angled) differently than shown,” Ex. 1001, 4:35–41, and that “the invention is not limited to use of a panel with any particular number of sections or orientation of sections.” *Id.*, 4:46–48. The specification further states that the angles between the inner surfaces of the sections and a plane parallel to the mounting surface:

can be less than or equal to forty-five degrees, thirty degrees, twenty-five degrees, fifteen degrees, ten degrees, or five degrees. Put another way, in various embodiments, the angles 204 and 206 can be greater than zero but less than or equal to forty-five degrees, thirty degrees, twenty-five degrees, fifteen degrees, ten degrees, or five degrees. In fact, all of the inner surfaces 130, 132, 134 of the all of [sic] sections 112, 118, 122 of the panel 110 can be with forty-five degrees, thirty degrees, twenty-five degrees, fifteen degrees, ten degree, or five degrees of parallel to each other and/or the mounting surface 104 of the circuit substrate 102.

Ex. 1001, 5:33–44; *see also id.*, 9:53–65 (describing Figure 8 embodiment having a plurality of electronic devices within the package assembly).

The POSA thus would have expected to successfully achieve an electronic packaging assembly having a heat-spreading panel in which the contiguous sections thereof have sections oriented at the claimed angles. As discussed above in Section VII, the anisotropic heat-spreading graphite material taught by Hanai was well-known before the priority date of the ’925 patent. The POSA would have been able

to make the combination through routine experimentation or design choices. Ex. 1003, ¶ 238.

- f. Limitation 3[e]: wherein each said section has a first thermal conductivity substantially parallel to the inner surface of said section and a second thermal conductivity substantially perpendicular to the inner surface of said section,**

This limitation would be satisfied by Kuo as modified to use the anisotropic heat-spreading graphite sheet of Hanai. As explained above in Ground I with respect to Limitation 3[e], dissipating heat from the source of the thermal energy and spreading it to the side of the package is an important thermal management technique.

The pliable graphite sheet 321 of Hanai conducts heat anisotropically. The heat conductivity of the graphite sheet is approximately 5 W/mK to approximately 20 W/mK in the direction of its thickness (perpendicular to the inner surface) and approximately 200 W/mK to approximately 800 W/mK in the direction of the plane of the inner surface. Ex. 1006, [0019]. The combination of Kuo's and Hanai's teachings thus would result in an electronic package assembly in which each contiguous section "has a first thermal conductivity substantially parallel to the inner surface of said section and a second thermal conductivity substantially perpendicular to the inner surface of said section," as claimed. Ex. 1003, ¶ 239.

- g. Limitation 3[f]: wherein for each said section, said first thermal conductivity is at least one-hundred times greater than said second thermal conductivity,**

This limitation would be satisfied by Kuo as modified to use the anisotropic heat-spreading graphite sheet of Hanai. The heat conductivity of Hanai's graphite sheet 321 is approximately 5 W/mK to approximately 20 W/mK in the direction of its thickness and approximately 200 W/mK to approximately 800 W/mK in the direction of the plane of the surface. Ex. 1006, [0019]. The POSA would have appreciated that these values provide a range of thermal conductivity differences from a lower bound of 10x (200 W/mK divided by 20 W/mK) to an upper bound of 160x (800 W/mK divided by 5 W/mK). Ex. 1003, ¶¶ 141, 239–40.

A presumption of obviousness applies where a claimed range overlaps with a range disclosed in the prior art. *See Ormco*, 463 F.3d at 1311. This presumption can be overcome if the “prior art teaches away from the claimed range, . . . the claimed range produces new and unexpected results,” or other evidence demonstrates non-obviousness of the claimed range. *Id.* Here, the '925 patent ascribes no particular importance or criticality to the range of values contained in this claim limitation. Ex. 1003, ¶ 241. To the contrary, the specification makes clear that the value can vary widely: “the first thermal conductivity can be significantly greater (e.g., two times or more, five times or more, fifty times or more, one-hundred times or more, or five hundred times or more) than the second thermal conductivity.” Ex. 1001, 5:59–65.

Moreover, in implementing the combination, the POSA would have understood that selection of the precise thermal conductivity characteristics of the graphite material in Hanai was a design choice. As Dr. Spangler explains, in many cases, the POSA would have been inclined to choose a thermal conductivity difference between the in-plane and perpendicular directions toward the higher end of the range from 10x to 160x, to maximize heat dissipation efficiency for those applications in which such maximization was important and the cost of doing so was within budget. Therefore, when modifying Kuo to use the anisotropic graphite sheet as taught by Hanai, it would have been obvious to use a sheet in which the first thermal conductivity (conductivity in the in-plane direction) is at least one hundred times greater than the second conductivity (conductivity in the thickness direction). Ex. 1003, ¶¶ 242–43.

2. Independent Claim 15

a. Preamble: An electronic assembly comprising:

To the extent the preamble is limiting, Kuo discloses this limitation as explained with respect to Claim 3 Preamble above.

b. Element 15[a]: a support structure comprising walls enclosing a space;

Kuo discloses this limitation as explained with respect to Limitation 3[a] above.

- c. **Element 15[b]: a circuit substrate coupled to a first portion of said support structure, said circuit substrate comprising a mounting surface;**

Kuo discloses this limitation as explained with respect to Limitation 3[b] above.

- d. **Element 15[c]: an electronic device attached to said mounting surface and disposed within said space; and**

Kuo discloses this limitation as explained with respect to Limitation 3[c] above. As explained, the use of the article “an” in this limitation includes one or more such electronic devices. *See Baldwin Graphic*, 512 F.3d at 1342-43 (Fed. Cir. 2008).

- e. **Element 15[d]: a panel coupled to a second portion of said support structure, said panel comprising contiguous sections, each said section comprising an inner surface facing said mounting surface of said circuit substrate and oriented within twenty-five degrees of parallel to said mounting surface,**

This limitation would be satisfied by Kuo alone or as modified to use the anisotropic heat-spreading graphite sheet of Hanai, as explained with respect to Ground II, Limitation 3[d] above.

- f. Element 15[e]: wherein each said section has a first thermal conductivity substantially parallel to the inner surface of said section and a second thermal conductivity substantially perpendicular to the inner surface of said section,**

This limitation would be satisfied by Kuo as modified to use the anisotropic heat-spreading graphite sheet of Hanai, as explained with respect to Ground II, Limitation 3[e] above.

- g. Element 15[f]: wherein said first thermal conductivity is greater than said second thermal conductivity,**

This limitation would be satisfied by Kuo as modified to use the anisotropic heat-spreading graphite sheet of Hanai. The heat conductivity of Hanai's graphite sheet 321 is approximately 5 W/mK to approximately 20 W/mK in the direction of its thickness and approximately 200 W/mK to approximately 800 W/mK in the direction of the plane of the surface. Ex. 1006, [0019]. The specific thermal anisotropy of a heat spreader is a design choice that the POSA would specify. The POSA would have appreciated that these values provide a range of thermal conductivity differences from a lower bound of 10x (200 W/mK divided by 20 W/mK) to an upper bound of 160x (800 W/mK divided by 5 W/mK). Every point in this range meets the requirement that the first thermal conductivity (in-plane) is greater than the second thermal conductivity (perpendicular to plane). Ex. 1003, ¶¶ 141, 251-52.

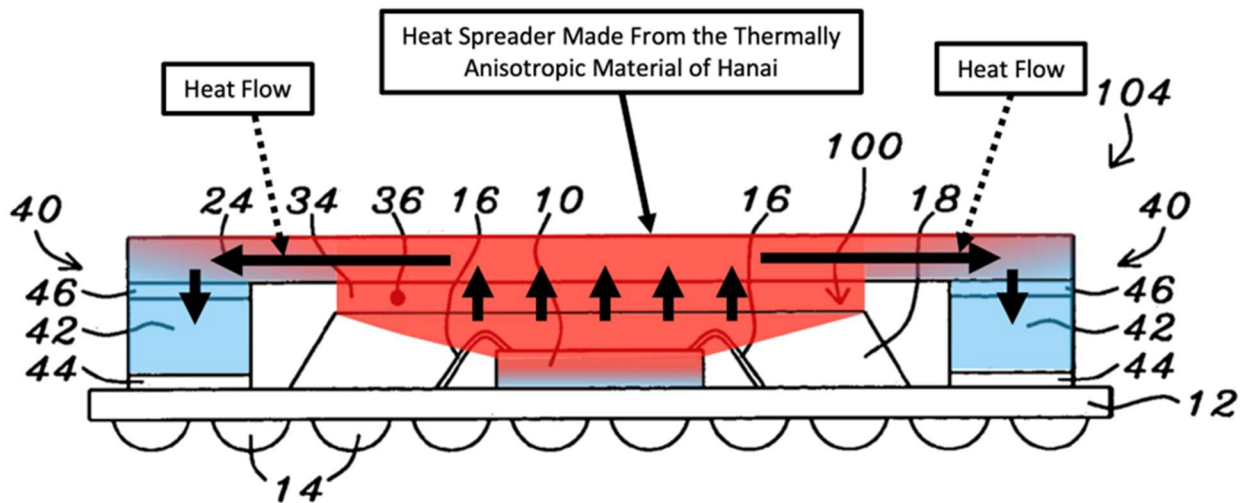
- This limitation would be satisfied by Kuo as modified to use the anisotropic heat-spreading graphite sheet of Hanai. In Hanai, heat is designed primarily to flow through pliable graphite sheet 321, which conducts heat anisotropically to aluminum heat sink 310 located at the side of PC board 300, as illustrated by the red arrows in the annotated figure below.



The POSA would have understood that the heat conductivity through the anisotropically heat-conducting pliable graphite sheet to the heat sink of Hanai is the

path of greatest thermal conductivity, as claimed, because the POSA would have appreciated that the greatest heat flux in Hanai flows along the path leading directly to heat sink 310, which is designed to quickly remove heat from the system through coolant flowing through fluid flow path 311. The thermal conductivity of the flexible graphite material in Hanai is 200–800 W/mK. The heat conductivity of the aluminum of the heat sink is approximately 240 W/mK. Ex. 1006, [0019]. Ex. 1003, ¶¶ 69, 253-255.

The POSA would have appreciated that, in implementing the combination of Kuo and Hanai using the anisotropically heat-conducting pliable graphite sheet for the panel, the thermally conductive path from the space enclosed by the walls of the support structure out of said electronic assembly having the greatest thermal conductivity would be the thermal path through the contiguous sections of the panel to the outer edges of the assembly, as illustrated. Ex. 1003, ¶ 256.



Ex. 1004, Fig. 3a (annotated)

Kuo, like Hanai, desires to transfer heat efficiently from the space enclosed by the assembly. Kuo as modified by Hanai would do so by transferring heat along the plane of the graphite sheet to the copper sidewall support structure of Kuo in a similar fashion to Hanai. For example, the thermal conductivity of copper is approximately 400 W/mK and thus the copper sidewalls of Kuo would receive heat from the graphite sheet in the modified structure and further dissipate the heat to the side of the assembly. In contrast, the thermal conductivity of a PCB material, such as that used for the substrate in a BGA like Kuo, typically ranges from 0.3 to 0.5 W/mK. The POSA therefore would have designed the assembly such that the path having the greatest thermal conductivity in Kuo as modified would comprise a thermal path through the contiguous ones of said sections of said panel to an outer edge of an outer one of said sections of said panel, as claimed. Ex. 1003, ¶ 257.

- i. **Element 15[h]: wherein said electronic assembly further comprises a thermally conductive adhesive coupling said outer edge of said outer one of said sections to said support structure.**

This limitation would be satisfied by Kuo as modified to use the anisotropic heat-spreading graphite sheet of Hanai. As explained with respect to Ground I, Limitation 15(h), the POSA would have understood that in Kuo, metal heat-spreading panel 24 is fixed to the upper end of metal pillar 40 by epoxy adhesive 46. Ex. 1004, 4:56–64. Kuo does not describe the epoxy as a thermally conductive material. However, the POSA would have understood that conventional epoxy materials used to connect heat-conducting structures were typically spread very thinly and filled with a heat-conducting material such as silver or other metal.

This is likely to be the case in Kuo because Kuo's ball grid array package is Kuo's ball grid array package is designed to conduct heat away from the semiconductor device primarily through thermal grease 36 to heat spreader 24 and the POSA would have understood that some heat was also intended to flow to support structure 42, which is made of the same material as heat spreader 24. The POSA therefore would have understood that the epoxy material 46 that attaches heat spreader 24 to support structure 42 was likely to have some thermally conductive properties in order to enable this heat transfer. Ex. 1003, ¶ 258.

In implementing the combination of Kuo and Hanai, the POSA would have been motivated to ensure that the adhesive material used to join the edge of heat-

spreading panel 24 and support structure walls 42 was thermally conductive to ensure efficient conduction of heat generated by the electronic device from the anisotropic heat-spreading composite graphite panel to the sidewalls of the electronic assembly where the heat can be further dissipated, as taught by Hanai. In making the combination, the POSA not only would have been aware of conventional heat-conducting epoxy adhesives as explained above, but also would have been aware that highly heat conductive adhesive materials were available for this purpose. Ex. 1003, ¶¶ 259–61.

3. Dependent Claim 16

- a. **The electronic assembly of claim 15 further comprising a thermally conductive material disposed between and in physical contact with said electronic device and the inner surface of one of said contiguous ones of said sections of said panel.**

Kuo satisfies this limitation. Kuo teaches the insertion of thermally conductive material in the space between epoxy-encapsulated electronic device 100 and metal heat spreader 24 in the form of thermal grease 36. Thermal grease 36 is described as silicone rubber “containing heat-conducting particles such as zinc oxide, aluminum oxide, aluminum nitride, boron nitride or ceramic fillers or other materials which have the properties of heat conduction.” Ex. 1004, 5:13-17. The POSA would have understood that additional heat dissipation efficiency would be achieved from the presence of the thermal grease between the epoxy-encapsulated electronic device

and the heat-spreading composite graphite panel in Kuo as modified by Hanai. Hanai teaches a similar concept in the form of flexible heat-conducting sheet 322, which the POSA would have understood serves the same purpose as does Kuo's thermal grease 36; that is, to facilitate the heat transfer from the heat-producing IC elements into anisotropic pliable graphite sheet 321 to enable further dissipation of heat to the side of the assembly. Ex. 1003, ¶ 262.

IX. DISCRETIONARY DENIAL IS INAPPROPRIATE UNDER *FINTIV*

The Board should decline to exercise its discretion to deny institution under 35 U.S.C. § 314(a) and *Apple Inc. v. Fintiv, Inc.*, IPR2020-00019, Paper 11 (P.T.A.B. Mar. 20, 2020) (precedential). While the '925 patent has been asserted in *Redstone Logics LLC v. Samsung Electronics Co., Ltd., et al.*, Case No. 2:23-cv-00485 (E.D. Tex.), that case remains in a very early stage. Infringement contentions were served on March 25, 2024. Exs. 1007, 1008. The court issued an amended scheduling order on April 23, 2024, scheduling a trial for August 4, 2025. *See* Ex. 1010.

Accordingly, the parties have made very little material investment in the parallel litigation. No discovery has taken place beyond initial disclosures required by the Federal and Local Rules, and the claim construction process has not even begun. Additionally, this Petition is being filed about nine weeks after service of infringement contentions, demonstrating that Petitioner has acted with diligence in

preparing its patent challenge. Discretionary denial is further inappropriate because this Petition presents compelling evidence of unpatentability, for the reasons discussed in Section VIII, above. Institution is thus favored to “serve the interest of overall system efficiency and integrity.” *Fintiv*, IPR2020-00019, Paper 11 at 15.

X. CONCLUSION

Petitioner respectfully requests *inter partes* review and cancellation of claims 3 and 15–16 of the ’925 patent.

Date: May 31, 2024

Respectfully submitted,

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CERTIFICATION OF WORD COUNT

Pursuant to 37 C.F.R. § 42.24(d), I certify that the foregoing complies with the type-volume limitation of 37 C.F.R. § 42.24 and contains 13,051 words based on the word count indicated by the word-processing system used to prepare the paper, and excluding those portions exempted by § 42.24(a).

Date: May 31, 2024

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CERTIFICATE OF SERVICE

Pursuant to 37 C.F.R. § 42.105, I hereby certify that on May 31, 2024, I caused a true and correct copy of the foregoing Petition for *Inter Partes* Review of U.S. Patent No. 9,253,925, supporting exhibits, and Power of Attorney to be served via Priority Mail Express on the Patent Owner at the following correspondence address of record as listed on the USPTO Patent Center:

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