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Paper No. 91
Date: August 14, 2020

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

CLEARONE, INC.,
Petitioner,

v.

SHURE ACQUISITION HOLDINGS, INC.,
Patent Owner.

IPR2019-00683
Patent 9,565,493 B2

Before MICHAEL R. ZECHER, JON M. JURGOVAN, and CHRISTA P. ZADO, *Administrative Patent Judges.*

ZADO, *Administrative Patent Judge*.

JUDGMENT
Final Written Decision
Determining Some Challenged Claims Unpatentable
Granting-in-Part Patent Owner's Motion to Amend
Granting Patent Owner's Motion to Seal
Granting Petitioner's Motion to Seal
35 U.S.C. § 318(a)

I. INTRODUCTION

We have authority to hear this *inter partes* review under 35 U.S.C. § 6. This Final Written Decision issues pursuant to 35 U.S.C. § 318(a) and 37 C.F.R. § 42.73. For the reasons discussed herein, we determine that ClearOne, Inc. ("Petitioner")[1] has shown, by a preponderance of the evidence, that claims 1–5, 7–33, and 35–40 ("challenged claims") of U.S. Patent No. 9,656,493 B2 (Ex. 1001, "the '493 patent") are unpatentable. *See* 35 U.S.C. § 316(e) (2012); 37 C.F.R. § 42.1(d) (2018). Petitioner has not demonstrated unpatentability of claims 6 and 34. In addition, Patent Owner's Revised Motion to Amend is hereby *granted-in-part*. Paper 57 ("Mot. Amend"). Specifically, Patent Owner's Revised Motion to Amend is granted as to proposed substitute claims 57–67.

A. Procedural History

Petitioner filed a Petition for *inter partes* review of claims 1–40 of the '493 patent. Paper 1 ("Pet." or "Petition"). Shure Acquisition Holdings, Inc. (Patent Owner")[2] subsequently filed a Preliminary Response. Paper 14 ("Prelim. Resp."). Petitioner subsequently filed a corrected Reply, with our authorization. Paper 18.[3] Patent Owner filed a Sur-Reply, also with our authorization. Paper 17. On August 16, 2019, we entered a decision instituting an *inter partes* review of all claims and all grounds presented in the Petition. Paper 21 ("Institution Decision" or "Inst. Dec.").

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[1] Petitioner identifies only itself as a real party-in-interest to the Petition. Pet. 4.

[2] Patent Owner identifies only itself as a real party-in-interest to this proceeding. Paper 4, 1.

[3] We refer to Petitioner's Corrected Reply to Patent Owner's Preliminary Response, filed July 25, 2019, Paper 18, the filing of which the Board authorized in a July 25, 2019 email to the parties.

After institution, Patent Owner filed a Response to the Petition, Paper 37 ("Response" or "PO Resp."),[4] along with an Unopposed Motion for Entry of a Modified Protective Order, Paper 33, and Unopposed Motion to Seal, Paper 34. Patent Owner also filed a Contingent Motion to Amend [Claims 1–40] Under 37 C.F.R. § 42.121, Paper 35, and requested preliminary guidance on such motion under the Patent Office's pilot program. Pilot Program Concerning Motion to Amend Practice, 84 Fed. Reg. 9497 (Mar. 15, 2019). Petitioner filed a Reply to Patent Owner's Response, Paper 49 ("Reply"),[5] along with a Motion to Seal Paper 48 and [Certain] Exhibits, Paper 50. Petitioner also filed an Opposition to [Patent Owner's] Motion to Amend. Paper 46. On February 25, 2020, we issued Preliminary Guidance [on] Patent Owner's Motion to Amend. Paper 55 ("Prelim. Guidance" or "Preliminary Guidance").

Thereafter, Patent Owner filed a Sur-Reply to Petitioner's Reply to Patent Owner's Response. Paper 67 ("Sur-Reply"). Patent Owner also filed a Revised Contingent Motion to Amend Claims 1–40 Under 37 C.F.R. § 42.121, Paper 57, which Petitioner opposed, Paper 68 ("Pet. Opp."). Patent Owner filed a Reply to Petitioner's Opposition to Patent Owner's Revised Motion to Amend. Paper 74 ("PO Reply").

[4] Herein, "Response" refers to the non-confidential version of Patent Owner's response to the Petition (Paper 37), and we cite to the non-confidential version in this Final Written Decision. A confidential version of Patent Owner's response to the Petition was filed as Paper 36.
[5] Herein, "Reply" refers to the non-confidential version of Petitioner's reply to Patent Owner's Response (Paper 49), and we cite to the non-confidential version in this Final Written Decision. A confidential version of Petitioner's reply to Patent Owner's Response was filed as Paper 48.

Prior to entry of this Final Written Decision, we granted Patent Owner's Unopposed Motion for Entry of a Modified Protective Order. Paper 85.

An oral hearing was held on June 15, 2020. A transcript of the hearing is included in the record. Paper 90 ("Tr.").

B. Related Matters

The parties advise that they are not aware of any related matters involving the '493 patent, other than abandoned U.S. patent applications and one pending application, U.S. Patent Application No. 15/833,404, which claims priority to the '493 patent. Pet. 4; Paper 4, 1.

C. The '493 Patent

The '493 patent, filed on April 30, 2015, and issued on February 7, 2017, does not claim priority to any earlier patent applications. Ex. 1001, code (22), (45). Accordingly, April 30, 2015 ("the priority date") is the earliest date to which the '493 patent may claim priority.

The '493 patent is titled, "Array Microphone System and Method of Assembling the Same," and generally relates to an array microphone capable of fitting into a ceiling tile of a drop ceiling. *Id.* at code (54), 1:6–11. The specification of the '493 patent ("Specification") explains that there were problems with microphones placed in conferencing environments, such as boardrooms. Problems resulted from microphone placement on tables or lecterns, and included: 1) obtrusive and/or unaesthetic appearance; 2) detection of undesirable noise, such as pen tapping or paper shuffling; and 3) being accidently covered by paper, cloth, or napkins in a manner that disrupts sound capture. *Id.* at 1:15–31. The Specification also describes problems with the microphone itself, stating that one type of microphone, the "shotgun" microphone, could lead to sub-optimal performance. *Id.* at

1:32–48. The shotgun microphone's primary sensitivity was focused in a single direction, thereby requiring the microphone to be pointed directly at a particular audio source for optimal detection. *Id.* According to the Specification, it was difficult and tedious to point the shotgun microphone in the ideal direction, and that proper adjustment required trial and error. *Id.*

Finally, the Specification explains that there were problems with some ceiling mounted microphones. *Id.* at 1:49–63. Although ceiling mounting addressed some problems associated with table mounted microphones and shotgun microphones, "[m]ost existing ceiling-mounted microphones are configured to be secured directly to the ceiling or hanging from drop-down cables that are mounted to the ceiling." *Id.* at 1:54–56. As a result, according to the Specification, such systems "require[d] complex installation and tend[ed] to become a permanent fixture." *Id.* at 1:56–58. "Furthermore, while ceiling microphones may not pick up tabletop noises given their distance from the table," such microphones, according to the Specification, had increased sensitivity to loud speakers, Heating Ventilation and Air Conditioning systems, air motion, and white noise. *Id.* at 1:57–63.

The Specification states there is, therefore,

> an opportunity for systems that address these concerns. More particularly, there is an opportunity for systems including an array microphone that is unobtrusive, easy to install into an existing environment, and can enable the adjustment of the microphone array to optimally detect sounds from an audio source, e.g., a human speaker, and reject unwanted noise and reflections.

Id. at 1:64–2:3. Moreover, the Specification states the invention is intended to address the above-noted problems

> by providing systems and methods that are designed to, among other things: (1) provide an array microphone

> assembly that is sized and shaped to be mountable in a drop ceiling in place of a ceiling tile; and (2) provide an array microphone system comprising a concentric configuration of microphones that achieves improved directional sensitivity over the voice frequency range and an optimal main to side lobe ratio over a prescribed steering angle range.

Id. at 2:8–16.

The Specification discloses that, in one embodiment, an array microphone system comprises a substrate having a plurality of microphones arranged thereon in concentric, nested rings of varying sizes. *Id.* at 2:17–22. Figure 5, reproduced below, is illustrative.

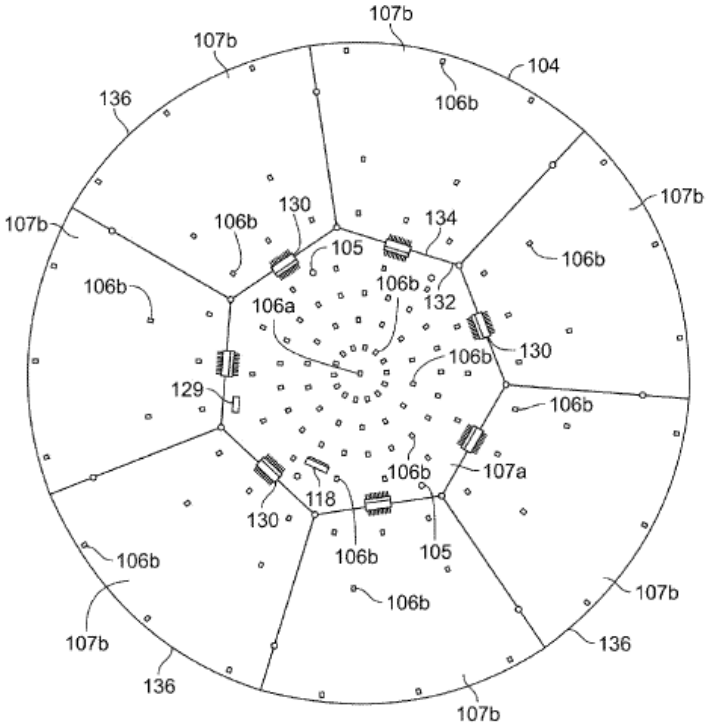


FIG. 5

Figure 5 depicts a top plan view of array microphone 104

Ex. 1001, Fig. 5, 2:62–64. Array 104 comprises a plurality of microphones 106, including microphone 106a positioned at the central point of a printed circuit board, surrounded by remaining microphones 106b,

arranged in a fractal configuration surrounding central microphone 106a. *Id.* at 9:4–11. As shown in Figure 5, "microphone 106 can be arranged in concentric, circular rings of varying sizes," the arrangement of which will, according to the Specification, "avoid undesired pickup patterns (e.g., due to grating lobes) and accommodate a wide range of audio frequencies." *Id.* at 9:25–28. The Specification provides that the term "ring," as used therein, "may include any type of circular configuration (e.g., perfect circle, near-perfect circle, less than perfect circle, etc.) as well as any type of oval configuration or other oblong loop." *Id.* at 9:29–32.

The Specification also states that, in another embodiment, the microphone assembly comprises a microphone array placed inside a housing sized and shaped to be mountable in a drop ceiling in place of at least one of a plurality of ceiling tiles included in the drop ceiling. *Id.* at 2:23–28. Furthermore, the front face of the housing has a sound permeable screen of substantially similar shape and size as the ceiling tile. *Id.* at 2:29–32. Figure 6, reproduced below, is illustrative.

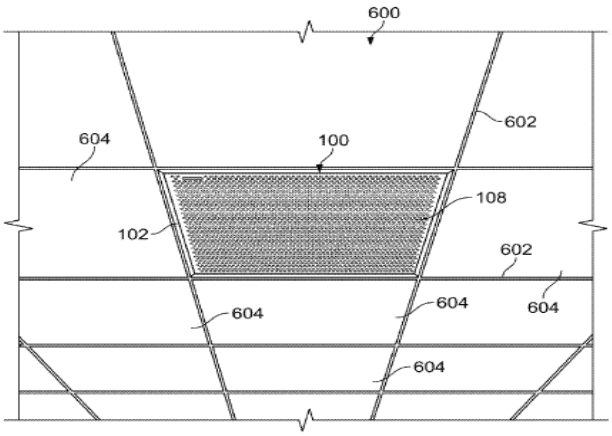


FIG. 6

Figure 6 shows example ceiling 600 with microphone assembly 100 installed therein

Id. Fig. 6, 2:65–67, 5:38–40. The Specification states ceiling 600 may be a drop ceiling, "a.k.a., dropped ceiling or suspended ceiling," hung below a main, central ceiling. *Id.* at 5:55–57. The Specification further provides

> [a]s is conventional, the drop ceiling 600 comprises a grid of metal channels 602 that are suspended on wires (not shown) from the main ceiling and form a pattern of regularly spaced cells. Each cell can be filled with a lightweight ceiling tile or panel 604 that, for example, can be removed to provide access for repair or inspection of the area above the tiles. In a preferred embodiment, the ceiling tiles 604 are drop-in tiles that can be easily installed or removed without disturbing the grid or other tiles 604. Each ceiling tile 604 is typically sized and shaped according to a "cell size" of the grid.

Id. at 5:57–67.

D. Illustrative Claims

Of the challenged claims, claims 1, 17, and 28 are independent. Claims 1 and 17, reproduced below, are illustrative.

> 1. An array microphone system comprising:
>
> a substrate; and
>
> a plurality of microphones arranged, on the substrate, in a number of concentric, nested rings of varying sizes, each ring comprising a subset of the plurality of microphones positioned at predetermined intervals along a circumference of the ring.

Ex. 1001, 17:50–56.

> 17. A microphone assembly comprising:
>
> an array microphone comprising a plurality of microphones; and
>
> a housing configured to support the array microphone, the housing being sized and shaped to be mountable in a drop ceiling in place of at least one of a plurality of ceiling tiles in the drop ceiling,

> wherein a front face of the housing includes a sound-permeable screen having a size and shape that is substantially similar to the at least one of the plurality of ceiling tiles.

Id. at 18:39–49.

E. Prior Art and Asserted Grounds of Unpatentability

Petitioner challenges claims 1–40 of the '493 patent on the following grounds. Pet. 9.

Claims	35 U.S.C. §	Reference(s)/Basis
1–7, 9–13, 28–31, 33, 34, 37–40	103	Tiete,[6] Chan[7]
8, 36	103	Tiete, Chan, Chou[8]
14, 16, 35	103	Tiete, Chan, Sawa[9]
15	103	Tiete, Chan, Beaucoup[10]
32	103	Tiete, Chan, Meyer[11]

[6] Jelmer Tiete, et al., *SoundCompass: A Distributed MEMS Microphone Array-Based Sensor for Sound Source Localization*, SENSORS (Jan. 23, 2014). Ex. 1005 ("Tiete").

[7] S. C. Chan & H. H. Chen, *Uniform Concentric Circular Arrays with Frequency-Invariant Characteristics—Theory, Design, Adaptive Beamforming and DOA Estimation*, IEEE TRANSACTIONS ON SIGNAL PROCESSING, Vol. 55, No. 1, 165 (Jan. 2007). Ex. 1006 ("Chan"). Petitioner filed two copies of the same reference, except the two copies each come from different libraries. Exhibit 1006 bears a date stamp from the library at University of California—Berkeley with a date of January 10, 2007, whereas Exhibit 1007 has a date stamp of January 5, 2007. Unless expressly stated otherwise, we refer to Exhibit 1006 as Chan.

[8] Thomas Chou, *Frequency-Independent Beamformer with Low Response Error*, THE 1995 INTERNATIONAL CONFERENCE ON ACOUSTICS, SPEECH, AND SIGNAL PROCESSING, sponsored by The Signal Processing Society of the IEEE, 2995 (May 9–12, 1995). Ex. 1014 ("Chou").

[9] U.S. Patent No. 9,826,211 B2, issued Nov. 21, 2017. Ex. 1008 ("Sawa").

[10] U.S. Patent Publication No. 2003/0118200 A1, published June 26, 2003. Ex. 1009 ("Beaucoup").

[11] U.S. Patent No. 8,903,106 B2, issued Dec. 2, 2014. Ex. 1010 ("Meyer").

Claims	35 U.S.C. §	Reference(s)/Basis
17, 18, 21, 23–26	103	Graham[12]
19, 20	103	Graham, Sawa
22	103	Graham, Berry[13]
27	103	Graham, Beaucoup

II. ANALYSIS

A. Motions to Exclude

The party moving to exclude evidence bears the burden of proof to establish that it is entitled to the relief requested—namely, that the material sought to be excluded is inadmissible under the Federal Rules of Evidence. *See* 37 C.F.R. §§ 42.20(c), 42.62(a). For the reasons discussed below, Petitioner's Motion is *dismissed* as moot, and Patent Owner's Motion is *denied-in-part* and *dismissed-in-part*.

1. Petitioner's Motion to Exclude

a) Exhibit 2014

Petitioner moves to exclude paragraphs 4, 5, and 9–11 of the declaration of James Schanz (Ex. 2014), a Vice President of Sales at Shure, Inc. Paper 76 ("Pet. Mot."), 1–12. Patent Owner opposes Petitioner's Motion. Paper 78 ("PO Opp. Mot."), 2–13.

[12] U.S. Patent Publication No. 2015/0078582 A1, published Mar. 19, 2015. Ex. 1011 ("Graham"). The Petition refers to Exhibit 1011 as "Graham." However, in subsequent papers, the parties sometimes refer to Exhibit 1011 as the "Graham Publication," to distinguish it from Exhibit 1040 (patent that issued from the application published in Graham), which the parties refer to as the Graham Patent. Herein, "Graham" shall refer to Exhibit 1011.
[13] PCT Application WO 2011/104501 A2, published Sept. 1, 2011. Ex. 1012 ("Berry").

The testimony Petitioner seeks to exclude is relied on by Patent Owner as objective evidence of non-obviousness. *See, e.g.,* PO Resp. 71–72, 74–75, 78 (citing Ex. 2014 ¶¶ 4, 5, 9–11).

In rendering our Final Written Decision, we have considered the testimony Petitioner seeks to exclude, but we do not rely on this testimony in a manner adverse to Petitioner in this Decision. Accordingly, Petitioner's Motion to Exclude certain paragraphs of Mr. Schanz's declaration is *dismissed* as moot.

b) Exhibit 2020

Petitioner moves to exclude paragraphs 199–201 of the declaration of Patent Owner's expert, Jeffrey S. Vipperman, Ph.D. (Ex. 2020). Paper 76 Pet. Mot. 13–15. Patent Owner opposes Petitioner's Motion. PO Opp. Mot. 13–15.

The testimony Petitioner seeks to exclude is relied on by Patent Owner to support its arguments regarding objective evidence of non-obviousness. *See, e.g.,* PO Resp. 68, 78 (citing Ex. 2020 ¶¶ 199–201).

In rendering our Final Written Decision, we have considered the testimony Petitioner seeks to exclude, but we do not rely on this testimony in a manner adverse to Petitioner in this Decision. Accordingly, Petitioner's Motion to Exclude certain paragraphs of Dr. Vipperman's declaration is *dismissed* as moot.

2. Patent Owner's Motion to Exclude

Patent Owner moves to exclude Exhibits 1040, 1054, 1055, 1125, 1127, 1128, 1131, 1132, 1136–1143, and portions of Exhibits 1043 and 1144. Paper 77 ("PO Mot.") Petitioner opposes Patent Owner's Motion. Paper 80 ("Pet. Opp. Mot.").

a) Exhibits 1040 and 1043

Exhibit 1040 ("Graham Patent") is a patent that issued from the application published in Graham (Ex. 1011). Exhibit 1043 is the supplemental declaration of Petitioner's expert, Durand R. Begault, Ph.D. Patent Owner submits that Exhibit 1040 should be excluded as irrelevant under FRE 401 and 402, arguing that new matter was added after the priority date of the '493 patent. PO Mot. 2–3. Patent Owner submits that paragraphs 22–36, 45, and 198–200 of Exhibit 1043 should be excluded under FRE 401–403 because they rely on Exhibit 1040. *Id.* at 3–4.

Patent Owner asserts that the new matter added to the Graham Patent (Ex. 1040) during prosecution included disclosure of a grille, front surface, and an acoustically transparent tile. *Id.* at 2–3. Petitioner responds that Exhibit 1040 is relied on in the Reply for the purpose of showing a skilled artisan would have considered Graham (Ex. 1011) as providing support for a grille, front surface, and acoustically transparent material, because the Examiner accepted claim amendments adding these features, and therefore Exhibit 1040 is relevant. Pet. Opp. Mot. 1–2. We agree with Petitioner that Exhibit 1040 is relevant. Even if the dates of the claim amendments leading to the issuance of Exhibit 1040 are after the priority date of the '493 patent, the acceptance of such amendments is relevant to the question of whether Ex. 1011 provides adequate disclosure of these features.

Although we do not exclude Exhibit 1040 and paragraphs 22–36, 45, and 198–200 of Exhibit 1043, we do not rely on this material in a manner adverse to Patent Owner in this Final Written Decision. Accordingly, Patent Owner's Motion to Exclude Exhibit 1040 and certain paragraphs of Dr. Begault's supplemental declaration is *dismissed* as moot.

b) Exhibits 1054 and 1055

Exhibit 1054 is the declaration of William Oxford, Ph.D., submitted by Patent Owner in IPR2017-01785, and Exhibit 1055 is the deposition transcript for the related cross-examination of Dr. Oxford. Patent Owner moves to exclude Exhibits 1054 and 1055 under FRE 401–403 and 801–803. PO Mot. 4–5. As to relevance, Patent Owner asserts, without explanation, that Exhibits 1054 and 1055 are irrelevant as failing to make any fact more or less probable in this proceeding and is more prejudicial than probative, confuses the issues, and/or wastes time. *Id.* This naked assertion, without any explanation, is insufficient to satisfy Patent Owner's burden to establish that Patent Owner is it entitled to the relief sought. As to hearsay, Patent Owner asserts the exhibits are from a different proceeding, and therefore are inadmissible hearsay without any exception. *Id.* Petitioner responds that Dr. Oxford's declaration and transcript testimony fall within the residual exception under FRE 807, because the testimony was given under oath and has the same guarantees of trustworthiness as testimony created for this proceeding, and is more probative on the point for which it is offered than any other evidence the proponent can obtain through reasonable efforts. Pet. Opp. Mot. 10 (citing Fed. Rule Evid. 807).

We are persuaded that Dr. Oxford's testimony falls within the residual exception under FRE 807. In response to Patent Owner's assertion that Chan is not analogous art to the '493 patent, PO Resp. 44–48, Petitioner argues Chan is in the same field of endeavor as the '493 patent because Chan's research overlaps with the same objectives for solutions as the '493 patent, Reply 30. In support of this argument, Petitioner relies on a reference citing Chan that relates specifically to microphone orientation in a Speakerphone, titled "Microphones Orientation and Size in a

Speakerphone," which lists Patent Owner's expert in IPR2017-01785, Dr. Oxford, as a co-inventor, as well as testimony by Dr. Oxford. Reply 30 (citing Ex. 1053; Ex. 1054; Ex. 1043 ¶ 101 (citing Ex. 1055)). Dr. Oxford previously testified that his discussion of designing a telephone conferencing system for LifeSize between the time frame of 2003–2007 included beaming techniques that Petitioner argues are like those taught in Chan. *Id.* (citing Ex. 1053, 3; Ex. 1054, 4, 7–10[14]; Ex. 1003 ¶ 101 (citing Ex. 1055)). Dr. Oxford's cited testimony in Exhibits 1054 and 1055 are more probative on the point for which it is offered—namely, Exhibit 1053, which names Dr. Oxford as co-inventor, teaches beamforming techniques like those taught in Chan—than any other evidence Petitioner can obtain through reasonable efforts. Patent Owner also has sufficient guarantee of trustworthiness, given the testimony was under oath and entered into evidence in IPR2017-01785 by Patent Owner.

For the foregoing reasons, Patent Owner's Motion to Exclude Exhibits 1054 and 1055 is *denied*.

c) Exhibit 1125, 1127, 1128, 1131, 1132, and 1136–1143

Patent Owner moves to exclude Exhibits 1125, 1127, 1128, 1131, 1132, and 1136–1143 under FRE 401–403 and/or 901. PO Mot. 5–14. Petitioner opposes Patent Owner's Motion. Pet. Opp. Mot. 11–13. Patent Owner argues, *inter alia*, that these exhibits bear dates after the priority date of the '493 patent, and therefore, they should be excluded. PO Mot. 5–14.

[14] Petitioner also cites "Ex. 1054, 157–11:22." Exhibit 1054 is a declaration that includes numbered paragraphs and page number at the bottom of each page. It is unclear what "157–11:22" is citing to.

Patent Owner also argues that some of these exhibits have not been properly authenticated. *Id.*

Petitioner responds that a document need not be prior art in order to be relevant. Pet. Opp. Mot. 11. As to authentication, Petitioner submits these exhibits have been authenticated in the declaration of Derek Meeker (Ex. 1234). *Id.* at 13.

The exhibits at issue relate to arguments Petitioner makes in its Opposition to Patent Owner's Revised Motion to Amend, specifically in regard to proposed substitute claims 57–67 involving a drop ceiling tile configuration. For reasons discussed below, *infra* Sec. II.F.3.c.(1)-(2), we determine Petitioner has not shown that these proposed substitute claims are unpatentable by a preponderance of the evidence.

Accordingly, Patent Owner's Motion to Exclude Exhibits 1125, 1127, 1128, 1131, 1132, and 1136–1143 is *dismissed* as moot, as we do not rely on these Exhibits in a manner adverse to Patent Owner in this Final Written Decision.

d) Exhibit 1144

Exhibit 1144 is the second supplemental declaration of Dr. Begault. Patent Owner seeks to exclude certain paragraphs of Dr. Begault's declaration as irrelevant. PO Mot. 14–15. Petitioner opposes Patent Owner's Motion. Pet. Opp. Mot. 13–15.

Patent Owner contends paragraphs 31, 35, 49–51, 55, 57, 58, 60, 62, 67, 75–77, and 90 should be excluded as irrelevant because they rely on Exhibits 1040, 1125, 1127, 1128, 1131, 1132, and 1136–1144, which Patent Owner asserts have not been authenticated and/or have not been shown to be a printed publication as of the priority date of the '493 patent. PO Mot. 14–

15. As we discussed above, we do not rely on Exhibits 1040, 1125, 1127, 1128, 1131, 1132, and 1136–1143, in a manner adverse to Patent Owner in this Final Written Decision. Accordingly, Patent Owner's Motion to Exclude paragraphs 31, 35, 49–51, 55, 57, 58, 60, 62, 67, 75–77, and 90 of Dr. Begault's second supplemental declaration is *dismissed* as moot.

Patent Owner asserts paragraphs 16–18, 62–64, 66, 68–70, 75–81, 83–85, and 94–97 should be excluded as irrelevant because Petitioner fails to rely on them in its papers. *Id.* at 15. Petitioner responds that failure to cite paragraphs of a declaration in a paper is not sufficient basis to show the paragraph are irrelevant. Pet. Opp. Mot. 13–14. Petitioner explains that the paragraphs Patent Owner seeks to exclude build on content of other paragraphs, are conclusion paragraphs, provide foundation for later paragraphs, and/or support conclusions in later paragraphs. *Id.* Petitioner argues there is no strict requirement to directly cite each paragraph of an expert declaration, because non-cited paragraphs provide useful foundations, conclusions, or cite to earlier testimony, and they make cited testimony more or less probable and are more probative than prejudicial, and do not confuse the issue or waste time. *Id.* at 14–15. We agree with Petitioner there is no strict requirement to cite each paragraph of a declaration in the substantive papers. Here, Patent Owner has not provided sufficient explanation as to why the paragraphs it seeks to exclude are irrelevant, and we determine Patent Owner has failed to meet its burden of establishing it is entitled to the relief sought. Accordingly, Patent Owner's Motion to Exclude paragraphs 16–18, 62–64, 66, 68–70, 75–81, 83–85, and 94–97 of Dr. Begault's second supplemental declaration is *denied*.

Patent Owner also includes an introductory sentence that states paragraphs 22–36 and 45 should be excluded under FRE 401–403, but

Patent Owner does not elaborate further as to why these particular paragraphs should be excluded. We determine with regard to these paragraphs that Patent Owner has failed to meet its burden of establishing it is entitled to the relief sought. According, Patent Owner's Motion to Exclude paragraphs 22–36 and 45 of Dr. Begualt's second supplemental declaration is *denied*.

B. Motions to Seal

Patent Owner filed an Unopposed Motion for Entry of a Modified Protective Order, Paper 33, which we granted, Paper 85.

Concurrently with filing for entry of a protective order, Patent Owner filed an Unopposed Motion to Seal. Paper 34. Patent Owner's Motion to Seal seeks to seal portions of Exhibits 2014 and 2020 designated as confidential that relate to objective evidence of non-obviousness and to seal portions of the version of Patent Owner's Response filed as paper 36 that include material designated as confidential. *Id.*

Petitioner filed a Motion to Seal, concurrently with the filing of its Reply. Paper 50. Petitioner's Motion to Seal seeks to seal Exhibits 1051, 1096, 1098, 1100, 1102, 1104, 1106, 1108, 1110, 1112, 1114, 1116, and 1118, and portions of the version of Petitioner's Reply filed as paper 48 that include material designated as confidential. *Id.*

Except as otherwise ordered, the record of an *inter partes* review trial shall be made available to the public. *See* 35 U.S.C. § 316(a)(1); 37 C.F.R. § 42.14. Motions to seal may be granted for good cause. *See* 37 C.F.R. §§ 42.14, 42.54(a). The moving party bears the burden of showing that there is good cause to seal the record. *See* 37 C.F.R. § 42.20(c). Also, relevant to these motions, the Patent Trial and Appeal Board Consolidated Trial Practice Guide states:

> The Board has a strong interest in the public availability of trial proceedings. Redactions to documents filed in this proceeding should be limited to the minimum amount necessary to protect confidential information, and the thrust of the underlying argument or evidence must be clearly discernible from the redacted versions. We also advise the parties that information subject to a protective order may become public if identified in a final written decision in this proceeding, and that a motion to expunge the information will not necessarily prevail over the public interest in maintaining a complete and understandable file history. *See* Practice Guide.

Patent Trial and Appeal Board Consolidated Trial Practice Guide 91–92 (Nov. 2019), *available at* https://www.uspto.gov/TrialPracticeGuideConsolidated; *see also* 84 Fed. Reg. 64,280 (Nov. 21, 2019).

The information the Patent Owner seeks to seal, according to Patent Owner, contains "highly confidential for its MXA910 product, including sales data and nonpublic information associated with the product that a business would not make public." Paper 34, 2. Patent Owner explains

> The confidential information Patent Owner seeks to seal consists of Patent Owner's highly confidential sales data and nonpublic schematics of Patent Owner's MXA910 product. Patent Owner relies on this sales and product data to support Patent Owner's assertion of secondary considerations of nonobviousness. The confidential data is presented in Patent Owner's Response, as well as in Exhibits 2014 and 2020. Exhibit 2014 is a declaration of James Schanz, VP of Sales for Shure, Inc. Exhibit 2020 is a declaration of Patent Owner's technical expert, Jeffery S. Vipperman, Ph.D., in support of Patent Owner's Response. Good cause exists to seal these documents because they include highly confidential sales data and data pertaining to the MXA910 that has not been published, publicized, or otherwise been shared or made public and are highly sensitive business and financial information that a business would not make public.

Id. at 3.

Petitioner attests the information it seeks to seal necessarily must be sealed because it "contain[s] sensitive business information of Shure or a third party, and public disclosure of that sensitive business information may irreversibly harm Shure or the third party." Paper 50; *id.* at 1–8 (explaining why the information contains sensitive business information and why harm would occur if made public).

Upon review of the information the parties seek to seal, we determine each party has shown good cause for an order protecting it from disclosure of the designated information, which contains sensitive business information that is not otherwise publicly available and would cause harm if made public. 37 C.F.R. § 42.54.

We also find that maintaining confidentiality is not outweighed by the public's interest. The designated information relates to showing secondary considerations of non-obviousness. The parties' redactions are minimal and relate only to a portion of the evidence relied upon to show secondary considerations. Also, this Final Written Decision does not reveal any designated material and is not redacted. Upon review of the above-discussed considerations, we find the parties' desire to keep this information confidential is not outweighed by the public interest in maintaining a complete and understandable record of this proceeding.

Accordingly, Patent Owner's Motion to Seal is *granted*. Petitioner's Motion to Seal also is *granted*.

C. Level of Ordinary Skill in the Art

To establish the level of ordinary skill in the art, we look to various factors including "the types of problems encountered in the art; prior art solutions to those problems; rapidity with which innovations are made;

sophistication of the technology; and education level of active workers in the field." *In re GPAC*, 57 F.3d 1573, 1579 (Fed. Cir. 1995) (citing *Custom Accessories, Inc. v. Jeffrey-Allan Indus., Inc.*, 807 F.2d 955, 962 (Fed. Cir. 1986)).

Petitioner asserts that a person of ordinary skill in the art in the field of the '493 patent as of April 2015 would have at least a Bachelor's degree in electrical engineering, engineering acoustics, physical acoustics, or signal processing in acoustics, or 3–5 years of work experience in fields related to acoustical engineering and signal processing. Pet. 28 (citing Ex. 1003 ¶¶ 88–89).

Patent Owner asserts that a person of ordinary skill in the art in the field of the '493 patent as of April 2015 would have possessed at least: (i) a bachelor's degree in mechanical engineering, electrical engineering, physics, or acoustical engineering that included coursework on the design of acoustic and/or antenna arrays, phased arrays, and/or beamforming, or (ii) at least 3 years of work experience in the field of directional microphone arrays. PO Resp. 15 (citing Ex. 2020 ¶¶ 22–26). Patent Owner contends its definition is "more accurate than that set forth by Petitioner's expert, Dr. Begault, because the study of microphone arrays is not necessarily part of undergraduate curricula." *Id.* (citing Ex. 2020 ¶¶ 22–26).

Based on the record before us, we adopt Petitioner's assessment of the level of ordinary skill in the art because it is consistent with the '493 patent and the asserted prior art, but without the qualifier "at least" because the qualifier renders the articulated level vague and expands it to include an expert's level of practical experience. We note that, if we were to adopt Patent Owner's proposal, which requires skills in addition to those proposed

by Petitioner that are specific to microphone arrays and beamforming techniques, it would not have altered the outcome of this Final Written Decision. *See Kinetic Concepts, Inc. v. Smith & Nephew, Inc.*, 688 F.3d 1342, 1366 (Fed. Cir. 2012) ("[I]t is generally easier to establish obviousness under a higher level of ordinary skill in the art.").

D. Claim Construction

We interpret a claim "using the same claim construction standard that would be used to construe the claim in a civil action under 35 U.S.C. 282(b)." *See* Changes to the Claim Construction Standard for Interpreting Claims in Trial Proceedings Before the Patent Trial and Appeal Board, 83 Fed. Reg. 51,340, 51,358 (Oct. 11, 2018) (amending 37 C.F.R. § 42.100(b) effective November 13, 2018) (now codified at 37 C.F.R. § 42.100(b) (2019)). Under that standard, we construe the claim in accordance with the ordinary and customary meaning of such claim, as would have been understood by one of ordinary skill in the art at the time of the invention, in light of the specification and prosecution history. *Phillips v. AWH Corp.*, 415 F.3d 1303, 1312–13 (Fed. Cir. 2005) (en banc). Only those terms that are in controversy need be construed, and only to the extent necessary to resolve the controversy. *See Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co. Matal*, 868 F.3d 1013, 1017 (Fed. Cir. 2017) (citing *Vivid Techs., Inc. v. Am. Sci. & Eng'g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999)).

Claim 2 recites the array microphone system of claim 1, "wherein the concentric, nested rings are rotationally offset from each other." Ex. 1001, 17:57–59. Patent Owner contends the term "rotationally offset from each other" should be construed "to mean that across the concentric, nested rings, 'no more than any two microphones are axially aligned.'" PO Resp. 16. Petitioner argues we should not limit the "rotationally offset" term in the

manner Patent Owner proposes, and that this term should be given its plain and ordinary meaning. The parties do not propose construction of any other claim terms. In our claim construction analysis below, we construe the term "rotationally offset from each other," as recited in claim 2 of the '493 patent. We determine, however, that no other terms require express construction.

To support its construction, Patent Owner relies on a non-limiting embodiment disclosing that microphone rings "can be offset from each other, for example, by rotating each ring a different number of degrees, so that no more than any two microphones 906 are axially aligned." PO Resp. 16 (citing Ex. 1001, 11:16–34). Patent Owner contends this configuration has various benefits that are disclosed in the Specification, and, therefore, a skilled artisan would have understood the "rotationally offset" embodiment of claim 2 would have meant "no more than any two microphones are axially aligned." *Id.* at 16–17 (citing Ex. 1001, 4:10–17, 11:16–34, 14:6–50; Ex. 2020 ¶¶ 101–104).

Based on the fully developed trial record, we do not agree with Patent Owner's construction. In particular, as argued by Petitioner, Patent Owner cites to one embodiment of rotationally offset rings, but fails to address disclosure of other embodiments of rotationally offset rings that do not support Patent Owner's proposed claim construction. Reply 28–29.

The Specification states that, in some embodiments, rings "*may be* at least slightly rotated relative to a central axis" in order to optimize directivity of the microphone, and that "*in such cases* . . . [*i*]*n some embodiments*" the rings "*can be* rotationally offset" in the manner proposed in Patent Owner's construction. Ex. 1001, 11:16–30 (emphasis added). The Specification discloses such an arrangement *may* be beneficial in microphone arrays with a smaller number of microphones. *Id.* at 11:26–30.

However, within that same paragraph, the Specification discloses *other* embodiments, that also may be optimized (e.g., beneficial), stating "[i]n *other* embodiments, for example in arrays with a large number of microphones, the rotational offset *may be more arbitrarily* implemented, if at all, *and/or other methods* may be utilized to optimize the overall directivity of the microphone array." *Id.* at 11:30–34.

We discern nothing in the claim language that limits the phrase "wherein the concentric, nested rings are rotationally offset from each other" to the embodiment relied on by Patent Owner and, as a result, we do not agree with Patent Owner's attempt to narrow the claim to exclude other embodiments disclosed in the Specification.

For the foregoing reasons, we determine the term "rotationally offset from each other," as recited in claim 2, is not limited to mean that across the concentric, nested rings, "no more than any two microphones are axially aligned." Instead, because the Specification states that, in at least some embodiments, "the rotational offset may be more arbitrarily implemented, if at all," and then refers to "other methods" that are not identified explicitly, and because the claim language does not specify a particular method of rotationally offsetting the concentric, nested rings, this term encompasses various, different ways of rotationally offsetting the concentric, nested rings, and is not limited to any particular way of offsetting the concentric, nested rings. In light of the parties' arguments regarding unpatentability, and in particular whether the prior art teaches the "rotationally offset" limitation under Patent Owner's proposed construction, we determine that we need not further construe the "rotationally offset" term.

E. Asserted Unpatentability

As we noted above, Petitioner asserts that claims 1–16 and claims 28–40 are unpatentable over Tiete in various combinations with other art. Pet. 9. Petitioner asserts further than claims 17–27 are unpatentable over Graham alone or in various combinations with other art. *Id.*

Patent Owner argues Petitioner has not shown unpatentability of the challenged claims.

For the reasons discussed herein, we determine Petitioner has demonstrated, by a preponderance of the evidence, that claims 1–5, 7–33, and 35–40 are unpatentable. Petitioner has not demonstrated, by a preponderance of the evidence, that claims 6 and 34 are unpatentable.

1. Tiete as Prior Art

The parties dispute whether Tiete was publicly accessible, and, therefore, available as a prior art printed publication under 35 U.S.C. § 102(a)(1) as Petitioner asserts. Pet. 6–7; PO Resp. 65–68; Reply 31.

A printed publication is not effective as a prior art reference until the date it becomes publicly accessible. *In re Hall*, 781 F.2d 897, 899 (Fed. Cir. 1986). "Whether a reference qualifies as a printed publication under § 102 is a legal conclusion based on underlying fact findings." *Acceleration Bay, LLC v. Activision Blizzard Inc.*, 908 F.3d 765, 772 (Fed. Cir. 2018). "A reference is considered publicly accessible if it was 'disseminated or otherwise made available to the extent that persons interested and ordinarily skilled in the subject matter or art, exercising reasonable diligence, can locate it.'" *Id.*

Petitioner asserts Tiete was published on January 23, 2014, in an online publication called *Sensors*. Pet. 6. Petitioner also avers that Tiete has

conventional markers, including: 1) a copyright notice; 2) a standard identifier; and 3) statements on the reference detailing the publication by a commercial publisher. *Id.*; Reply 31. Petitioner also submits the declaration of Dr. James L. Mullins, Dean Emeritus of Libraries and Esther Norton Professor Emeritus at Purdue University, who has more than 44 years of experience as a librarian, and who is knowledgeable about online library management systems. Ex. 1025 ¶ 2, 5–9 ("Mullins Declaration"). Dr. Mullins testifies he evaluated Tiete by: 1) assessing Exhibit 1005; 2) accessing a digital copy of Tiete downloaded from the *Sensors* periodical database; and 3) identifying papers and articles that cite Tiete that were presented at international conferences or published prior to April 30, 2914. *Id.* ¶ 36. Dr. Mullins testifies further that he searched the OCLC WorldCat Database, which he contends demonstrates *Sensors* was available in 840 libraries worldwide, including in the United States at MIT Libraries and Cornell University Libraries, and was searchable and accessible by title and subject headings. *Id.* ¶ 39; Ex. 1027. Dr. Mullins also testifies that he confirmed on the OPAC online catalog that *Sensors* would have been accessible through both MIT Libraries OPAC and Cornell University Libraries OPAC by title and subject. Ex. 1025 ¶¶ 41–42; Ex. 1028; Ex. 1029.

We find the evidence upon which Petitioner and Dr. Mullins rely to be credible, and shows both that Tiete was disseminated and that Tiete was made available to the extent that persons interested and ordinarily skilled in the subject matter or art, exercising reasonable diligence, could have located it. Tiete on its face indicates it was received on October 28, 2013, and published on January 23, 2014. Ex. 1005. The three articles identified by Dr. Mullins corroborate Tiete's publication date as being before the critical

date. Ex. 1025 ¶¶ 48–50; Exs. 1030–1032. First, the articles cite to Tiete, because each of the three articles identify the names of the authors and title, and also publication information, identifying Tiete as published in issue 2 of *Sensors* in 2014, at pages 1918–1949, all of which corresponds with the information provided in Exhibit 1005. Exs. 1030–1032; 1005. Second, each article bears a date after Tiete's alleged date of publication—January 23, 2014—and prior to the critical date—April 15, 2015—which corroborates both a publication date and dissemination between January 23, 2014 and April 15, 2015. Ex. 1030; Ex. 1031; Ex. 1032; Ex. 1005 ¶¶ 48–50. Accessibility of Tiete finds further corroboration in the OPAC WorldCat and OPAC databases, upon which Dr. Mullins relies, which confirm accessibility of *Sensors* by both title and subject. Ex. 1025 ¶¶ 39–42; Exs. 1027–1029.

Patent Owner contends that Petitioner's evidence fails to demonstrate that Tiete is a prior art printed publication. PO Resp. 66–67. Patent Owner asserts that Dr. Mullins is not a person of ordinary skill in the art, and therefore is unqualified to testify as to whether a skilled artisan would have been able to locate Tiete, arguing Petitioner must show that Tiete was publicly accessible to the relevant public. *Id.* at 66–67 (citing *Blue Calypso, LLC v. Groupon, Inc.*, 815 F.3d 1331, 1348 (Fed. Cir. 2016)). In so doing, Patent Owner fails to distinguish between: 1) dissemination of Tiete, and 2) otherwise making Tiete available to the extent that persons interested and ordinarily skilled in the subject matter or art, exercising reasonable diligence, can locate it.

With regard to dissemination of Tiete, Patent Owner's argument that Dr. Mullins is not a person of ordinary skill in the art of the '493 patent is irrelevant. Here, the issue is not whether Tiete could have been located by a person of ordinary skill in the art exercising reasonable diligence. Rather,

the issue is whether Tiete was actually disseminated. Tiete's being referenced in three technical articles bearing 2014 publication dates indicates Tiete was disseminated to the authors of these articles prior to the articles' publication dates. Dr. Mullins, who has extensive experience in cataloguing and library systems, is competent to testify regarding his confirmation that the citations in these articles refer to Tiete. Ex. 1025 ¶¶ 48–50.

With regard to whether Tiete was made available to the extent a person of ordinary skill in the art could have located it, Dr. Mullins is competent to testify that Tiete bears markers on its face that it was accessible to the public (Ex. 1025 ¶ 37), and to verify the authenticity of *Sensors*, including confirming that *Sensors* was accessible and searchable in online catalog databases and available in university libraries (*id.* ¶ 38–44). As to whether Tiete was available to the *relevant* public, evidence of this includes evidence that *Sensors* was accessible and searchable by title and subject at 840 libraries, including the libraries at MIT and Cornell University. We find these facts sufficiently indicate that a person of ordinary skill in the art would have been able to locate Tiete. The title of Tiete itself, i.e., "Sound Compass: A Distributed MEMS Microphone Array-Based Sensor for Sound Source Localization," would have made Tiete accessible to a skilled artisan searching by title for information about array microphone systems. Both MIT and Cornell University have engineering programs, which would have made *Sensors* available to engineering professors and students. In addition, 840 libraries worldwide hold *Sensors*, including issues dating to at least as early as 2001. *See, e.g.,* Ex. 1028. Although Dr. Mullins does not indicate the date that *Sensors* first became available at the libraries, we do not view evidence of library cataloging in a vacuum, but rather we view it alongside the other evidence, including evidence that the libraries hold issues of

Sensors dating back to at least as early as 2001, the markers on the face of Tiete, and the fact that three technical articles relating to acoustic design dated 2014 cite to Tiete. When considering all this evidence, Tiete was publicly accessible and was located by persons in the field of acoustic sensing prior to the critical date.

For the foregoing reasons, having considered the totality of the evidence, we determine Petitioner has shown that Tiete is available as a prior art printed publication under § 102(a)(1).

2. Tiete (Ex. 1005)

Tiete, titled "SoundCompass: A Distributed MEMS Microphone Array-Based Sensor for Sound Source Localization," generally describes SoundCompass, an acoustic sensor capable of measuring sound intensity and directionality. Ex. 1005, 1919. Tiete explains that SoundCompass is a compass for a sound field that points to the direction of the loudest sound sources, while measuring the total sound pressure level ("SPL"). *Id.* Tiete explains that in the environmental, industrial, and military domains, the ability to localize sound sources is of vital importance. *Id.* The driving application of SoundCompass is noise pollution mapping in urban environments, but applications may range from localizing sniper fire to identifying noisy engine parts. *Id.*

Tiete describes a prototype SoundCompass comprising a 20-cm circular printed circuit board ("PCB") containing a sensor array of 52 microphones, an inertial measurement unit ("IMU"), and a low-power field programmable gate array ("FPGA"). *Id.* The microphone array comprises microelectromechanical machine ("MEM") microphones mounted in a specific pattern on the circular PCB. *Id.* at 1923. The MEMs microphones

are off-the-shelf components commonly found in mobile phones, used because of their low-cost/high-quality and small package size. *Id.* The 52 MEMs microphones are arranged on a single plane and consist of four concentric rings. *Id.* at 1926. Tiete explains that this array

> is capable of performing spatial sampling of the surrounding sound field by using beamforming techniques. Beamforming focuses the array in one specific direction or orientation, amplifying all sound coming from that direction and suppressing sound coming from other directions. By iteratively steering the focus direction in a 360˚ sweep, the SoundCompass can measure the directional variations of its surrounding sound field.

Id.

3. Chan (Ex. 1006)

Chan, titled "Uniform Concentric Circular Arrays With Frequency-Invariant Characteristics—Theory, Design, Adaptive Beamforming and DOA Estimation," generally describes a digital beamformer for uniform concentric circular arrays ("UCCAs") having nearly frequency-invariant ("FI") characteristics. Ex. 1006, 165. Chan explains that beamforming using sensor arrays is an effective method for suppressing interference whose angles of arrival are different from the desired looking direction, and is useful in applications involving radio communications, sonar, radar, and acoustics. *Id.* The beamforming techniques described in Chan relate to how to implement filters to achieve a desired frequency response. *Id.* Chan explains that traditional adaptive broad beamformers use tapped-delay lines or linear transversal filters with adaptive coefficients to generate appropriate beam patterns for suppressing undesirable interference. *Id.* The drawback, however, is that a considerable number of adaptive coefficients are required, leading to increased convergence time, degraded numerical properties, and

high implementation complexity. *Id.* In light of various alleged shortcomings of alternative solutions to this problem, Chan describes a solution involving an electronically steerable UCCA comprising P concentric, circular rings, each ring having K_p omni-directional sensors. *Id.* at 166–167.

4. Sawa (Ex. 1008)

Sawa, titled "Sound Processing System and Processing Method that Emphasize Sound from Position Designated in Displayed Video Image," generally describes a sound processing system and method capable of reproducing recorded video and audio data. Ex. 1008, code (57), 1:8–10. Sawa discloses that in video monitoring systems, for example in a factory, retail space, or public space, a plurality of monitoring cameras may be deployed, and typically are connected to each other via a network. *Id.* at 1:14–22. Moreover, in such systems, video cameras may use a microphone to obtain audio, in addition to video, data. *Id.* at 1:23–28. Sawa avers that a problem with such systems is that, when certain accidents occur within the vicinity of the monitoring target, the sound processing apparatus may be unlikely to obtain audio data in the direction of where the accident occurred. *Id.* at 1:58–2:15. Sawa seeks to address this problem by providing a sound processing system and method, capable of emphasizing and outputting audio data having directivity toward positions corresponding to designated locations. *Id.* at 2:17–23.

Sawa discloses, in pertinent part, microphone array 20 installed, for example, on the ceiling of an event hall, wherein array 20 comprises a set of microphones 22 and collects sound in the vicinity of the monitoring target point. *Id.* at 7:29–39. Furthermore, Sawa discloses sound processing

apparatus 40, that includes recorder 45, signal processing unit 50, operation unit 55, and reproducing unit 60. *Id.* at 7:40–42. Sawa states that

> By using the audio data recorded in the recorder 45, the signal processing unit 50 adds audio data collected by each of the microphones thereto through a directivity control process of the audio data to be described later, and generates audio data in which directivity is formed in a specific directivity in order to emphasize (amplify) sound (volume level thereof) in the specific direction from a position of each microphone 22 of the microphone array 20. In addition, by using audio data transmitted from the microphone array 20, the signal processing unit 50 may generate audio data in which directivity is formed in a specific direction in order to emphasize (amplify) a volume level of sound in the specific direction (directivity) from the microphone array 20. Further, the specific direction is a direction which is directed from the microphone array 20 toward a position corresponding to a predetermined designated location which is designated from the operation unit 55, and is a direction designated by a user in order to emphasize (amplify) a volume level of audio data.

Id. at 7:57–8:8.

5. Beacoup (Ex. 1009)

Beaucoup, titled "System and Method of Indicating and Controlling Sound Pickup Direction and Location in a Teleconferencing System," generally describes a method of identifying talker location that includes picking up audio signals using a steerable microphone array and processing the picked up signals to determine location of an active talker. Ex. 1017, codes (54), (57). The microphone array then is steered in the direction of the active talker and a cue is generated to identify the direction in which the microphone has been steered. *Id.* at code (57).

6. Meyer (Ex. 1010)

Meyer, titled "Augmented Elliptical Microphone Array," generally describes am audio system having a microphone array and a signal processing subsystem that processes audio signals generated by the array to produce an output beam pattern. Ex. 1010, codes (54), (57). In one embodiment, the array comprises a single microphone at the center of a circular microphone array. *Id.* at 1:47–49. The central microphone, according to Meyer, makes it possible to gain control over the vertical direction beampattern response, thereby avoiding undesirable increased sensitivity in the vertical direction. *Id.* at 1:49–53. Meyer also discloses arranging the microphone array as two elliptical arrays, one smaller array located within the other, larger array. *Id.* at 1:54–2:14.

7. Graham (Ex. 1011)

Graham, titled "Beamforming Microphone Array with Support for Interior Design Elements," generally describes beamforming microphone array systems. Ex. 1011, codes (54), (57). Graham discloses that traditional beamform arrays configured for use with professionally installed applications, such as video conferencing in a conference room, typically had an electro-mechanical design requiring the array to be installed or set-up as a separate device with its own mounting system in addition to other design elements, such as lighting fixtures, decorative items and motifs, etc. *Id.* ¶ 6. Graham provides as an example a ceiling-mounted beamforming microphone array installed separately from ceiling tiles of a drop ceiling. *Id.* Graham discloses that a problem with the prior art is that such traditional approaches involving a separate microphone array resulted in the arrays being visible to people in the conference room. *Id.* ¶ 7. Graham addresses

this problem by disclosing a beamforming microphone array that has support for interior design elements. *Id.* ¶ 8. In one embodiment, an apparatus comprises at least one tile capable of being coupled to a wall or ceiling, and a beamforming microphone system integrated with the at least one tile. *Id.* ¶ 10. The microphone system includes a plurality of first microphones, and at least one second microphone. *Id.* Graham also discloses, with reference to Figures 2F–2I, microphone array 116 with beamforming microphones 212 integrated into a ceiling tile for drop ceiling mounting configuration 260. *Id.* ¶ 51.

8. Berry (Ex. 1012)

Berry, titled "Acoustic Composite Panel Assembly Containing Phase Change Materials," generally describes acoustic composite panel assemblies that include a phase change material for use in construction, wherein the tiles are applicable, but not limited to, ceiling tiles. Ex. 1012, code (54), 1:3–5. Berry explains that phase change materials and compositions are materials that reversibly undergo state changes and act as a sink for thermal energy, absorbing or releasing heat as necessary. *Id.* at 1:7–9. They are used, for example, to regulate temperatures within a desired range, and may provide protection against extreme heat or cold, and may be used for building applications, such as in wallboards, sheetrock, drywall, plasterboard, and fibreboard for absorbing or releasing heat energy into or from a room environment. *Id.* at 1:9–16. Berry discloses using phase change materials in an acoustic barrier of an acoustic composite panel in order to provide both latent heat storage capacity and acoustic damping properties in the same panel. *Id.* at 8:5–15. In a preferred embodiment, the panel front

incorporates depending edges to form a tray construction that is particularly useful for use as ceiling tiles. *Id.* at 8:17–18.

9. Chou (Ex. 1014)

Chou, titled "Frequency-Independent Beamformer with Low Response Error," generally describes a method for designing broadband beamformers with highly frequency-invariant behavior. Ex. 1014, 2995.

10. Principles of Law

A claim is unpatentable under 35 U.S.C. § 103 if the differences between the claimed subject matter and the prior art are such that the subject matter, as a whole, would have been obvious at the time of the invention to a person having ordinary skill in the art. *KSR Int'l Co. v. Teleflex, Inc.*, 550 U.S. 398, 406 (2007). The question of obviousness is resolved on the basis of underlying factual determinations, including: (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of ordinary skill in the art; and (4) objective evidence of non-obviousness (i.e., secondary considerations), if present. *See Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966). When evaluating a claim for obviousness, we also must "determine whether there was an apparent reason to combine the known elements in the fashion claimed by the patent at issue." *KSR*, 550 U.S. at 418 (citing *In re Kahn*, 441 F.3d 977, 988 (Fed. Cir. 2006)).

The Supreme Court has made clear that we apply "an expansive and flexible approach" to the question of obviousness. *KSR*, 550 U.S. at 415. Whether a patent claiming the combination of prior art elements would have been obvious is determined by whether the improvement is more than the predictable use of prior art elements according to their established functions.

Id. at 417. Reaching this conclusion, however, requires more than a mere showing that the prior art includes separate references covering each separate limitation in a claim under examination. *Unigene Labs., Inc. v. Apotex, Inc.*, 655 F.3d 1352, 1360 (Fed. Cir. 2011). Rather, obviousness requires the additional showing that a person of ordinary skill at the time of the invention would have selected and combined those prior art elements in the normal course of research and development to yield the claimed invention. *Id.*

11. Objective Evidence of Non-Obviousness

Patent Owner contends that objective evidence supports a finding of non-obviousness of the '493 patent. PO Resp. 68–78. According to Patent Owner, Shure's MXA910—a commercial product—embodies claims 1, 17, and 28 of the '493 patent, and that product's "commercial success, industry praise, and copying by competitors" evinces non-obviousness of claims 1–40. *Id.* at 68.

Obviousness is a question of law based on underlying findings of fact. *In re Gartside*, 203 F.3d 1305, 1316 (Fed. Cir. 2000). One of the underlying findings of fact include, when in evidence, objective indicia of non-obviousness (i.e., secondary considerations). *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966). In order to accord substantial weight to secondary considerations in an obviousness analysis, "the evidence of secondary considerations must have a 'nexus' to the claims, *i.e.,* there must be 'a legally and factually significant connection' between the evidence and the patented invention.'" *Fox Factory, Inc. v. SRAM, LLC*, 944 F.3d 1366, 1373 (Fed. Cir. 2019) (quoting *Henny Penny Corp. v. Frymaster LLC*, 938 F.3d 1324, 1332 (Fed. Cir. 2019)); *Lectrosonics, Inc. v. Zaxcom, Inc.*,

IPR2018-01129, Paper 33, 32 (PTAB January 24, 2020) (precedential, designated April 14, 2020). "The patentee bears the burden of showing that a nexus exists." *Id.* One way for a patentee to satisfy this burden is to show that the asserted evidence is tied to a specific product *and* that the specific product "embodies the claimed features and is coextensive with them." *Polaris Indus., Inc. v. Arctic Cat, Inc.*, 882 F.3d 1056, 1072 (Fed. Cir. 2018). If the patentee makes this showing, patentee is entitled to a rebuttable presumption that a nexus exists. *Id.* Even if a patentee fails to invoke the rebuttable presumption, a patentee can still demonstrate a nexus exists "by showing that the evidence of secondary considerations is the 'direct result of the unique characteristics of the claimed invention.'" *Fox Factory*, 944 F.3d at 1373–74 (quoting *In re Huang*, 100 F.3d 135, 140 (Fed. Cir. 1996)).

As argued by Petitioner, "[t]he '493 Patent claims entirely separate, distinct, and unrelated inventions: (1) a ceiling tile form factor [claims 17–27] and (2) concentric nested rings of microphones [claims 1–16 and 28–40]." Reply 37–38. Patent Owner's evidence relates primarily to a drop ceiling tile configuration, and provides little evidence regarding the microphone array that includes concentric, nested rings of microphones. *See* PO Resp. 68–78.

a) Claims 1–16 and 28–40

Claims 1–16 and 28–40 recite "an array microphone system" and "method of assembling an array microphone," respectively. Ex. 1001, 17:50, 19:21. Claims 1–16 require a plurality of microphones arranged on a substrate in a number of concentric, nested rings, wherein the microphones within each ring are positioned at predetermined intervals along the ring's circumference. *Id.* at 17:51–56. Claims 28–40 require arranging a second

plurality of microphones on a substrate to form a second configuration that concentrically surrounds a first plurality of microphones arranged to form a first configuration on the substrate. *Id.* at 18:23–31. Patent Owner briefly touches upon these microphone arrays, alleging the MXA910 microphone array is arranged in a number of concentric, nested rings of varying sizes, each ring including a subset of the plurality of microphones positioned at predetermined intervals along the circumference of each ring. PO Resp. 68–70. However, Patent Owner fails to demonstrate a nexus between the alleged evidence of non-obviousness, and claims 1–16 and 28–40. *See id.* at 68–78.

Specifically, relying on the declaration of Dr. Vipperman, Patent Owner asserts that MXA910 embodies claims 1 and 28. PO Resp. 69–70 (citing Ex. 2020 ¶¶ 61–65). Patent Owner and Dr. Vipperman both rely on an alleged photograph of MXA910's microphone array. *Id.*; Ex. 2020 ¶¶ 61–65. However, neither Patent Owner nor Dr. Vipperman provide similar analysis for claims 2–16 and 29–40. Accordingly, aside from claims 1 and 28, Patent Owner fails to show that MXA910 embodies the claims. Second, Patent Owner neither contends nor shows the claims are coextensive with the evidence of non-obviousness. *See* PO Resp. 68–78. Therefore, we find Patent Owner has failed to demonstrate it is entitled to a presumption of nexus as to claims 1–16 and 28–40. *Polaris Indus.,* 882 F.3d at 1072. As discussed below, Patent Owner has otherwise failed to show nexus to claims 1–16 and 28–40. *Fox Factory*, 944 F.3d at 1373–74.

For evidence of commercial success, Patent Owner cites sales figures for MXA910, but asserts without any supporting evidence that the alleged success was due to "superior audio performance" that improved existing offerings "by enabling 360-degree pickup and improved directionality while

avoiding unwanted noise." *Id.* at 71–72. Patent Owner does not cite to any testimony or document to support its assertion that this feature, i.e., 360-degree pickup and improved directionality while avoiding unwanted noise, was attributable to the claimed nested harmonic ring configuration and led to any alleged commercial success. *Id.*; *see also* Reply 38 (arguing that, to the extent MXA910 had improved sound quality, such improvement resulted from signal processing, not the array configuration of concentric nested rings). Accordingly, we find the evidence is insufficient to show MXA910 sales is the direct result of the unique characteristics of the invention covered by claims 1–16 and 28–40.

For evidence of copying, Patent Owner contends that Petitioner's beamforming microphone array (BMA) and Sennheiser's TeamConnect Ceiling copied MXA910. PO Resp. 72–77. Patent Owner's evidence of copying is directed to the ceiling tile configuration of MXA910, and Patent Owner provides no evidence, much less any assertion, that the alleged copies used the microphone array of MXA910. *Id.* Indeed, Patent Owner admits that BMA does not "incorporate[e] the same array microphone geometry as the MXA910." *Id.* at 75–76. Patent Owner similarly provides no evidence, and does not even assert, that the Sennheiser TeamConnect Ceiling uses the MXA910 microphone array, but rather focuses on Sennhesier's ceiling tile configuration. *Id.* at 76–77.

For industry praise, Patent Owner asserts "the industry has bestowed several honors on the MXA910 since its introduction." PO Resp. 77–78. However, we give little weight to this assertion because Patent Owner does not cite to any underlying documents. Rather, Patent Owner cites to the declaration of Mr. Schanz, Vice President of Shure, Inc., who provides a list enumerating alleged awards received, without any explanation of the

awards, specific identification of alleged praise, or any attempt to show any alleged praise is the direct result of the unique characteristics of the inventions covered by claims 1–16 and 28–40.

For the foregoing reasons, as to claims 1–16 and 28–40, although we have considered Patent Owner's evidence regarding objective indicia of non-obviousness in our overall obviousness analysis, we find it to be of limited weight.

b) Claims 17–27

Claims 17–27 recite a microphone assembly comprising, *inter alia*, a housing configured to support an array microphone that is "sized and shaped to be mountable in a drop ceiling in place of at least one of a plurality of ceiling tiles," and wherein "a front face of the housing includes a sound-permeable screen" shaped and sized substantially similarly to one of the ceiling tiles. Ex. 1001, 18:39–49. For the reasons discussed below, Patent Owner fails to demonstrate a nexus between the alleged evidence of non-obviousness, and claims 17–27. PO Resp. 68–78.

Patent Owner contends its MXA910 product embodies claim 17. PO Resp. 68, 71 (citing Ex. 2020 ¶¶ 61–65). However, neither Patent Owner nor Dr. Vipperman provide similar analysis for claims 18–27. Accordingly, aside from claim 17, Patent Owner fails to show MXA910 embodies the claims. Second, Patent Owner neither contends nor shows the claims are coextensive with the evidence of non-obviousness. *Id.* at 68–78. Therefore, we find Patent Owner has failed to demonstrate it is entitled to a presumption of nexus as to claims 17–27. *Polaris Indus.,* 882 F.3d at 1072. As discussed below, Patent Owner has otherwise failed to show nexus to claims 17–27. *Fox Factory*, 944 F.3d at 1373–74.

For evidence of commercial success, Patent Owner, once again, cites sales figures for MXA910, but asserts without supporting evidence that the alleged success was due to a new market created by Shure for ceiling-mounted arrays that could be integrated into a drop ceiling in place of a ceiling tile. PO Resp. 71 (citing Ex. 2014 ¶¶ 9–10). For evidence of copying, Patent Owner contends that Petitioner's beamforming microphone array (BMA) and Sennheiser's TeamConnect Ceiling copied MXA910. PO Resp. 72–77.

Patent Owner suggests that the success of MXA910 was attributable to its design that "provides a complete assembly housing an array microphone with a sound-permeable screen sized and shaped substantially similar to a ceiling tile." *Id.* at 74. The sales figures and evidence of alleged copying Patent Owner provides is weak. As Petitioner points out, Shure sells MXA910 for multiple different configurations, including configurations that do not involve the claimed ceiling tile configuration. Reply 38 (citing Ex. 1049 ¶¶ 27–34; Ex. 2014 ¶ 10; Ex. 1051 21:21–22:3, 23:15–20, 65:7–8, 113:6–15). The evidence supports Petitioner's argument that MXA910 features multiple configurations that do not involve the claimed ceiling tile configuration. Ex. 2017, 1–2, 4 (depicting configurations of the array hanging from the ceiling, rather than replacing a ceiling tile). The MXA910 brochure entered into evidence by Patent Owner depicts several installations of MXA910, none of which embodies the claimed configuration in which the microphone assembly replaces a ceiling tile. Ex. 2017. Specifically, the brochure depicts installations in which the microphone assembly hangs from the ceiling—i.e., an embodiment Patent Owner argues is distinguishable from a drop ceiling configuration in arguing Graham does not render claim 26 unpatentable. *Id.* at 1–2, 4; PO Resp. 42–

44. Although claim 17 does not expressly require the microphone assembly to be fitted into a ceiling to replace a ceiling tile, Patent Owner fails to establish the value of the claimed features in the configurations where the microphone assembly hangs from the ceiling. Indeed, Exhibit 2017 depicts installations that do not even have a drop ceiling, much less ceiling tiles in the ceiling. Ex. 2017, 1–2, 4. Accordingly, we find the evidence is insufficient to show that MXA910 sales and alleged copying are the direct result of the unique characteristics of the invention covered by claims 17–27.

For industry praise, Patent Owner asserts "the industry has bestowed several honors on the MXA910 since its introduction." PO Resp. 77–78. However, we give little weight to this assertion because Patent Owner does not cite to any underlying documents. Rather, Patent Owner cites to the declaration of Mr. Schanz, who provides a list enumerating alleged awards received, without any explanation of the awards, specific identification of alleged praise, or any attempt to show any alleged praise is the direct result of the unique characteristics of the invention covered by claims 17–27.

For the foregoing reasons, as to claims 17–27, although we have considered Patent Owner's evidence regarding objective indicia of non-obviousness in our obviousness analysis, we find it to be of limited weight.

12. Asserted Obviousness Over Tiete in Combination with Other Art

As we noted above, Petitioner asserts that claims 1–16 and claims 28–40 are unpatentable over Tiete in various combinations with other art. Pet. 9. For the reasons discussed below, we determine Petitioner has demonstrated, by a preponderance of the evidence, the unpatentability of claims 1–5, 7–16, 28–33, and 35–40 under § 103. Petitioner, however, has

not demonstrated, by a preponderance of the evidence, the unpatentability of claims 6 and 34 under § 103.

a) Claim 1

Petitioner has demonstrated, by a preponderance of the evidence, that claim 1 is unpatentable over the combination of Tiete and Chan. As we discussed above, Tiete describes a device called SoundCompass—a compass, containing an array of 52 microphones on a PCB, for measuring a sound field. *Supra*, Sec. II.E.2. Figures 1(b) and 5 of Tiete, reproduced below, are illustrative.

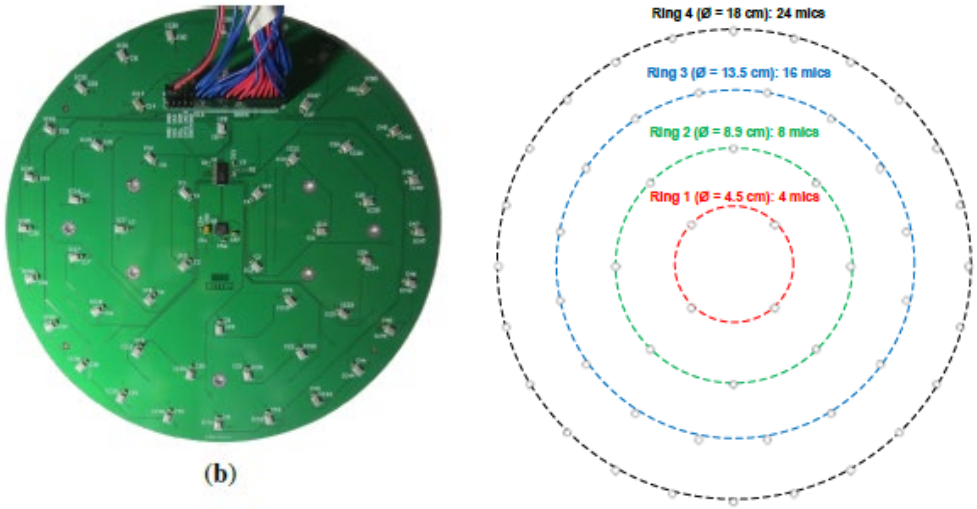


Figure 1(b) of Tiete is a photograph showing a bottom view of the SoundCompass PCB. Figure 5 of Tiete is an illustration showing the geometry of the 52 microphone array on the SoundCompass PCB.

Ex. 1005, Fig. 1(b) (left), Fig. 5 (right). Figure 1(b) is a photograph showing a bottom view of the SoundCompass PCB, and shows a microphone array and attached debug cable. *Id.* at 1919, Fig. 1(b). Figure 5 is an illustration showing the geometry of the 52 microphone array on the SoundCompass PCB. *Id.* at 1926, Fig. 5.

To the extent the preamble of claim 1 should be treated as limiting, Petitioner shows Tiete's SoundCompass discloses "[a]n array microphone system," as recited in the preamble of claim 1, because SoundCompass includes an array of 52 microphones. Pet. 40 (citing Ex. 1005, 1918, 1919, 1923, 1926–27, Figs. 1, 3, 5).

Petitioner shows Tiete discloses "a substrate," as recited in claim 1, because, as shown in Figure 1(b) of Tiete, SoundCompass includes 20-cm circular printed circuit board ("PCB"). *Id.* (citing Ex. 1005, 1919, 1923–24, 1931–32, Figs. 1, 2; Ex. 1003 ¶ 122).

Petitioner shows Tiete discloses "a plurality of microphones arranged, on the substrate, in a number of concentric, nested rings of varying sizes, each ring comprising a subset of the plurality of microphones positioned at predetermined intervals along a circumference of the ring," as recited in claim 1, based on Tiete's disclosure of a 52 microphone array. *Id.* at 30–32, 41–42. As we noted above, Figures 1(b) and 5 show the geometry of the 52 microphone array on the SoundCompass PCB. *Id.* at 1919, 1926. As shown in these figures, and explained in Tiete, the 52 microphones are arranged in four concentric rings. *Id.* at 1926.

Claim 1 further requires the microphones to be "positioned at predetermined intervals along a circumference of the ring." Petitioner argues Tiete teaches this feature because Tiete discloses that the microphone arrangement is predetermined to "maintain the array's [polar-steered power response], and also [directivity] D_p, independent of orientation." Pet. 30–31 (citing Ex. 1005, 1931); *see also id.* at 41 (explaining that the microphones are "mounted in a specific pattern on a circular circuit board with a diameter of 20 cm," and that certain parameters, including an array's polar steered response power ("P-SRP") and polar directivity, motivate the chosen array

geometry shown in Figure 5) (citing Ex. 1005, 1923, 1927, Fig. 5). In addition, Petitioner's declarant, Dr. Begault, opines that a skilled artisan viewing Figures 1 and 5 of Tiete would have understood that the microphones are uniformly arranged with purpose at predetermined intervals on each ring of the array. Ex. 1003 ¶ 98 (citing Ex. 1005, 1931). We credit Dr. Begault's testimony, and we find Petitioner's argument persuasive, for the following reasons.

Tiete explains that the digital array of microphones on the SoundCompass are "mounted in a specific pattern" on the circular PCB. Ex. 1005, 1923. As Dr. Begault points out, a skilled artisan looking at the depictions of SoundCompass in Tiete's Figures 1 and 5 would have observed regularly spaced intervals between microphones along the circumference of each concentric ring. Ex. 1003 ¶ 98 (citing Ex. 1005, 1931). Tiete's description of the microphone array geometry supports Dr. Begault's testimony. Section 4.4 of Tiete, titled "Motivating the Array Geometry," explains that a circular array geometry having radial symmetry, unlike linear arrays, maintains P-SRP and D_p in all directions. *Id.* at 1931. Teite's disclosure that the array has radial symmetry supports Dr. Begault's testimony that the microphones are evenly spaced along the circumference of the ring. Tiete further discloses that adding more microphones to the array results in positioning microphones more closely together, thereby suggesting that the spacing between microphones along a concentric ring depends on the number of microphones. *Id.* This disclosure in Tiete also supports Dr. Begault's testimony. Therefore, we find Dr. Begault's testimony to be credible, and we are persuaded that Tiete teaches positioning microphones at predetermined intervals along a circumference of the rings.

For the foregoing reasons, Petitioner has shown sufficiently that Tiete teaches all the limitations of claim 1, even without relying on the teachings Chan.

Alternatively, Petitioner asserts that Chan also teaches microphones "positioned at predetermined intervals along a circumference of the ring." Pet. 31–32 (citing Ex. 1003 ¶ 99). Petitioner explains that "Chan determined that the spacing between each microphone on each ring is 'λ/2, where λ is the smallest wavelength of the array to be operated.'" Pet. 31 (citing Ex. 1006, 167). Based on the fully developed trial record, we find Petitioner's argument persuasive. Figures 1 and 2 of Chan illustrate the spacing between microphones, i.e., inter-sensor spacing, along the circumference of a ring. The figures are reproduced below.

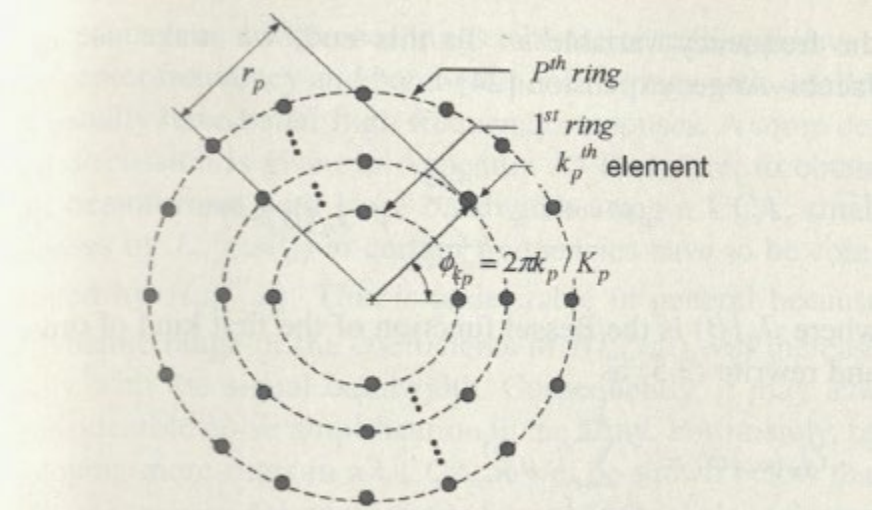


Fig. 1. UCCA with P rings. The pth ring has K_p equally spaced sensors.

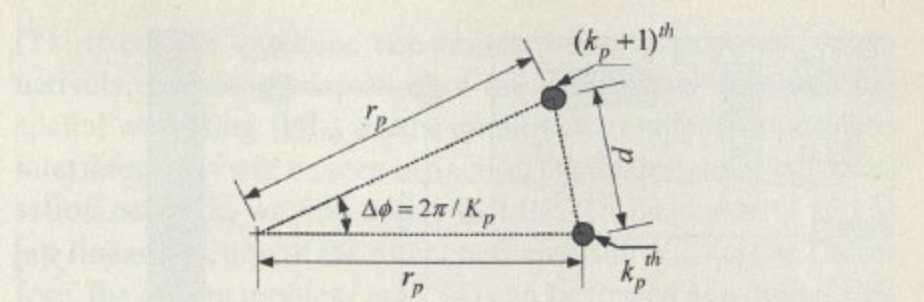


Fig. 2. Relationship between intersensor spacing and the radius of the *p*th ring of the UCCA.

Figure 1 of Chan illustrates a uniform concentric circular array (UCCA) with p rings. Figure 2 of Chan illustrates the relationship between inter-sensor spacing and the radius of the p^{th} ring of the UCCA.

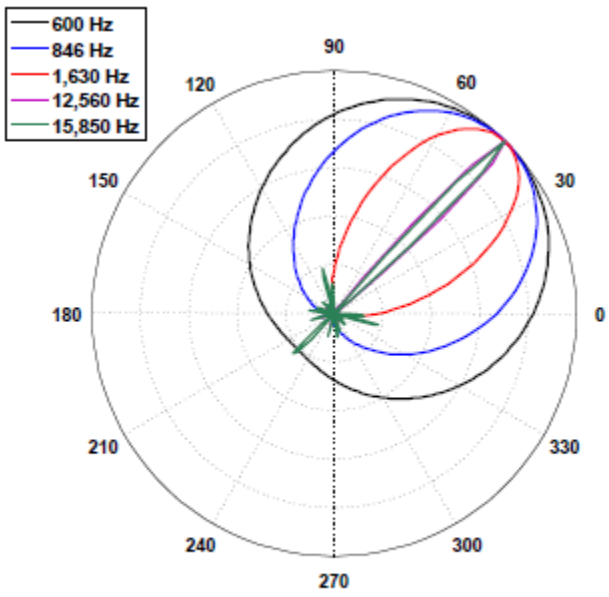
Ex. 1006, 167 (Figs. 1–2). Figure 1 shows a uniform concentric circular array ("UCCA") of microphones, i.e., sensors, wherein the UCCA has *p* rings, and each p^{th} ring has K_p "equally spaced" microphones along the circumference of the respective ring. *Id.* Figure 2 shows the "[r]elationship between intersensor [i.e., microphone] spacing and the radius of the *p*th ring of the UCCA." *Id.* As seen in these figures, Chan teaches equally spaced microphones along the circumference of the ring, and Chan teaches that the spacing is λ/2, where λ is the smallest wavelength of the array to be operated. *Id.* Accordingly, we find that Chan also teaches microphones "positioned at predetermined intervals along a circumference of the ring," as recited in claim 1.

Petitioner articulates a rationale to combine the teachings of Chan with those of Tiete. Pet. 31–32, 37–39. Both Tiete and Chan are in the field of acoustics and, as discussed above, each employ a microphone array comprising multiple concentric circular rings. Petitioner argues that a skilled artisan would have been motivated to apply Chan's teachings about beamforming techniques because beamforming, according to Chan, "find[s]

important applications in . . . acoustics." Pet. 38 (quoting Ex. 1006, 165–166). A skilled artisan, according to Petitioner, would have been interested in applying beamforming techniques like those taught in Chan to improve an acoustical array like that taught in Tiete. *Id.* (citing Ex. 1003 ¶ 117).

We find that Petitioner's argument and evidence is supported by the teachings of Tiete and Chan. Both Tiete and Chan teach that beamforming techniques are useful for suppressing sound coming from directions other than the direction from which the desired sound originates. Chan states that beamforming using sensor, e.g., microphone, arrays "is an effective method for suppressing interference whose angles of arrival are different from the desired looking direction." Ex. 1006, 165. Tiete, likewise, states that it uses beamforming techniques to sample the surrounding sound field, and that beamforming focuses the microphone array "in one specific direction or orientation, amplifying all sound coming from that direction and suppressing sound coming from other directions." Ex. 1005, 1926.

Tiete also teaches a need for detecting bearing, i.e., direction, of sound sources in, for example, an urban environment, where the sounds may have a broad range of characteristics, such as a broad range of frequencies. Tiete's SoundCompass is "designed to sample the directionality of the sound field of an urban environment where multiple sound sources of different characteristics might be present." Ex. 1005, 1922. Tiete teaches that the SoundCompass's ability to discriminate sound sources of various frequencies to a particular degree of directivity D_p depends on the circumference of the ring. *Id.* at 1930. Figure 8(a) of Tiete, reproduced below, is illustrative.



(a)

Figure 8(a) of Tiete illustrates a SoundCompass at different frequencies.

Ex. 1005, 1930. Figure 8(a) shows a polar plot indicating responses of the SoundCompass to sounds of various frequencies, namely 600, 846, 1,630, 12,560, and 15,850 Hz. *Id.* The sound sources all have the same bearing of 45˚. *Id.* As can be seen in Figure 8(a), the main lobe (circular curve) for a 600 Hz sound source, shown in black, is wide, and therefore, does not provide high directivity, because it does not narrow the sound source even to within a 90˚ quadrant. *Id.* In contrast, the main lobe for a 15,850 Hz sound source, shown in green, is narrow and provides for much greater directivity that can more confidently estimate the bearing of the sound source. *Id.* Tiete explains that increasing the diameter of the ring array increases directivity over all frequencies. *Id.* at 1931. Therefore, in order to achieve desired directivity for lower frequencies, rings of greater diameter may be useful. "[Polar directivity] D_p increases as the total diameter of a circular array increases . . . the bigger the better," and, therefore, removing outer

rings "reduces [polar] directivity, D_p," over all frequencies. Ex. 1005, 1931; *see also* Pet. 37–38 (citing Ex. 1005, 1931).

Chan teaches a beamforming technique that provides improved operation over a broad range of frequency bands, i.e., is frequency invariant. Ex. 1006, 165. Chan teaches that increasing the radius (and hence diameter, which is twice the radius) of a circular array results in a narrower passband, and that by employing multiple rings of progressively increasing radius, frequency invariance over a much larger frequency bandwidth may be achieved. Ex. 1006, 166.

We are persuaded, therefore, by Petitioner's assertion that a person of ordinary skill in the art "would have been motivated to look to Chan to determine how to optimize and expand Tiete's [microphone] array." Pet. 38.

We also find sufficient Petitioner's argument that skilled artisans would have applied Chan's teachings to those of Tiete with a reasonable expectation of success. *Id.* at 39. As Petitioner points out, both Tiete and Chan employ similar concentric circular ring arrays. *Id.* (citing Ex. 1003 ¶ 118; Ex. 1005, 1926; Ex. 1006, 165). Dr. Begault testifies that a skilled artisan would not have encountered any difficulty applying Chan's teachings to Tiete's microphone array because changes to the design would have been straight-forward. *Id.* (citing Ex. 1003 ¶ 118). The record supports Dr. Begault's testimony. The '493 patent provides little detail as to how to determine interval spacing, thereby leaving the implementation details to a person of ordinary skill in the art. The '493 patent states that the predetermined interval spacing along the circumference of a ring "can depend on size or diameter of the ring, a number of microphones 106b included in the subset assigned to that ring, and/or a desired sensitivity or overall pressure for the microphones 106b in the ring." Ex. 1001, 9:42–56.

With regard to claim 1, Patent Owner contends: 1) the Petition fails to demonstrate Tiete is a printed publication, and therefore qualifies as prior art to the '493 patent, and 2) Tiete and Chan are not analogous art, and a skilled artisan therefore would not have looked to the teachings of either Tiete or Chan. PO Resp. 44–48, 65–68.

As to Patent Owner's first argument, for reasons discussed above, we determine Tiete is a printed publication, and qualifies as prior art to the '493 patent under 35 U.S.C. § 102(a)(1). *Supra* Sec. II.E.1.

As to Patent Owner's second argument, under *In re Klein*, 647 F.3d 1343, 1348 (Fed. Cir. 2011), "[a] reference qualifies as prior art for an obviousness determination under § 103 only when it is analogous to the claimed invention." 647 F.3d at 1348. "'Two separate tests define the scope of analogous prior art'":

> (1) whether the art is from the same field of endeavor, regardless of the problem addressed and, (2) if the reference is not within the field of the inventor's endeavor, whether the reference still is reasonably pertinent to the particular problem with which the invention is involved.

Id. (citations omitted). Whether a reference in the prior art is analogous is a question of fact. *In re Clay*, 966 F.2d 656, 658 (Fed. Cir. 1992).

Patent Owner contends that neither Tiete nor Chan are in the same field of endeavor as the '493 patent, and that neither reference addresses the same problems that the invention of the '493 patent seeks to solve. PO Resp. 44–48.

Patent Owner submits the field of endeavor is defined in the '493 patent as "an array microphone system and method of assembling the same" that is "capable of fitting into a ceiling tile of a drop ceiling and providing 360-degree audio pickup with an overall directivity index that is optimized

across the voice frequency range." *Id.* at 45–46 (quoting Ex. 1001, 1:6–11). Patent Owner argues that, in contrast, Tiete seeks localizing sounds such as sniper fire or wildlife in noisy environments, and therefore is not concerned with an overall directivity matrix that is optimized across the voice frequency range. *Id.* at 45 (citing Ex. 1005, 1918; Ex. 2020 ¶¶ 142–145). With regard to Chan, Patent Owner does not address whether Chan is concerned with optimization across the voice frequency range. *See id.* at 46–47. Instead, Patent Owner identifies Chan's disclosure of beamforming techniques as directed to attaining nearly frequency invariant characteristics and argues that Chan "refers generally to 'applications in radio, communications, sonar, radar, and acoustics." *Id.* at 46 (citing Ex. 1006, 165). Patent Owner argues further that the '493 patent does not contemplate a system that maintains frequency invariance using Chan's techniques. *Id.* at 46–47 (citing Ex. 2020 ¶ 146).

Petitioner responds that the field of endeavor is an array microphone system and method of assembling the same. Reply 29–30. As argued by Petitioner, claims 1–16 and 28–40—i.e., the claims against which Petitioner asserts Tiete and Chan—do not state a field of use and are not limited to a particular use. *Id.* at 29 (citing Ex. 1052, 29:16–17, 24:13–29:17, 80:4–6). Petitioner responds further that Tiete is in the same field of endeavor because Tiete is based on indoor telephone conference systems, and the frequency range of Tiete's system ranges from 100–16,000 Hz, and therefore covers the prominent sound frequencies of speech, i.e., 100–8,000 Hz. *Id.* at 30 (citing Ex. 1005, 1921; Ex. 1003 ¶ 97). Petitioner argues that Chan also is in the same field of endeavor because Chan "overlaps with the same objectives for solutions as the '493 patent." *Id.* at 30 (citing Ex. 1003 ¶ 99–103). For example, Chan is cited in a patent titled "Microphones

Orientation and Size in a Speakerphone," which lists Patent Owner's expert in IPR2017-01785, William Oxford, Ph.D., as a co-inventor. *Id.* (citing Ex. 1053, 3). Dr. Oxford previously testified that his discussion of designing a telephone conferencing system for LifeSize between the time frame of 2003–2007 included beaming techniques that Petitioner argues are like those taught in Chan. *Id.* (citing Ex. 1053, 3; Ex. 1054, 4, 7–10[15]; Ex. 1003 ¶ 101).

Based on the fully developed trial record, we find Petitioner's arguments persuasive. The title of the '493 patent is "Array Microphone System and Method of Assembling the Same." Ex. 1001, code (54). It does not state or indicate a field of use or narrow the field of use to a microphone capable of fitting into a ceiling tile of a drop ceiling and providing 360-degree audio pickup with an overall directivity index optimized across a voice frequency range. In order to import this narrowing feature into the alleged field of use, Patent Owner cites to the Technical Field of the '493 patent. PO Resp. 45 (citing Ex. 1001, 1:6–11). We find this unavailing because, as argued by Petitioner, claims 1–16 and 28–40—i.e., the claims against which Petitioner asserts Tiete and Chan—do not state a field of use and are not limited to a particular use. Reply 29. This is in contrast with claims 17–27, which specifically require, inter alia, a "housing shaped to be mountable in a drop ceiling." We find that the field of endeavor for the invention recited in claims 1–16 and 28–40 is array microphone systems and methods of assembling the same. We are persuaded by Petitioner's arguments that both Tiete and Chan are in this field of endeavor because

[15] Petitioner also cites "Ex. 1054, 157–11:22." Exhibit 1054 is a declaration that includes numbered paragraphs and page number at the bottom of each page. It is unclear what "157–11:22" is citing to.

Tiete relates to a distributed microphone array based sensor for sound localization and Chan relates to beamforming microphone (i.e., sensor) arrays. Ex. 1005; Ex. 1006.

Even if we were to assume that the field of endeavor pertained to providing 360-degree audio pickup with an overall directivity index that is optimized across the voice frequency range, as argued by Patent Owner, our finding that Tiete and Chan are analogous to the '493 patent would be the same. As argued by Petitioner, Tiete is based on indoor telephone conference systems, and the frequency range of Tiete's system ranges from 100–16,000 Hz and, therefore, covers the prominent sound frequencies of speech, i.e., 100–8,000 Hz. Reply 30 (citing Ex. 1005, 1921; Ex. 1003 ¶ 97). We find Chan also is applicable with regard to the voice frequency arrange. As acknowledged by Patent Owner, Chan's beamforming techniques are broadly applicable, and include applications in acoustics. PO Resp. 46 (citing Ex. 1006, 165). Chan's citation in a patent titled "Microphones Orientation and Size in a Speakerphone," further supports our finding that a person of ordinary skill in the art would have considered the teachings of Chan in the context of microphone arrays optimized across the voice frequency range. Ex. 1053, 3.

Patent Owner also contends that Tiete and Chan do not address the same problem as the '493 patent. PO Resp. 47. Petitioner disputes this contention, but does not provide a substantive response. Reply 29–30. However, we need not decide this question because, as we discussed above, we find Tiete and Chan are in the same field of endeavor as the '493 patent.

For the foregoing reasons, having reviewed the fully developed trial record, we determine Petitioner has shown, by a preponderance of the evidence, that claim 1 is unpatentable as obvious over Tiete and Chan.

b) Claim 28

Petitioner contends claim 28 is unpatentable as obvious over Tiete and Chan. Pet. 30, 56–58. Claim 28 is similar to claim 1, but with some differences. Ex. 1001, 17:50–56, 19:21–31. Patent Owner does not provide arguments specific to claim 28. For the foregoing reasons, Petitioner has shown unpatentability of claim 28.

The preamble of claim 28 recites "[a] method of assembling an array microphone." Ex. 1001, 19:21–22. To the extent the preamble of claim 28 should be treated as limiting, Petitioner shows that Tiete describes a method of assembling an array microphone, because Tiete discloses the assembly of a SoundCompass prototype, described as "a 20-cm circular printed circuit board (PCB) (Figure 1) containing a sensor array of 52 microphones." Pet. 56 (citing Ex. 1003 ¶ 134; Ex. 1005, 1918, 1919, 1923, 1926, 1927, Figs. 1, 3, 5).

Claim 28 next recites "arranging a first plurality of microphones to form a first configuration on a substrate" and "arranging a second plurality of microphones to from a second configuration on the substrate, the second configuration concentrically surrounding the first configuration." Ex. 1001, 19:23–28. Petitioner shows that Tiete teaches these limitations because Tiete's microphone array comprises four concentric, nested rings, as illustrated in Figure 5 of Tiete. Pet. 56–57 (citing Ex. 1003 ¶ 134; Ex. 1005, 1923, 1924, 1926, 1927, 1931, 1932, Figs. 1, 5). As argued by Petitioner, the two inner rings are arranged in a first plurality of microphones to form a first configuration and the two outer rings are arranged in a second plurality of microphones to form a second configuration concentrically surrounding the first configuration. *Id.*

Finally, claim 28 recites "electrically coupling each of the first and second pluralities of microphones to an audio processor for processing audio signals captured by the microphones." Ex. 1001, 18:29–31. Petitioner shows that Tiete teaches this limitation because Tiete discloses that the data captured from the microphones forming the array, e.g., MEMs microphones, are processed. More specifically, the MEMs microphones on the PCB connect to an FPGA add on board on the bottom of the PCB, wherein the FPGA is connected via an Inter-Integrated Circuit (I^2C) interface with a host platform for processing audio signals captured by the MEMs microphones. Pet. 57–58 (citing Ex. 1001 ¶ 134; Fig. 1005, 1919, 1923–1932, Figs. 1, 4).

For the foregoing reasons, having reviewed the fully developed trial record, we determine that Petitioner has shown, by a preponderance of the evidence, claim 28 is unpatentable as obvious over Tiete and Chan.

c) Claims 2–16, 29–40

(1) Claim 2

Claim 2 depends from claim 1, further reciting "wherein the concentric, nested rings are rotationally offset from each other." Ex. 1001, 17:57–59. We find that Tiete discloses this feature. As demonstrated by Petitioner, Tiete Figures 1 and 5 depict rings that are rotationally offset from each other. Pet. 42–43 (citing Ex. 1005, Figs. 1, 5; Ex. 1003 ¶ 123). Patent Owner contends that Tiete does not disclose rotationally offset rings based on Patent Owner's proposed claim construction requiring that "no more than any two microphones are axially aligned." PO Resp. 48. As we discussed above, Patent Owner's construction is unduly narrow because the Specification and claim language do not require a particular way of rotationally offsetting the concentric, nested rings. *Supra* Sec. II.D.

For the foregoing reasons, having reviewed the fully developed trial record, we determine that Petitioner has shown, by a preponderance of the evidence, claim 2 is unpatentable as obvious over Tiete and Chan.

(2) Claims 3–5

Claims 3–5 depend directly from claim 1. Patent Owner does not raise arguments for these claims in addition to those argued for claim 1. Having reviewed Petitioner's evidence and arguments, we are persuaded Tiete teaches the additional claimed features required by claims 3–5. Pet. 43–45. Petitioner demonstrates Figure 5 of Tiete depicts concentric nested rings "positioned at different radial distances from a central point of the substrate to form a nested configuration," as recited in claim 3. *Id.* at 43–44. Petitioner also demonstrates the plurality of microphones in Tiete are "micro-electrical mechanical system (MEMS) microphones," as recited in claim 4, based on Tiete's explicit disclosure that the microphone array "is composed of a sensor array of 52 Microelectricalmechanical systems (MEMS) microphones." *Id.* at 44 (citing Ex. 1005, 1918, 1926, 1923, 1924, 1938, 1946). Lastly, Petitioner demonstrates Tiete's Figure 5 depicts each of Tiete's rings "form[ing] a circle with a different diameter," as recited in claim 5, because each ring progressively is larger and, therefore, has a larger diameter. *Id.* at 45 (citing Ex. 1005, Fig. 5, 1923, 1924, 1926, 1927, Fig. 1).

For the foregoing reasons, having reviewed the fully developed trial record, we determine that Petitioner has shown, by a preponderance of the evidence, claims 3–5 are unpatentable as obvious over Tiete and Chan.

(3) Claims 6 and 34

Claims 6 and 34 depend from claims 5 and 30, respectively, and they recite "wherein the diameter of each ring is determined based on a *lowest*

operating *frequency* assigned to the subset of microphones included in the ring" and "wherein a diameter of each concentric ring is defined by a *lowest* operating *frequency* assigned to the microphones forming the ring," respectively. Ex. 1001, 18:1–4, 20:12–14. Petitioner relies on Chan's teaching that rings with a larger radius perform better in lower frequency bandwidths, and rings with a smaller radius perform better in higher frequency bandwidths. Pet. 32–34, 45–46, 61. According to Petitioner, Chan determines the radius (i.e., half the diameter) of the ring based on the smallest wavelength the array measures. *Id.* at 32 (citing Ex. 1006, 167); *id.* at 45–46. Specifically, Petitioner argues "[t]he spacing between the rings in each microphone is fixed at λ/2, 'where λ is the smallest wavelength of the array to be operated.' λ_{min}". *Id.* at 46 (citing Ex. 1006, 167).

Based on the fully developed trial record, Petitioner has failed to show that Chan teaches the limitations of claims 6 and 34. The formula Petitioner identifies is not used to calculate the radius of the ring, but rather is used to calculate the spacing between sensors within a particular ring: "In UCCAs, the *intersensor spacing in each ring* is fixed at λ/2, where λ is the smallest wavelength of the array to be operated and is denoted by λ_{min}." Ex. 1006, 167 (emphasis added). Neither Petitioner nor Dr. Begault explain how calculating inter-sensor spacing amounts to defining a diameter of each concentric ring by a lowest operating frequency assigned to the microphones forming the ring, as required by these two claims. Chan includes a formula to calculate the radius of the p^{th} ring of the microphone array, namely

$$r_p = \lambda_{min}/ (4\sin (\pi/K_p)).$$

Id. However, neither Petitioner nor Dr. Begault discuss this formula.

Patent Owner points out that a smallest wavelength corresponds to a *highest* frequency, because frequency and wavelength are inversely

proportional. PO Resp. 53. But the claims require determining diameter based on the *lowest* operating frequency within the operational frequency range assigned to the ring. Neither Petitioner nor Dr. Begault explain why a skilled artisan would determine the diameter of a ring using the *lowest* operating frequency assigned to the microphones forming a particular *ring*, especially based on Chan's teaching to use the *highest* frequency of the *array* —i.e., λ_{min}. Ex. 1006, 167 ("λ is the smallest wavelength of the array to be operated and is denoted by λ_{min}").

For the foregoing reasons, having reviewed the fully developed trial record, we determine that Petitioner has not shown, by a preponderance of the evidence, claims 6 and 34 are unpatentable as obvious over Tiete and Chan.

(4) Claim 7

Claim 7 depends from claim 1, and further recites "wherein the number of concentric, nested rings is seven." Ex. 1001, 18:5–6. Petitioner appears to acknowledge that neither Tiete nor Chan explicitly disclose seven rings. Pet. 48–49; Ex. 1003 ¶ 107 (Dr. Begault acknowledging Tiete does not expressly disclose seven rings). Tiete explicitly discloses an array comprising four rings. Ex. 1005, Fig. 5 (1926). However, Tiete's teachings are not limited to the disclosed 52 microphone array comprising four rings. As explained by Dr. Begault, Tiete discloses that, "as for most sensor array applications, the bigger, the better" and "adding more microphones to the array increases the array's output signal-to-noise ratio (SNR)"). Ex. 1003 ¶ 107; Pet. 35, 48 (citing Ex. 1005, 1931, 1932, 1946). Based on these teachings, Dr. Begault contends a person of ordinary skill in the art would

have been motivated to add additional rings to improve the array's SNR. Ex. 1003 ¶ 107.

Petitioner and Dr. Begault rely further on Chan to teach the limitation of claim 7. Figure 1 of Chan depicts an array comprising *p* rings, where *p* in an integer number, e.g., *p* encompasses the number 7. Pet. 35, 48–49 (citing Ex. 1006, 167, Fig. 1; Ex. 1003 ¶¶ 107–109, 128). According to Dr. Begault, a person of ordinary skill in the art would have applied Chan's teachings of using *p* rings to Tiete's teaching of larger microphone arrays, to arrive at an array of seven rings. Ex. 1003 ¶ 108; Pet. 35, 48–49. Indeed, as Dr. Begault points out, Christensen, discloses an array comprising 10 rings. *Id.*; Pet. 36, 49 (citing Ex. 1013, Fig. 5, 4:53–5:2).

Patent Owner responds that none of the references Petitioner cites teaches seven rings, arguing that seven is not an arbitrary or random number rendered obvious by the teachings in the cited prior art. PO Resp. 54–55. Patent Owner explains the '493 patent's Specification discloses that each ring is a sub-array that covers a different frequency octave within the frequency range of human speech, leading to the number seven. *Id.* (citing Ex. 1001, 10:42–67, 13:60–64, 10:57–61, 17:6–10). According to Patent Owner, Tiete does not use sub-arrays within the main array, but instead discloses that all of its signals are processed and summed. *Id.* at 56 (citing Ex. 1005, 1925–1926).

Petitioner responds that Patent Owner improperly attempts to read into claim 7 the requirement that the seven rings correspond to the seven octaves within the frequency range of human speech. Reply 32. Petitioner contends, nonetheless, that seven rings corresponding to seven octaves would have been obvious given the range of frequencies for human speech. *Id.* (citing Ex. 1043 ¶¶ 114–116, 141–147).

We are persuaded by the argument in the Petition and the testimony in the Begault Declaration (Ex. 1003). We agree with Petitioner that the claims do not require the rings to correspond with octaves of human speech. As we discussed above and as argued by Petitioner, Tiete teaches increasing the number of microphones in the array to increase SNR, and Chan teaches using *p* rings, wherein *p* is an undefined integer. Pet. 35–36, 48–49. We credit Dr. Begault's testimony that skilled artisan reading Tiete and Chan would have reasonably understood that *p* includes seven. Ex. 1003 ¶¶ 107–109. As noted by Dr. Begault, Tiete discloses four rings, but also discloses it would have been desirable to use more microphones, and Christensen discloses using ten rings. Pet. 35–36, 48–49; Ex. 1003 ¶¶ 107–109.

For the foregoing reasons, having reviewed the fully developed trial record, we determine that Petitioner has shown, by a preponderance of the evidence, claim 7 is unpatentable as obvious over Tiete and Chan.

(5) Claims 8 and 36

Claims 8 and 36 depend from claims 1 and 30, respectively, and they recite "the concentric rings of the microphones are harmonically nested" and "the concentric rings in each of the first and second configurations are harmonically nested," respectively. Ex. 1001: 18:7–8, 20:22–24. Petitioner contends "harmonically nested" rings would have been obvious over the combined teachings of Tiete and Chan in view of the teachings of Chou. Pet. 65–67 (citing Ex. 1003 ¶¶ 145–149, 174). Chou teaches using harmonic nesting of array microphones "to cover a large frequency range by implementing several subarrays, each designed for a smaller frequency range, typically an octave." *Id.* at 65 (quoting Ex. 1014, 2995) (citing Ex. 1022, 201). Petitioner acknowledges Chou discloses harmonic nesting

of linear microphone arrays, whereas the claims recite harmonically nested ring (i.e., circular) arrays. *Id.* at 66. Petitioner argues, nonetheless, that a skilled artisan would have known Chou's principles would apply to circular nested arrays, such as those taught in Chan. *Id.* (citing Ex. 1003 ¶ 147). According to Petitioner, "[s]killed artisans would have known to overlay the harmonic subarrays to obtain a 'composite array' shown in Chou, Ex. 1014 at 2995, Fig. 2, or join the ends of the linear subarrays to form circular subarrays like those taught in Chan and Tiete, Ex. 1006 at 1067; Begault Decl. ¶147." *Id.* Petitioner contends, moreover, that an ordinarily skilled artisan would have been motivated to modify the combined teachings of Tiete and Chan with those of Chou with a reasonable expectation of success. *Id.* at 66 (citing Ex. 1003 ¶ 148).

Patent Owner responds that Chou teaches harmonic nesting of *linear* subarrays of microphones, whereas the claims require harmonically nested *ring* arrays. PO Resp. 56–59. Patent Owner argues the combination of these references would have led to either: 1) a large ring, or 2) a linear array configuration. *Id.* at 57–58. Patent Owner also contends Dr. Begault's testimony is derived solely from hindsight. *Id.* at 59. To support this contention, Patent Owner argues that Chan discloses a composite array that consolidates multiple linear arrays into a single linear array. *Id.*

We find unavailing Patent Owner's argument that the proposed combination would have resulted in either: 1) a large ring, or 2) a linear array configuration. *See* PO Resp. 56–59. Dr. Begault does not bodily incorporate the teachings of Chou into those of Chan and Tiete, or vice-versa. Rather, as Dr. Begault explains, in the proposed combination the rings remain concentrically nested, as taught by Tiete and Chan. Ex. 1043 ¶ 119. As Petitioner points out, Dr. Begault explains that a skilled artisan

would have recognized that the harmonic nesting technique in Chou may be applied to circular arrays. Reply 33 (citing Ex. 1043 ¶¶ 117–122). The physical configuration of the rings in the proposed combination of Tiete and Chan remains in a nested, concentric configuration, but they are harmonically nested, as taught by Chou. Ex. 1043 ¶ 119.

Moreover, as argued by Petitioner, and attested to by Dr. Begault, harmonic nesting was a well-known technique for microphone arrays to cover a larger frequency range by using sub-arrays, each covering a smaller frequency range. Pet. 66 (citing Ex. 1003 ¶ 148; Ex. 2014, 2995; Ex. 2019, 5; Ex. 1022, 201, Fig. 3.57); Ex. 1043 ¶ 119. Quoting a text Book titled "Microphone Arrays: Signal Processing Techniques and Applications," Dr. Begault explains that harmonic nesting techniques "are based on the idea that at different frequencies, a different array should be used that has a total size and inter-sensor spacing appropriate for that particular frequency." Ex. 1043 ¶ 150 (citing Ex. 1019, 4–5). Dr. Begault quotes several additional references describing the technique of harmonic nesting of microphone arrays that confirm his testimony that harmonic nesting was a well-known technique to cover a broadband frequency range by using sub-arrays. *Id.* ¶¶ 150–152 (citing Ex. 1019, 290 ("Accounting for the wideband nature of speech and audio signals, nested arrays are often employed using different sets of sensors for different frequency bands."); Ex. 1014, 2995 ("The harmonic nesting approach is to cover a large frequency range by implementing several subarrays, each designed for a smaller frequency range, typically an octave."); Ex. 1069, 909 (explaining with regard to speech signals that a "[n]ested array is designed so that covers frequency range of [50-7200]Hz through 4 sub-arrays"); Ex. 1078, 143 ("Harmonic nesting is a widely used method in order to step towards frequency

invariance, whereby for a number of frequency bands, different subarrays with appropriate apertures and sensor spacings are operated.”). Accordingly, we credit Dr. Begault’s testimony that harmonic nesting was a well-known technique that, when implemented, permitted microphone arrays to cover a large frequency range.

We note that, although Chan does not use the phrase “harmonic nesting,” like Chou, Chan also describes broadband adaptive beamforming as leading to problems (e.g., increased convergence time, degraded numerical properties, and high implementation complexity). Ex. 1006, 165. Furthermore, like Chou, Chan overcomes the problems with broadband beamforming by using sub-band arrays. *Id.* at 166. Chan acknowledges the use of linear arrays, stating that traditionally frequency invariant beamformers mainly focused on linear arrays with fixed spatial-frequency responses, but that “motivated by the potential advantages of FIB and the symmetric geometry of uniform circular arrays,” the author of Chan developed electronically steerable uniform circular arrays, and further developed uniform concentric circular arrays comprising ring subarrays. *Id.* Thus, Chan teaches the use of sub-band arrays and also teaches improving linear arrays by using uniform concentric circles.

We find the record evidence provides sufficient support for Dr. Begault’s testimony and that, contrary to Patent Owner’s assertion, his testimony is not based solely on hindsight.

For the foregoing reasons, having reviewed the fully developed trial record, we determine Petitioner has shown, by a preponderance of the evidence, that claims 8 and 36 are unpatentable as obvious over Tiete and Chan in view of Chou.

(6) Claims 9 and 10

Claim 9 depends from claim 1, and further recites "wherein the plurality of microphones includes at least 113 microphones." Ex. 1001, 18:9–10. Claim 10 depends from claim 9, and further recites "wherein the plurality of microphones includes up to 120 microphones." *Id.* at 18:11–12. Accordingly, due to its dependence on claim 9, claim 10 requires the number of microphones to be 113 to 120 microphones.

Petitioner contends that claims 9 and 10 would have been obvious over the combined teachings of Tiete and Chan. Pet. 36–37. Petitioner argues a skilled artisan would have found it obvious to add microphones to Tiete's 52 microphone array to improve frequency range, signal-to-noise ratio, and directivity. *Id.* at 37 (citing Ex. 1003 ¶ 110; Ex. 1005, 1931, 1946). We find Petitioner's argument persuasive because Tiete expressly teaches using more microphones. Tiete teaches that the "total number of microphones has a direct effect on the array gain; adding more microphones to the array increases the array's output signal-to-noise ratio (SNR)." *Id.* at 36–37 (citing Ex. 1005, 1931). Tiete teaches, furthermore, that "as microphones are positioned closer together, the directivity, D_p, increases in the high ranges." *Id.* at 37 (citing Ex. 1005, 1931, 1946). Petitioner also points out, correctly, that Chan teaches using an abstract number of P rings and K_p microphones that would encompass 113 to 120 microphones. *Id.* at 37 (citing Ex. 1006, 167). Petitioner's argument that 113 to 120 microphones would have been obvious finds further support in Petitioner's identification of a 118 beamforming array in Christensen. *Id.* (citing Ex. 1013, Fig. 5).

Patent Owner contends the range of the number of microphones, i.e., 113 to 120, is not arbitrary, but rather is based on the array comprising seven

rings—one ring for each the of seven octave bands covering the frequencies of human speech—wherein each ring comprises a specific number of microphones based on scaling requirements to achieve harmonic nesting. PO Resp. 60–61 (citing Ex. 2020 ¶¶ 189–92); Ex. 1001, 1061–67, Fig. 9). However, we find Patent Owner's argument unavailing. Claims 9 and 10 do not include any limitations directed to a specific number of octaves/rings and/or a specific number of microphones per ring. Reply 33. Even though the Specification provides an example in Figure 9 of a microphone array comprising 113 microphones, claims 9 and 10 do not require this specific configuration in the Specification.

Also unavailing, Patent Owner contends Tiete teaches away from adding microphones to the array, arguing Tiete discloses that it is desirable to reduce the number of microphones from 52 to a "prototype[] with fewer microphones." PO Resp. 61 (citing Ex. 1005, 1946). Whether a reference teaches away from a claimed invention is a question of fact. *In re Harris*, 409 F.3d 1339, 1341 (Fed. Cir. 2005). A reference may be said to teach away when a person of ordinary skill, upon reading the reference, would be discouraged from following the path set out in the reference, or would be led in a direction divergent from the path that was taken by the applicant. *In re Gurley*, 27 F.3d 551, 53 (Fed. Cir. 1994). "A reference does not teach away [. . .] if it merely expresses a general preference for an alternative invention[.]" *DePuy Spine, Inc. v. Medtronic Sofamor Danek, Inc.*, 567 F.3d 1314, 1327 (Fed. Cir. 2009). Here, we are not persuaded by Patent Owner's argument that Tiete discourages the use of more microphones. Tiete merely discloses that the number of microphones "can probably be reduced, while still resulting in almost equally good results." Reply 34 (citing Ex. 1005, 1946). In contrast with this consideration, Tiete encourages the use of more

microphones, stating that "removing the outer rings, has a negative impact of the array directivity over all frequencies" and that "for most sensor applications, the bigger the better," with the caveat for achieving a compromise between size and cost. *Id.* (citing Ex. 1005, 1931). The fact that Tiete discloses costs and benefits of larger arrays and smaller arrays does not nullify its teaching of using a larger array or teach away from adding more microphones to its array.

For the foregoing reasons, having reviewed the fully developed trial record, we determine Petitioner has shown, by a preponderance of the evidence, that claims 9 and 10 are unpatentable as obvious over Tiete and Chan.

(7) Claims 11 and 29

Claims 11 and 29 depend from claims 1 and 28, respectively, and they recite that the "microphones are configured to cover preset frequency ranges" and "the first and second pluralities of microphones are configured to cover different present frequency ranges," respectively. Ex. 1001, 18:13–15, 19:32–34. Petitioner contends that claims 11 and 29 would have been obvious over the combination of Tiete and Chan. Pet. 32–34. Petitioner argues persuasively that Chan teaches this limitation, because Chan discloses that "rings with larger radii will have a lower frequency and bandwidth, while rings with smaller radii usually will have better high frequency responses." Pet. 32 (citing Ex. 1006, 168–69). Accordingly, we are persuaded Chan teaches different rings covering different preset frequency ranges. Patent Owner does not provide arguments specific to claims 11 and 29.

For the foregoing reasons, having reviewed the fully developed trial record, we determine that Petitioner has shown, by a preponderance of the evidence, claims 11 and 29 are unpatentable as obvious over Tiete and Chan.

(8) Claims 12–15

Petitioner contends the following claims are unpatentable as obvious over the following combinations: 1) claims 12 and 13 over Tiete and Chan (Pet. 53–55); 2) claim 14 over Tiete, Chan, and Sawa (*id.* at 67–69); and 3) claim 15 over Tiete, Chan, and Beaucoup (*id.* at 69–70). Petitioner identifies how each claim limitation is taught by the asserted prior art reference and persuasively provides a rationale to combine. *Id.* at 53–55, 67–70. Patent Owner does not provide arguments specific to claims 12 through 15.

For the foregoing reasons, having reviewed the fully developed trial record, we determine that Petitioner has shown, by a preponderance of the evidence: 1) claims 12 and 13 are unpatentable as obvious over Tiete and Chan; 2) claim 14 is unpatentable as obvious over Tiete, Chan, and Sawa; and 3) claim 15 is unpatentable as obvious over Tiete, Chan, and Beaucoup.

(9) Claims 16 and 35

Claim 16 depends from claim 1, and further recites "wherein the substrate comprises a central printed circuit board (PCB) and a plurality of peripheral printed circuit boards (PCBs) radially positioned around, and electrically connected to, the central PCB, at least one of the number of concentric, nested rings being positioned on the plurality of peripheral PCBs." Ex. 1001, 18:33–38. Claim 35 depends ultimately from claim 28, and recites a similar limitation. *Id.* at 20:14–20. Petitioner contends claims 16 and 35 are unpatentable as obvious over Tiete, Chan, and Sawa.

Pet. 71–74. Petitioner acknowledges Tiete's SoundCompass does not have a substrate comprising a central PCB with a plurality of radially positioned surrounding PCB's. Pet. 71 (citing Ex. 1005, 1926). Petitioner argues, however, that such a design would have been obvious in view of Tiete's teaching that the microphone array mounted on a 20 centimeter PCB would be improved with additional microphones, because a skilled artisan would have known to add additional peripheral PCBs, as taught in Sawa, in order to accommodate additional microphones. *Id.* (citing Ex. 1005, 1926, 1923, 1931, 1946; Ex. 1003 ¶¶ 161–164). Specifically, Sawa teaches arranging a ring of microphones on multiple peripheral PCBs around a central point. *Id.* at 71–72 (citing Ex. 1008, 21:54–22:4, Fig. 16). According to Petitioner, use of multiple PCBs was conventional, and Tiete itself taught the use of "add-on" boards for including additional components. *Id.* at 71 (citing Ex. 1005, 1924).

Figure 16 of Sawa depicts four PCB microphone array boards radially positioned around a central point, thereby forming a circular microphone array. Figure 16, as annotated by Petitioner in red, is reproduced below:

FIG. 16

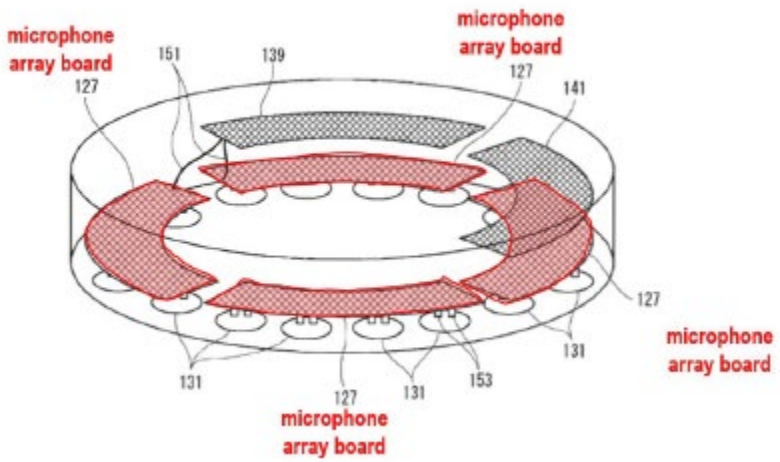
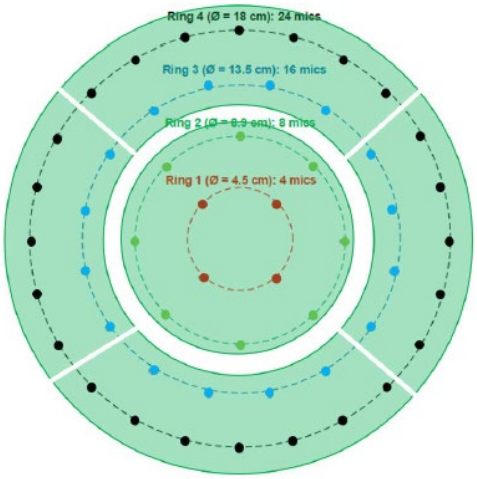


Figure 16 of Sawa is a schematic diagram illustrating a microphone array structure including four microphone boards 127.

Pet. 72 (reproducing Ex. 1008, Fig. 16 annotated)). As shown in Figure 16 of Sawa, four PCBs (i.e., microphone boards 127) are arranged radially around a central point. Petitioner argues that a skilled artisan combining Tiete, which has a single, round PCB, with Sawa, would have modified Tiete so that Tiete's two inner rings (as shown in Figure 5 of Tiete) would have been on a central PCB, and the two outer rings would have been implemented using the configuration in Sawa around the central PCB. *Id.* at 72–74 (citing Ex. 1005, Fig. 5, Fig. 1; Ex. 1008, 21:66–22:4; Ex. 1015, Fig. 2; Ex. 1003 ¶¶ 165–167). The combination, according to Petitioner, would have been as shown in the figure generated by Dr. Begault, reproduced below.



Dr. Begault's Figure illustrating Tiete's microphone array of Figure 5 in Tiete, as modified in view of Sawa

Pet. 73 (reproducing a modified illustration of Ex. 1005, Fig. 5 (citing Ex. 1003 ¶¶ 165–167)). Petitioner argues using multiple peripheral PCBs, instead of a single PCB, would have improved the performance of Tiete's and Chan's arrays. *Id.* (citing Ex. 1003 ¶ 163). Petitioner argues further that

using additional or smaller boards would have provided the additional advantage of reducing cost, relying on Dr. Begault, who testifies that it was known in the industry that smaller PCBs were cheaper to fabricate. *Id.* (citing Ex. 1003 ¶ 164). Moreover, according to Petitioner, using one PCB versus multiple interconnected PCBs was an established design choice, and either could have been accomplished predictably and with a reasonable expectation of success. *Id.* at 73–74 (citing Ex. 1003 ¶¶ 165–167).

Based on the fully developed trial record, we find credible Dr. Begault's testimony, which is supported, for example, by McElveen. Dr. Begault explains designs like that required by claims 16 and 35 "were already implemented in other microphone arrays, as evinced by McElveen." Ex. 1003 ¶ 167. McElveen relates to a directional audio array apparatus, and explicitly discloses a microphone array implemented on multiple PCBs arranged radially around a central PCB. Ex. 1003 ¶ 167; Ex. 1015 codes (54), (57), Fig. 2; Pet. 74; Reply 34–35. Figure 2 of McElveen is reproduced below, and discloses a microphone array implemented using a plurality of PCBs radially positioned around a central PCB.

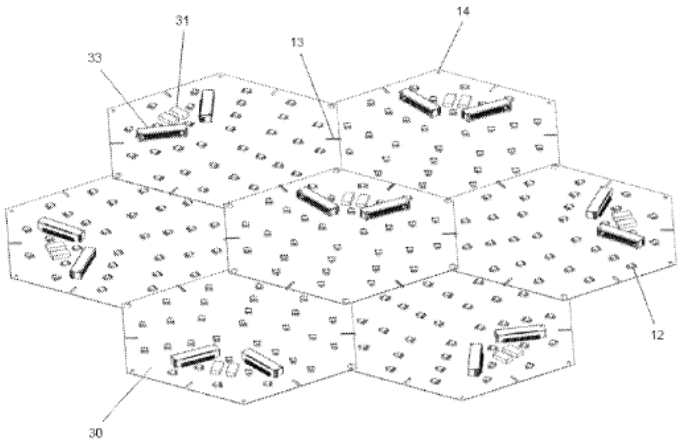


Fig. 2

Figure 2 of McElveen is an isometric view of an embodiment of the invention with multiple tiles operating as a single directional audio array. Ex. 1015 ¶ 24.

Ex. 1015, Fig. 2. As shown in Figure 2, a microphone array is implemented on a plurality of PCBs radially positioned around a central PCB, confirming Dr. Begault's testimony that such designs were well-known.

Patent Owner contends that Petitioner has failed to show claims 16 and 35 would have been obvious over the combined teachings of Tiete, Chan, and Sawa. PO Resp. 61–65. First, Patent Owner argues Tiete itself fails to sufficiently teach claims 16 and 35, arguing that Tiete's teaching of using multiple PCBs relates to additional components, and not to the microphone array and, therefore, does not teach implementing a microphone array using multiple PCBs. *Id.* at 62–63 (citing Ex. 1005, 1924; Pet. 71; Ex. 2020 ¶¶ 193–194). We agree with Patent Owner that Tiete does not expressly disclose using multiple PCBs to implement a microphone array. However, Petitioner does not rely on Tiete by itself to teach that the overall SoundCompass may be implemented on several PCBs. Instead, Petitioner relies on Sawa for the specific teaching of using multiple PCBs to implement a circular microphone array. Pet. 71–74; Reply 34–37. Patent Owner also points out Sawa does not disclose a central PCB and teaches leaving the central space open to accommodate a video camera. PO Resp. 63 (citing Ex. 1008 19:55–64, Figs. 16, 19A, 19B, 20; Ex. 2020 ¶¶ 193–194). However, Petitioner does not rely on Sawa's microphone arrangement, which leaves interior space for a camera. On the contrary, Petitioner relies specifically on Tiete's arrangement of concentric circular rings to form a microphone array, and relies on Sawa for teaching use of a plurality of PCBs. Pet. 71–74.

Patent Owner further contends Petitioner fails to provide a basis for showing why the proposed combination of Sawa and Tiete would have improved performance, but we disagree that Petitioner's showing is without basis. PO Resp. 63–64. As Dr. Begault explains,

> Tiete explains the benefits of adding more outer rings and adding more microphones, which provides ample motivation to expand the number of rings in Sawa. As I indicated in [Ex. 1003] ¶ 164, it was known in the industry that smaller PCBs are cheaper to fabricate and that using additional and smaller boards would reduce the cost of the system. Additionally, Tiete specifically mentions tradeoffs between the number of microphones and performance as a design consideration. Thus, a person of ordinary skill in the art would be motivated by Sawa to modify Tiete's PCB design by using the modularity taught by Sawa for the outer rings added to Tiete's PCB design.

Ex. 1043 ¶ 138; *see also* Ex. 1003 ¶¶ 160–167. Dr. Begault's testimony finds basis in Tiete's teaching of using larger microphone arrays. We find credible Dr. Begault's opinion that a skilled artisan would have been motivated to implement a microphone array having a larger diameter using a plurality of PCBs rather than one large PCB, as taught in Sawa and evinced by McElveen.

Patent Owner also criticizes Petitioner's reliance on McElveen, arguing McElveen's array does not have nested concentric rings. PO Resp. 64–65. We find this argument unavailing because, as we discussed earlier, Petitioner relies on Tiete, not McElveen, for a microphone array arranged in nested concentric rings.

For the foregoing reasons, having reviewed the fully developed trial record, we determine that Petitioner has shown, by a preponderance of the evidence, claims 16 and 35 are unpatentable as obvious over Tiete, Chan, and Sawa.

(10) Claims 30–33, 37–40

Petitioner contends claims 30, 31, 33, and 37–40 would have been obvious over Tiete and Chan. Pet. 30–32, 37–39, 59–66. Petitioner contends claim 32 would have been obvious over Tiete, Chan, and Meyer. *Id.* at 74–76. Petitioner identifies how each limitation of claims 30–33 and 37–40 is taught by the asserted prior art and provides a rationale to combine the art. *Id.* at 30–32, 37–39, 59–66, 74–76. Patent Owner does not provide arguments in addition to those for the claims discussed above.

For the foregoing reasons, having reviewed the fully developed trial record, we determine that Petitioner has shown, by a preponderance of the evidence: 1) claims 30–31, 33, and 37–40 are unpatentable as obvious over Tiete and Chan; and 2) claim 32 is unpatentable as obvious over Tiete, Chan, and Meyer.

13. Obviousness Over Graham Alone or Combined with Other Art

As we noted above, Petitioner asserts that claims 17–27 are unpatentable as obvious over Graham alone or in various combinations with other art. Pet. 9. For the reasons discussed below, we determine Petitioner has demonstrated, by a preponderance of the evidence, the unpatentability of claims 17–27 under § 103.

a) Claim 17

Petitioner has demonstrated, by a preponderance of the evidence, that claim 17 is unpatentable as obvious over Graham alone. As we discussed above, Graham discloses a beamforming microphone array (BMA) with support for interior design element. *Supra*, Sec. II.E.7. Figure 2F of Graham, reproduced below, is illustrative.

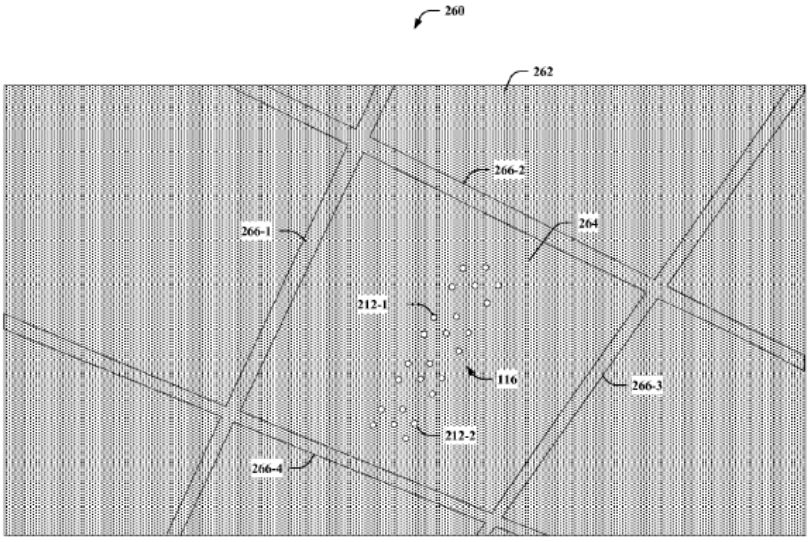


FIG. 2F

Figure 2F illustrates a BMA integrated into a ceiling tile for a drop ceiling mounting configuration.

Ex. 1011, Fig. 2F, ¶ 51. Like Figure 6 of the '493 patent, Figure 2F of Graham depicts a ceiling tile for a drop ceiling mounting configuration that provides support for a BMA. Ex. 1011 ¶ 51. Figure 2H of Graham is also illustrative, and is reproduced below.

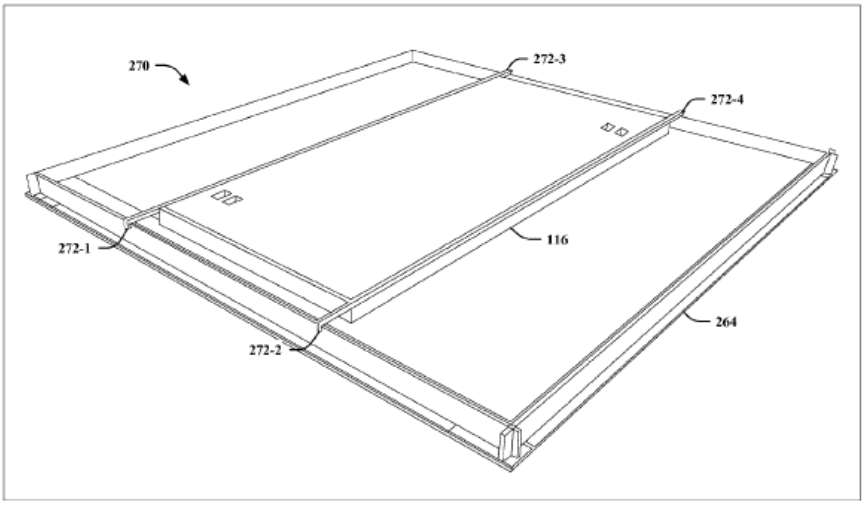


FIG. 2H

Figure 2H illustrates the mounting of microphone array 116 to ceiling tile 264 secured with hooks 272.

Ex. 1011, Fig. 2H, ¶¶ 53, 54. Figure 2H illustrates microphone array 116 mounted to the back of ceiling tile 264 and secured with hooks 272, such that ceiling tile 264 provides support for the microphone array. *Id.* Fig. 2A, ¶¶ 53, 54.

Petitioner shows that Graham renders obvious claim 17 of the '493 patent as follows.

To the extend the preamble of claim 17 should be treated as limiting, Petitioner shows that Graham discloses "[a] microphone assembly," as recited in the preamble of claim 17, because Graham discloses environment 100, which includes beamforming microphone array 116. Pet. 86 (citing Ex. 1011 ¶¶ 5, 9, 38, 43, 51–58, Figs. 2F–I, code 57)).

Petitioner shows that Graham's beamforming microphone array 116 discloses "an array microphone comprising a plurality of microphones," as recited in claim 17. Pet. 86 (citing Ex. 1011 ¶¶ 38, 43, 51–58, Figs. 2F, 2G, 2I). As can be seen in Figures 2F and 2G, and as disclosed in Graham, microphone array 116 comprises a plurality of microphones. *See, e.g.,* Ex. 1011 ¶ 38 ("array 116 may include multiple microphones").

Petitioner shows that Graham discloses "a housing configured to support the array microphone, the housing being sized and shaped to be mountable in a drop ceiling in place of at least one of a plurality of ceiling tiles included in the drop ceiling," as recited in claim 17, because Graham discloses ceiling tile 264, which integrates microphone array 116 and is mounted onto ceiling frame 266. Pet. 87 (citing Ex. 1011 ¶¶ 43, 51–58, Figs. 2F–2I). As can be seen in Figure 2H, ceiling tile 264 forms a front face of the housing that supports microphone array 116. Ex. 1011, Fig. 2H.

The housing in sized and shaped to be mountable in a drop ceiling in place of at least one of a plurality of ceiling tiles included in the drop ceiling, as shown in Figure 2F.

More specifically, as shown in Figure 2H, Graham's microphone assembly includes ceiling tile 264 that forms a front face, support beams 266-1, 266-2, 266-3, and 266-4 (collectively support beams 266) that form a support frame around ceiling tile 264, and hooks 272-1, 272-2, 272-3, and 272-4 (collectively hooks 272). Ex. 1011, Fig. 2H, ¶¶ 51–53; Pet. 87; Reply 8 (citing Ex. 1043 ¶¶ 37–42; Ex. 1011 ¶ 55). We are persuaded this discloses a "housing configured to support the array microphone," because, as can be seen in Figure 2H and as disclosed in Graham, microphone array 116 is supported by beams 266 and secured using hooks 272. Ex. 1011, Fig. 2H, ¶¶ 51–53; Pet. 87; Reply 8 (citing Ex. 1043 ¶¶ 37–42; Ex. 1011 ¶ 55). We are persuaded, furthermore, that the housing disclosed in Graham is sized and shaped to be mountable in a drop ceiling in place of at least one of a plurality of ceiling tiles included in the drop ceiling," as recited in claim 17, because Graham explicitly discloses this to be so. Graham discloses that the drop ceiling mounting configuration shown in Figures 2F through 2I may be integrated for a drop ceiling mounting configuration, and as shown in Figure 2F, the microphone assembly comprising ceiling tile 264, support beams 266, microphone array 116, and which may further include hooks 272, is sized and shaped to be dropped into the ceiling frame. Ex. 1001, Fig. 2F, ¶¶ 51–53; Pet. 87.

Petitioner shows that Graham discloses "wherein a front face of the housing includes a sound-permeable screen having a size and shape that is substantially similar to the at least one of the plurality of ceiling tiles," as recited in claim 17, based on Graham's disclosure of an acoustically neutral

material forming ceiling tile 264. *Id.* at 87–88 (citing Ex. 1011 ¶¶ 51–58, Fig. 2G). We credit Dr. Begault's testimony that a skilled artisan would have understood to use a sound-permeable screen for ceiling tile 264. Ex. 1003 ¶ 190. As is taught in Graham, use of acoustically transparent material was an obvious design choice for covering microphones. Pet. 88–89 (citing Ex. 1011 ¶¶ 51–58; Ex. 1003 ¶ 190).

Patent Owner contends that Petitioner fails to show Graham teaches or suggests "a front face of the housing [that] includes a sound-permeable screen having a size and shape that is substantially similar to [] at least one . . . ceiling tile[]." PO Resp. 18–33. Patent Owner submits the following arguments in support of its contention.

Patent Owner argues that Graham's disclosure in paragraph 20 of an acoustically transparent screen applies only to a wall-mounted microphone assembly disclosed in Graham, and does not apply to the drop ceiling assembly illustrated in Figures 2H–2I of Graham. *Id.* at 18–21. In support of this argument, Patent Owner submits Graham uses the term "outer surface" exclusively with regard to the wall-mounted configuration, but uses the term "front side" when describing the drop ceiling configuration. *Id.* (citing Ex. 1011 ¶¶ 11, 54, 56–57, 59, 61–63, 86, Ex. 2020 ¶¶ 106–110; Ex. 2013, 139:2–146:9, 146:10–22); According to Patent Owner, paragraph 20 of Graham describes an acoustically transparent screen of an "outer surface," and, therefore, is referring to the wall-mounted embodiment only. *Id.*

Patent Owner also argues Graham's disclosure of modifying front side 268 of ceiling tile 264 to include various contours, corrugations, depressions, extensions, color schemes, and designs does not teach or suggest a sound-permeable screen, again focusing on the purported

distinction between the ceiling tile's "front side" and the wall-mount's "outer surface." PO Resp. 21–22 (citing Ex. 1011 ¶ 55–63; Ex. 2020 ¶¶ 109–110; *In re Kotzab*, 217 F.3d 1365, 1370 (Fed. Cir. 2000).). Patent Owner then argues "contours, corrugations, depressions, extensions, color schemes, and designs," described in connection with the "front face" of a ceiling tile, does not teach a sound permeable screen. *Id.* at 22–23 (citing Ex. 1011 ¶¶ 51–58; Ex. 2020 ¶ 111).

Patent Owner also argues that Graham's disclosure of embedding microphones in contours, corrugations, or depressions in the ceiling tile to disguise the microphones fails to teach a sound-permeable screen having a size and shape substantially similar to a ceiling tile, explaining this embodiment contemplates attaching the microphones to the back side of a ceiling tile and/or placing microphones in visible holes in the ceiling tile, and, therefore, does not disclose a "screen." PO Resp. 22–25 (citing Ex. 1011 ¶¶ 51–58, Figs. 2G–2I; Ex. 2020 ¶¶ 111–113; Ex. 1003 ¶ 190). According to Patent Owner, nothing in Graham teaches the ceiling tile is "covered" by anything, let alone "covered" by a "screen" shaped as a ceiling tile. *Id.* at 26; *see also id.* at 25–28 citing Ex. 1003 ¶ 114; Ex. 2020 ¶¶ 114–117; Ex. 2013, 169:14–172:4; Ex. 1001, Fig. 6; Ex. 1011 ¶ 58). Rather, according to Patent Owner, Graham's approach is to retrofit a ceiling tile to support a microphone array. *Id.* at 28–30 (citing Ex. 2020 ¶¶ 118–119; Ex. 2019, 140 ¶ 9, 148 ¶ 72). Patent Owner submits that "punching holes in a ceiling tile and attaching the tile to a microphone array is fundamentally different than the configuration of claim 17." *Id.* at 27 (citing Ex. 2020 ¶¶ 115–117). Patent Owner relies on the provisional application to which the Graham publication claims priority (Ex. 2019) to support its argument that Graham's approach is fundamentally different from claim 17. *Id.* at 28–

33 (citing Ex. 2020 ¶¶ 118–123; Ex. 2019 ¶¶ 9, 72, Fig. 1, Fig. 53; Ex. 1001, 5:14–37, code (57), 5:55–7:3, Figs. 3, 4, 6–8; Ex. 1011, Figs. 2A, 2F, 2J).

Patent Owner argues

> Rather than retrofit a ceiling tile to include microphones in "holes" or "depressions," in the tile, the '493 patent discloses and claims a distinct self-contained "microphone assembly" in claim 17 that includes a "housing" supporting the array microphone, and a "front face of the housing" [that] includes a sound-permeable screen having a size and shape that is substantially similar to [] at least one . . . ceiling tile.

Id. at 29–30.

We find Patent Owner's arguments unavailing. First, Patent Owner's argument that paragraph 20 of Graham is referring only to the wall mount configuration, and does not apply to the drop ceiling configuration, does not alter our determination. Discussed below, we find a sound permeable screen as claimed would have been an obvious design choice, regardless of whether Graham's disclosure that "the outer surface is acoustically transparent to the audio input signal" in paragraph 20 refers to the drop ceiling configuration. Dr. Begault opines that a skilled artisan would have known to use a sound permeable screen in any application where a microphone is covered. Ex. 1003 ¶ 190. We agree that a skilled artisan would have understood that in a configuration in which a material, e.g., ceiling tile, is covering a microphone, the material would be sound permeable so that sound can reach the microphone. *Id.* (explaining that a skilled artisan would have known to use a sound permeable material so that sound can reach the microphones). Paragraph 20, whether it refers to a ceiling tile or a wall's outer surface, supports the notion that a skilled artisan would have understood that a microphone array, if covered, would be covered with a sound permeable material.

However, we need not solely rely on paragraph 20 for confirmation of this understanding because, with regard to the drop ceiling configuration, Graham expressly teaches using a sound permeable material for ceiling tile 264:

> The ceiling tiles such as the ceiling tile 264 may be made of a variety of materials or combinations of materials including, but not limited to, metals, alloys, ceramic, fiberboards, fiberglass, plastics, polyurethane, vinyl, or *any suitable acoustically neutral material known in the art, related art, or developed later*.

Ex. 1011 ¶ 52 (emphasis added).

Despite Graham's disclosure of a sound permeable material for ceiling tile 264, Patent Owner nonetheless argues that Graham does not teach a "screen," because Graham "merely affixes a ceiling tile to its array and, as shown in Fig. 2G . . . , places microphones 212-1 and 212-2 in visible holes in the tile." PO Resp. 24. This argument is unavailing. Graham's teaching are not limited to the ceiling tile shown in Figures 2F–I, which Patent Owner argues depict holes punched through ceiling tile 264 into which microphones are embedded. *Id.* at 27–30. Indeed, Graham teaches that such a configuration may, but need not, be used, stating that in *some embodiments*, the microphones *may* be embedded within contours, corrugations, or depressions, in the ceiling tile, but this is non-limiting. Ex. 1011 ¶ 58. As we noted above, with regard to the drop ceiling configuration, Graham teaches that ceiling tile 264—i.e., the asserted front face of the housing—may be made of a variety of materials that are suitable acoustically neutral materials. Ex. 1011 ¶ 52. Given the variety of materials from which ceiling tile 264 may be made, including but not limited to metals, alloys, ceramic, fiberboards, fiberglass, plastics, polyurethane, vinyl, or any suitable acoustically neutral material known in the art, related art, or

developed later, Ex. 1011 ¶ 52, and Dr. Begault's testimony that sound permeable material would be used so sound can reach the microphones, we are persuaded a sound-permeable screen would have been an obvious design choice.

For the foregoing reasons, having reviewed the fully developed trial record, we determine Petitioner has shown, by a preponderance of the evidence, that claim 17 is unpatentable as obvious over Graham.

b) Claims 18–27

Petitioner asserts the following unpatentability combinations: 1) claims 18, 21, and 23–26 over Graham; 2) claims 19 and 20 over Graham and Sawa; 3) claim 22 over Graham and Berry; 4) claim 27 over Graham and Beaucoup. Pet. 83–103. For the following reasons, we determine Petitioner has shown claims 18–27 are unpatentable as obvious over Graham alone or in various combinations with other art.

(1) Claims 18, 21, 23–25, and 27

Petitioner demonstrates how each limitation of claims 18, 21, 23–25, and 27 is taught by the asserted prior art, and where applicable, persuasively provides a rationale to combine Graham with an additional prior art reference. Pet. 83–92, 97–99, 103. Patent Owner does not provide additional arguments specific to these claims.

For the foregoing reasons, having reviewed the fully developed trial record, we determine that Petitioner has shown, by a preponderance of the evidence, claims 18, 21, and 23–25 are unpatentable as obvious over Graham and claim 27 is unpatentable as obvious over Graham and Beaucoup.

(2) Claims 19 and 20

Claim 19 recites:

> a control box coupled to the second face of the housing and configured to house a processor coupled to the array microphone
>
> an external port coupled to the control box and electrically connected to the processor.

Ex. 1001, 18:54–60. Claim 20 depends from claim 19, and further recites;

> the external port is electrically connectable to a cable configured for at least one of outputting audio signals received at the processor from the array microphone, receiving control signals from an external control system, and providing power to the processor and array microphone from an external power supply.

Id. at 18:61–67.

Petitioner contends that Graham teaches all the limitations of claims 19 and 20, except a "control box." Pet. 93–94. Petitioner relies on Sawa for this teaching. *Id.* at 94–96. Sawa generally discloses an acoustic system, and in Figure 12, Sawa depicts an exploded view illustrating a casing structure of a microphone array. Figure 12 of Sawa, as annotated by Petitioner, is reproduced below.

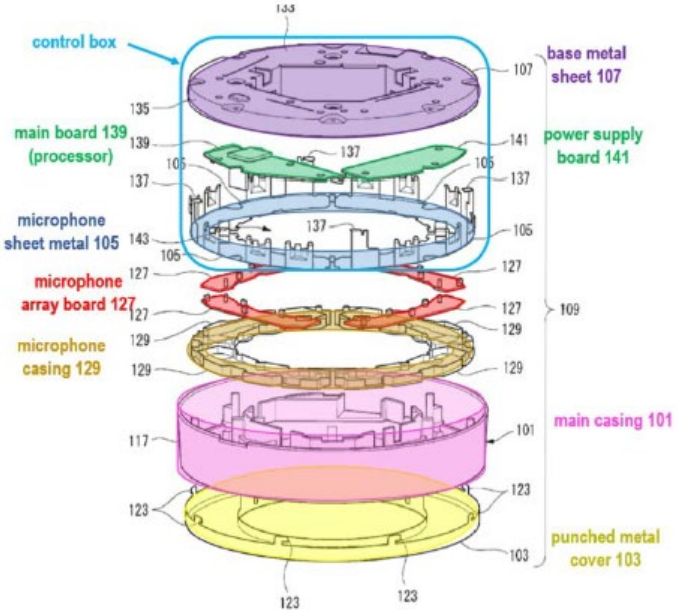


Figure 12 of Sawa is an exploded perspective view illustrating a casing structure of microphone array 20.

Pet. 94 (reproducing Ex. 1008, Fig. 12 with annotations). The casing structure shown in Figure 12 includes microphone sheet metal 105 and base sheet metal 107 encasing main board 139. Petitioner asserts that Sawa discloses a "control box" that is "configured to house a processor coupled to the array microphone," as claimed, because Sawa teaches main board 139 housed between two metal sheets. Pet. 94 (citing Ex. 1008, 21:17–23).

We find that Sawa's disclosure of microphone sheet metal 105 and base sheet metal 107 teaches a "control box," because the metal sheets house main board 139. *Id.* (citing Ex. 1008, 21:17–23); Ex. 1008, Fig. 12. Our finding that Sawa's metal sheets teach a "control box" is consistent with the disclosure of a "control box" is the '493 patent. Figure 3 of the '493 patent, reproduced below, shows a "control box."

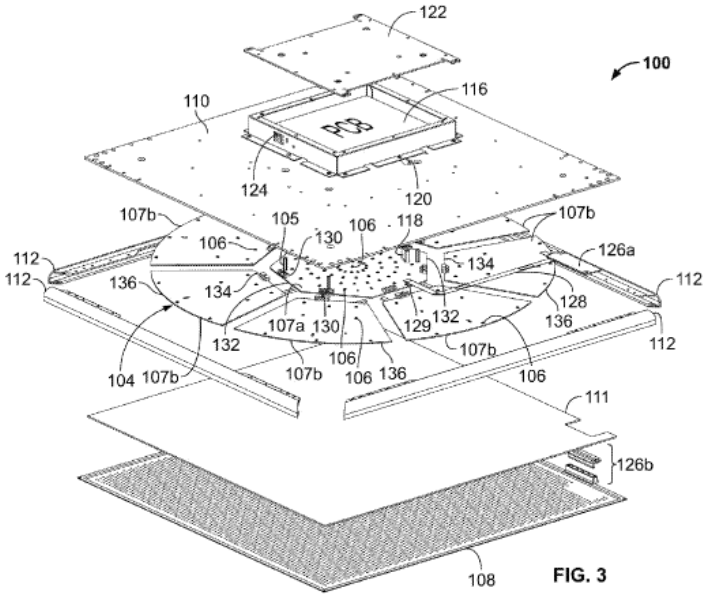


Figure 3 is an exploded view of microphone array assembly 100.

Ex. 1001, Fig. 3. As shown in Figure 3 above, and described in the Specification, control box 114 is mounted to the back of support 110 and

comprises backside 122 and houses printed circuit board 116. *Id.* at 7:21–26. As such, a "control box" may simply be two sheets, i.e., support 110 and backside 122, encasing a printed circuit board. *See, e.g.,* Ex. 1043 ¶ 51 (Dr. Begault testifying that "[u]sing the description in the '493 Patent, Sawa's control box equates to the ['493 Patent] control box 114, which is just a wall around the audio PCB 116, with the optional removable cover 122 to provide access to the audio PCB 116"); Reply 18 (citing Ex. 1001, 7:36–38; Ex. 1052, 143:15–144:19); *id.* at 23 (citing Ex. 1043 ¶ 57). Accordingly, the '493 disclosure supports our finding that Sawa's metal sheets that house main board 139 would have been considered a "control box."

We find Sawa's main board 139 includes a "processor coupled to the array microphone," as recited in claim 19, because Sawa discloses main board 139 has mounted thereon components "for controlling a process in the microphone array 20." Pet. 94 (citing Ex. 1008, 21:17–23).

We also find that the combination of Graham and Sawa teach that the control box is "coupled to the second face of the housing and configured to house a processor coupled to the array microphone," as recited in claim 19. In its analysis for claim 18, from which claim 19 depends, Petitioner identifies where Graham teaches the claimed "second face of the housing." Pet. 89. Claim 18 recites the microphone assembly of claim 17 "wherein the housing comprises a second face positioned opposite the first face, the second face being positioned inside the drop ceiling, when the housing is mounted to the drop ceiling." Ex. 1001, 18:50–53. Petitioner identifies the back of Graham's ceiling tile as the claimed "second face." Pet. 89. For claim 19, Petitioner argues that it would have been obvious to modify Graham to co-locate the processor (and therefore the control box in which the processor is housed, as taught in Sawa) to the back of Graham's ceiling

tile, i.e., to the back of the asserted second face. *Id.* at 95. We are persuaded that a skilled artisan would have known to co-locate the processor in Graham with array 116, as taught in Sawa, because doing so would have facilitated easy connection between array 116 and a teleconferencing system, and would have reduced system cost by eliminating the need for a separate computer or server. *Id.* (citing Ex. 1003 ¶¶ 199–200; Ex. 1008, 21:16–26).

Petitioner also argues persuasively that a skilled artisan would have understood that Sawa's control box included an external port to allow communications with the processor. *Id.* at 94 (citing Ex. 1003 ¶ 198; Ex. 1008, 2:27–46, 7:49–56, 21:15–23). As mentioned above, Sawa discloses that main board 139 includes components for controlling a process in microphone array 20. Ex. 1008, 21:17–23. Accordingly, we are persuaded that microphone array 20 and main board 139 are in communication with each other. Because microphone array 20 is external to main board 139 and the metal sheets asserted to form the control box, we are persuaded that a skilled artisan would have understood that Sawa's control box includes an external port to allow communications with the processor.

We are also persuaded by Petitioner's arguments and evidence regarding the rationale to combine the teachings of Sawa with those of Graham and regarding whether there would have been a reasonable expectation of excess in doing so. Pet. 95–96 (citing Ex. 1003 ¶¶ 199–202; Ex. 1011 ¶¶ 36, 39, 41, 82, 67–69, Figs. 4A, 2F; Ex. 1008, 21:16–26, 8:63–9:8, Figs. 6A, 21A). As explained by Dr. Begault, Graham describes a first communication device to process microphone array signals with regard to the embodiment shown in Figure 1A and 4A. Ex. 1003 ¶ 200 (citing Ex. 1011 ¶ 39). Dr. Begault testifies that a person of ordinary skill in the art

would have been motivated to simplify and reduce the costs of Graham by reducing the need for external components, and, therefore, would have been motivated to include the processor with a control box, as taught in Sawa, on the back of Graham's microphone housing. *Id.* We also are persuaded that modifying Graham by moving the processor to the back of the ceiling tile would have been a straight-forward design change within the abilities of a skilled artisan, because Graham's system already included a processor for processing signals from the microphone array, and the proposed modification simply moves the location of the processor to be nearer to the microphone array. *Id.* ¶ 202 (citing Ex. 1011 ¶¶ 36, 39, 41, 82; Ex. 1008, 21:17–23).

Patent Owner contends that Sawa fails to render obvious the claimed "control box" and "external port coupled to the control box and electrically connected to the processor." PO Resp. 33–40.

First, Patent Owner asserts that Sawa's microphone sheet meal 105 and base metal sheet 107 fail to disclose a "control box," but Patent Owner fails to adequately explain why, in light of the disclosure in the '493 patent, this would not have been considered a "control box" to a person of ordinary skill in the art. PO Resp. 34–35. As we discussed above, in the Specification a "control box" is simply two layers, i.e., support 110 and backside 122, encasing a printed circuit board. Ex. 1001, Fig. 3, 7:21–26. Petitioner points out that the control box disclosed in the Specification is simply "a wall that houses a PCB 116 (processor), 'can include a removable cover 122,' and lacks a bottom opposite the cover 122." Reply 18 (citing Ex. 1001, 7:36–38; Ex. 1052, 143:15–144:19). Patent Owner attempts to distinguish Sawa, arguing Sawa's metal sheets are components of a casing structure, rather than components to form a "control box." PO Resp. 34–35;

Sur-reply 19 (asserting the structure in Sawa is arbitrary). We find Patent Owner's argument unavailing. Patent Owner has not provided any claim construction for the term "control box," and has not provided evidence showing that Sawa's microphone sheet metal 105 and base metal sheet 107 would not have been understood to form a "control box." As explained by Dr. Begault, the control box disclosed in the '493 patent has generally the same structure in the same vertical order as Sawa's asserted control box. Reply 23 (citing Ex. 1043 ¶ 57); Ex. 1043 ¶ 51 ("Using the description in the '493 Patent, Sawa's control box equates to the ['493 Patent] control box 114, which is just a wall around the audio PCB 116, with the optional removable cover 122 to provide access to the audio PCB 116"). Moreover, Dr. Vipperman, Patent Owner's declarant, does not disagree that a control box is just a box housing a processor. Reply 20 (citing Ex. 1052, 72:8–16). Accordingly, we find Sawa teaches a "control box."

Patent Owner also argues that Sawa's asserted "control box" fails to satisfy the claim because it is not "coupled to the second face of [a] housing," as recited in claim 19. PO Resp. 34–35. We find this argument unavailing. As explained by Dr. Begault, Sawa's asserted control box is attached to a microphone array structure. Ex. 1043 ¶ 57; Ex. 1008, Fig. 12 (showing microphone sheet metal 105 stacked on top of microphone casing 129 that houses microphone array board 127). Applying the teaching of placing Sawa's control box on top of microphone array board 127, Dr. Begault explains that Graham, as modified, would include Sawa's control box on top of the back Graham's array 116, i.e., a second face. Patent Owner argues that Petitioner's analysis for claim 19 does not use the word "face." PO Resp. 35. However, Patent Owner's argument fails to address Petitioner's analysis for claim 18, from which claim 19 depends, and which

recites "wherein the housing comprises a second face positioned opposite the first face, the second face being positioned inside the drop ceiling when the housing is mounted to the drop ceiling." Ex. 1001, 18:50–53. For claim 18, Petitioner identifies the back side of Graham's drop ceiling tile assembly as the claimed "second face." Pet. 89. Consistent with Petitioner's identification of Graham's "second face" for claim 18 as the back side of the drop ceiling tile assembly, for claim 19 Petitioner asserts Sawa's control box would have been mounted on the back of the ceiling tile, i.e., second face, as taught by Sawa's teaching of mounting a control box on to microphone array board 127. Pet. 95 (citing Ex. 1003 ¶ 200).

Patent Owner also argues that co-locating a processor on the back of Graham's ceiling tile, as argued by Petitioner, is hindsight and the opposite of what Graham teaches. PO Resp. 36–37. In particular, Graham teaches communication device 110 for processing audio input signals, and in one embodiment, illustrated in Figure 1A, communications device 110 (and its processor) communicates with microphone array 116 via network 114. Ex. 1011 ¶ 39, Fig. 1A. Based on this embodiment, Patent Owner submits that Graham teaches keeping the processor remote from microphone array 116, i.e., Graham's processor is not coupled to the ceiling tile assembly. PO Resp. 36. Patent Owner's arguments are unavailing. First, the embodiment of Graham identified by Patent Owner is exemplary only, and is non-limiting. Ex. 1011 ¶ 36 ("FIGS. 1A and 1B are schematics that illustrate environments for implementing an *exemplary* band-limited beamforming microphone array." (emphasis added)). Second, Figure 1A is a functional schematic, not a physical one. Functionally, microphone array 116 communicates with communication device 110 through network 114. *Id.* Fig. 1A, ¶¶ 36–39. However, there is nothing that limits the physical

proximity of microphone array 116 and communication device 110. *Id.* Accordingly, we disagree that Graham teaches the opposite of locating the processor remotely from the ceiling tile assembly. Rather, as we discuss above, Graham does not limit the physical location of the processor, and Sawa teaches that the processor may be located near the microphone array within a single assembly. Pet. 95 (citing Ex. 1008, 21:16–25); Reply 21–22 (citing Ex. 1043 ¶¶ 58–60; Ex. 1008, 21:2–26).

Patent Owner also takes issue with Petitioner's argument in the Reply that Graham's microphone array 116 is an example of a control box and implicitly includes a processor, asserting that this is new argument. Sur-Reply 19 (citing Pet. 19–21). We, however, do not rely in this Final Written Decision on the argument discussed in Petitioner's Reply that Graham's microphone array 116 is an example of a control box and implicitly includes a processor. Reply 19–21.

Patent Owner also contends that Petitioner fails to identify an external port on either Sawa's asserted "control box" or Graham's microphone array 116. PO Resp. 38–40. Patent Owner argues that Sawa has no explicit disclosure of the claimed "port," and that Graham discloses electrical conduits, at most, but not the claimed "external port." *Id.* Based on the fully developed trial record, Patent Owner's arguments do not persuade us. As explained by Dr. Begault, including an external port would have been a straightforward design task within the abilities of one of ordinary skill in the art. Pet. 96 (citing Ex. 1011 ¶¶ 36, 39, 41, 82; Ex. 1008, 21:17–23; Ex. 1003 ¶ 202). We are persuaded that it was well-known and understood to use electrical ports to facilitate electrical connections between components, as argued by Petitioner and explained by Dr. Begault. Reply 23–24 (citing Ex. 1011, Fig. 4A, ¶¶ 55, 67; Pet. 100–101; Ex. 1043 ¶¶ 66–74). Graham

confirms this, teaching multiple ports electrically connected to microphone array 116, including USB and Ethernet ports in Figure 4A. *Id.* Dr. Vipperman confirmed in his deposition that it was known for ports to be electrically connectable to a cable to achieve the functions recited in claim 20 (which depends from claim 19). *Id.* at 24 (citing Ex. 1052, 73:2–76:2). Accordingly, we are persuaded that the use of ports was well-known. As to the combination of Sawa's control box in which a processor is located, we are persuaded that it would have been obvious to include a connection to facilitate communication between microphone array 116 and the processor, because microphone array 116 transmits (i.e., communicates) data to communication device 110 for processing. Ex. 1011 ¶ 39 ("[microphone] array 116 may transmit the captured audio input signals to the first communication device 110 for processing"). Moreover, we are persuaded that Sawa's control box would have had an external port connected to the processor to connect microphone array 116 and the processor in embodiments using electrical connections, because such port would have been necessary in order facilitate these connections. Pet. 94–96, 99–101; Reply 25 (citing Ex. 1043 ¶¶ 198–202).

For the foregoing reasons, having reviewed the fully developed trial record, we determine Petitioner has shown, by a preponderance of the evidence, that claims 19 and 20 are unpatentable as obvious over Graham and Sawa.

(3) Claim 22

Claim 22 recites "wherein the housing includes an aluminum back panel comprising a honeycomb core." Ex. 1001, 19:3–5. Petitioner argues it would have been obvious to make Graham's housing from aluminum,

which we find persuasive because Graham discloses that the ceiling tile may be made of a variety of materials, including but not limited to metal alloys. Pet. 90 (citing Ex. 1011 ¶ 52); *id.* at 96. However, Petitioner acknowledges Graham does not expressly teach an aluminum back panel with a honeycomb core. Petitioner accounts for the "honeycomb core" feature by relying on Berry, which teaches that ceiling tiles can incorporate an "aluminum honeycomb (hexagonal cells) . . . core." *Id.* (citing Ex. 1012, 39:18–19; Ex. 1003 ¶ 203). Petitioner argues further that the '493 patent admits that aluminum board comprising a honeycomb core was a known commercial product, and, therefore, was not inventive. *Id.* (citing Ex. 1001, 6:55; Ex. 1021); Ex. 1001, 6:52–55 ("[I]n certain embodiments, at least back panel 110 comprises a flat, aerospace-grade, aluminum board comprising a honeycomb core (e.g., as manufactured by Plascore®)."). Petitioner explains that both Graham and Berry teach ceiling tiles that use metal back panels, and, therefore, a skilled artisan would have predictably replaced Graham's metal back panel with the honeycomb design described in Berry. Pet. 97 (citing Ex. 1003 ¶ 206); Reply 27 (citing Pet. 96–97; Ex. 1003 ¶¶ 203–206; Ex. 1043 ¶¶ 75–79).

Patent Owner argues that Berry teaches using an aluminum honeycomb core for the *front* of a ceiling tile to provide improved strength for the ceiling tile, but does not teach using the same material for the *back* of a microphone housing, as required by claim 22. PO Resp. 41 (citing Ex. 1012, 39–18–19). Based on the fully developed trial record, we are not persuaded by Patent Owner's argument. As we discussed above, Petitioner persuasively provides a rationale for using Berry's aluminum honeycomb core for the back panel of the ceiling tile, namely that both Graham and Berry teach a metal back panel, and that using an aluminum honeycomb core

for the metal back panel would have had the added benefits of using a light weight design that improves the strength of the ceiling tile assembly. Pet. 97 (citing Ex. 1003 ¶ 206); Reply 27 (citing Pet. 96–97; Ex. 1003 ¶¶ 203–206; Ex. 1043 ¶¶ 75–79).

For the foregoing reasons, having reviewed the fully developed trial record, we determine Petitioner has shown, by a preponderance of the evidence, that Claim 22 is unpatentable as obvious over Graham and Berry.

(4) Claim 26

Claim 26 recites the microphone assembly of claim 17, "wherein the housing is sized and shaped to replace more than one of the plurality of ceiling tiles." Ex. 1001, 19:13–15. Petitioner relies on: 1) Graham's teaching of microphone array 116 suspended from a ceiling, as shown in Figures 2B–2E, that spans multiple ceiling tiles in size; and 2) Graham's teaching of creating larger microphone arrays using multiple ceiling tiles. Pet. 85 (citing Ex. 1011, Figs. 2B–2F, ¶ 51). In view of these teachings, and Dr. Begault's testimony that a larger array would improve performance in large conference rooms, we find that a skilled artisan would have been motivated to design a larger microphone array (as taught in Figs. 2B–2H) hidden in the ceiling (as taught in Fig. 2F), and, therefore, would have created a housing that would replace more than one ceiling tile. *Id.* (citing Ex. 1003 ¶¶ 186–188); Reply 28; Ex. 1003 ¶ 196; Ex. 1043 ¶ 80.

Patent Owner contends Petitioner fails to show that Graham teaches claim 26, arguing that Petitioner relies on, and improperly combines, separate embodiments of Graham. PO Resp. 42–44. Patent Owner distinguishes the multi-ceiling tile sized array embodied by Graham's Figures 2B–2F on grounds that the array is a suspended light fixture, not a

drop ceiling tile. *Id.* at 42. Patent Owner then distinguishes the ceiling tile configuration embodied in Graham's Figure 2H on the grounds that it is the size of only a single ceiling tile. *Id.* at 42–43. Based on the fully developed trial record, we find this unavailing, because Petitioner relies not on one embodiment or the other, but rather combines the teachings to arrive at the claimed housing "sized and shaped to replace more than one of the plurality of ceiling tiles." Pet. 85. Patent Owner argues "Petitioner tries to fill the gaps in Graham using hindsight," arguing that Dr. Bergault does not explain why a larger conference room would necessarily require a larger array or why this would provide motivation to alter Graham's disclosure. PO Resp. 43 (citing Ex. 1011 ¶ 68 (disclosing multiple arrays); Ex. 2020 ¶ 139). We find this argument unpersuasive, because Dr. Begault explains why a larger array would have been desirable in a larger conference room in order to improve performance. Ex. 1003 ¶ 186. Dr. Begault explains that a larger array would be used in order to effectively detect the people speaking throughout the room, and that a skilled artisan would have adapted the size of the microphone array in order to provide adequate performance, e.g., sound localization and signal-to-noise ratio, for all speakers distributed throughout the room. *Id.* (citing Ex. 1011 ¶ 51). Patent Owner attempts to argue that Graham does not teach using a larger microphone array in a larger conference room, but instead teaches using multiple microphone arrays. PO Resp. 43 (citing Ex. 1011 ¶ 68). Patent Owner is referring to an embodiment shown in Graham's Figure 4B, in which microphone array 116 is connected to a first auxiliary band-limited array 414–1 and a second auxiliary band-limited array 414–2 in a daisy chain arrangement. Ex. 1011 ¶ 67, Fig. 4B. It appears, therefore, that Patent Owner's argument is that Graham teaches using multiple, separately housed, microphone arrays

spread throughout a large room, and, therefore, does not teach a larger array in a single housing that is the size and shape of more than one ceiling tile.

We find that Patent Owner's argument and evidence does not undermine Petitioner's showing. Patent Owner's evidence relates to Graham's Figure 4B, which is a schematic of the back side of the exemplary band-limited BFM array of Figure 1A. *Id.* ¶ 67. Graham's Figure 3 relates to the same embodiment as Figure 4B, but shows the front, rather than the back, side of the exemplary band-limited BFM array of Figure 1A. *Id.* ¶ 64. With regard to Figure 3, Graham discloses that microphone array 116 itself is comprised of multiple BFMs 302-1, 302-2, 302-3, . . . 302-n, as is shown in Figure 3, *Id.* ¶ 64, Fig. 3. The microphone array is rectangular in shape, and, therefore, teaches a microphone array suited to a ceiling tile sized and shaped to replace more than one ceiling tile. Graham also confirms Dr. Begault's testimony as to the desirability of arranging microphone array 116 in this configuration, stating the BFMs may be arranged in a specific pattern that facilitates maximum directional coverage of various sound sources in the ambient surrounding. *Id.* ¶ 64. Therefore, the embodiment in Graham upon which Patent Owner relies, if anything, supports Petitioner arguments and Dr. Begault's supporting testimony.

For the foregoing reasons, having reviewed the fully developed trial record, we determine Petitioner has shown, by a preponderance of the evidence, that claim 26 is unpatentable as obvious over Graham.

F. Contingent Motion to Amend

Patent Owner initially filed a Contingent Motion to Amend, Paper 35, and Petitioner field an Opposition to the Motion, Paper 46. In the Contingent Motion to Amend, Patent Owner requested that we provide preliminary guidance concerning the Contingent Motion to Amend in

accordance with the Board's pilot program concerning motion to amend practice and procedures. Paper 35, 1; *see also* Notice Regarding a New Pilot Program Concerning Motion to Amend Practice and Procedures in Trial Proceedings under the America Invents Act before the Patent Trial and Appeal Board, 84 Fed. Reg. 9,497 (Mar. 15, 2019) (providing a patent owner with the option to receive preliminary guidance from the Board on its motion to amend) ("Notice"). Consistent with Patent Owner's request under the pilot program, we issued Preliminary Guidance to Patent Owner's Motion to Amend. Paper 55.

In accordance with the pilot program, Patent Owner subsequently filed a Revised Contingent Motion to Amend. Paper 57 ("Mot. Amend" or "Motion"). Petitioner filed an Opposition to Patent Owner's Revised Motion to Amend. Paper 68 ("Pet. Opp."). Patent Owner filed a Reply in Support of its Revised Contingent Motion to Amend. Paper 74 ("PO Reply."). Petitioner filed a Surreply to Patent Owner's Reply in Support of Revised Contingent Motion to Amend. Paper 84 ("Pet. Sur-reply").

In the Motion, Patent Owner seeks to amend the patent by adding substitute claims 41–80, each of which corresponds to a respective one of challenged claims 1–40, contingent on our determining claims 1–40 are unpatentable. Mot. Amend 1.

Having determined claims 1–5, 7–33, and 35–40 are unpatentable, we decide Patent Owner's Motion as to substitute claims 41–45, 47–73, and 75–80. We do not reach the issue of whether proposed substitute claims 46 and 74 have been shown to be unpatentable, because Patent Owner's Motion is contingent on finding unpatentability. The contingency has not been reached as to substitute claims 46 and 74 because the claims they are

proposed to substitute, claims 6 and 34, were not shown by Petitioner to be unpatentable. *Supra* Sec. II.E.12.c.3.

1. Burden of Persuasion

"[A] patent owner does not bear the burden of persuasion to demonstrate patentability of substitute claims presented in a motion to amend." *Lectrosonics, Inc. v. Zaxcom, Inc.*, IPR2018-01129, Paper 15 at 4 (PTAB Feb. 25, 2019). "[T]he burden of persuasion ordinarily will lie with the petitioner to show that any proposed substitute claims are unpatentable by a preponderance of the evidence." *Id.* "The Board itself also may justify any finding of unpatentability by reference to evidence of record in the proceeding, for example, when a petitioner ceases to participate, as further noted in *Aqua Products* and *Bosch*." *Id.* (citing *Bosch Automotive Service Solutions, LLC v. Matal*, 878 F.3d 1027, 1040 (Fed. Cir. 2017) (citing *Aqua Products, Inc. v. Matal*, 872 F.3d 1290, 1311 (Fed. Cir. 2017))). "Thus, the Board determines whether substitute claims are unpatentable by a preponderance of the evidence based on the entirety of the record, including any opposition made by the petitioner." *Id.* "Although the Board may, in certain rare circumstances, raise a ground of unpatentability that a petitioner did not advance, or insufficiently developed, against substitute claims proposed in opposing a motion to amend, those circumstances are limited to situations in which the adversarial process fails to provide the Board with potential arguments of patentability with respect to the proposed substitute claims." *Hunting Titan, Inc. v. DynaEnergetics Europe GMBH*, IPR2018-00600, Paper 67 at 25 (PTAB July 6, 2020) (precedential) ("*Hunting Titan*").

"Before considering the patentability of any substitute claims, however, the Board first must determine whether the motion to amend meets the statutory and regulatory requirements set forth in 35 U.S.C. § 316(d) and 37 C.F.R. § 42.121." *Lectrosonics*, Paper 15 at 4.

2. Statutory and Regulatory Requirements

a) Reasonable Number of Substitute Claims

Patent Owner proposes a reasonable number of substitute claims. 35 U.S.C. § 316(d)(1)(B). Patent Owner proposes no more than one substitute claim for each of challenged claims 1–40. Mot. Amend 1; *see id.* at App'x A. Petitioner does not argue otherwise. *See generally* Pet. Opp.

b) Responsiveness to Ground of Unpatentability

Patent Owner's Motion responds to a ground of unpatentability involved in this trial. 37 C.F.R. § 42.121(a)(2)(i). Patent Owner presents the claim amendments in an attempt to add features to further distinguish the proposed substitute claims as patentable over the references asserted in the instituted grounds. In particular, Patent Owner explicitly addresses the prior art references underlying our Decision on Institution, and the Motion responds to at least a ground of unpatentability involved in trial. Petitioner does not argue otherwise. *See generally* Pet. Opp.

c) Scope of Amended Claims

The proposed amendment does not seek to enlarge the scope of the claims. 35 U.S.C. § 316(d)(3); 37 C.F.R. § 42.121(a)(2)(ii). Proposed substitute claims 41, 56, 57, 60, 61, and 68 add limitations as compared to their original claims, and therefore, do not enlarge the scope of challenged claims 1, 16, 17, 20, 21, and 28. Proposed substitute claim 53 deletes the

phrase "[array microphone system] further comprising" and replaces it with "wherein the audio component includes," thereby narrowing claim scope by requiring the processor to be specifically in the audio component, rather than merely in the array microphone system. Proposed substitute claim 58 deletes the word "first [face]" and replaces it with "front [face]," thereby providing antecedent basis for the term because proposed substitute claim 57, from which proposed substitute claim 58 depends, recites a "front face," but does not recite a "first face." Remaining substitute claims 42–55, 58, 59, 62–67, and 69–80 merely change the dependency of challenged claims 2–15, 18, 19, 22–27, and 29–40 of the '493 patent. Petitioner does not argue otherwise. *See generally* Pet. Opp.

d) New Matter

The proposed amendment does not seek to add new subject matter. 35 U.S.C. § 316(d)(3); 37 C.F.R. § 42.121(a)(2)(ii); Mot. Amend 2–8 (identifying support for the substitute claims). Petitioner does not argue otherwise. *See generally* Pet. Opp.

3. Patentability

a) Substitute Claims 41–45, 47–55, 68–73, and 75–80

Proposed substitute claim 41 amends claim 1 by adding the word "harmonically" in from the of the phrase "nested rings of varying sizes." Mot. Amend, App'x A, 1. Substitute claim 41 also adds the following limitations:

> an audio component that receives audio signals from the plurality of microphones; and
>
> a communications interface configured to allow communications between the audio component and an external control device;

> wherein the external control device is configured to control at least one of: directionality of the audio signals, noise suppression of the audio signals, muting of the audio signals, or a pickup pattern of the audio signals.

Id.

Proposed substitute claim 68 amends claim 28 by adding the words "and being harmonically nested with" after "the second configuration concentrically surrounding" and before "the first configuration." Mot. Amend App'x A, 1. Substitute claim 68 also adds the following limitations

> electrically coupling a communications interface to the audio processor, the communications interface being configured to allow communications between the audio processor and an external control device;
>
> wherein the external control device is configured to control at least one of: directionality of the audio signals, noise suppression of the audio signals, muting of the audio signals, or a pickup pattern of the audio signals.

Id.

Proposed substitute claims 42–45, 47–55, 69–73, and 75–80 merely change the dependency of challenged claims 2–5, 7–15, 29–33, and 35–40 of the '493 patent.

Petitioner contends that the proposed substitute claims are unpatentable as obvious as follows:

1) substitute claims 41–45, 47–53, 68–71, 73, and 76–80 over Tiete, Chan, Chou, and Firoozabadi[16];

[16] Ali Dehghan Firoozabadi & Hamid Reza Abutalebi, *Combination of Nested Microphone Array and Subband Processing for Multiple Simultaneous Speaker Localization*, 6th International Symposium on Telecommunications (2012). Ex. 1069 ("Firoozabadi").

2) substitute claim 56 over Tiete, Chan, Chou, Firoozabadi, and McElveen[17];

3) substitute claims 54 and 75 over Tiete, Chan, Chou, Firoozabadi, and Sawa;

4) substitute claim 55 over Tiete, Chan, Chou, Firoozabadi, and Beaucoup;

5) substitute claim 72 over Tiete, Chan, Chou, Firoozabadi, and Meyer; and

6) substitute claim 42 over Tiete, Chan, Chou, Firoozabadi, Lai,[18] and Hald.[19]

Opp. 20–25. For the matter in the proposed substitute claims that is in the original claims, for the reasons discussed above Petitioner has made a persuasive showing of unpatentability. Below, we address the recitations added to proposed substitute claims 41 and 68 by amendment, and Petitioner's arguments for proposed substitute claim 42 in view of Lai and Hald.

(1) "harmonically"

For the amendment requiring that the rings must be "harmonically" nested, for reasons discussed above for challenged claims 8 and 36 (which recite that the rings are harmonically nested) Petitioner has shown this

[17] U.S. Patent Publication No. 2013/0101141 A1, published Apr. 25, 2013. Ex. 1015 ("McElveen").
[18] Chiong-Ching Lai et al., *Design of Robust Steerable Broadband Beamformers with Spiral Arrays and the Farrow Filter Structure* (2010). Ex. 1067 ("Lai").
[19] J. Hald & J. J. Christensen, *A Class of Optimal Broadband Phased Array Geometries Designed for Easy Construction*, The 2002 International Congress and Exposition on Noise Control Engineering (2002). Ex. 1072 ("Hald").

feature is taught by the combination of Tiete, Chan, and Chou. *Supra* Sec. II.E.12.c.5. Petitioner includes an additional reference, Firoozabadi (Ex. 1069), in its unpatentability ground for proposed substitute claims 41 and 68. Opp. 21–22. For challenged claims 8 and 36, although Petitioner did not include Firoozabadi in its unpatentability grounds (and we did not rely on Firoozabadi in finding claims 8 and 36 unpatentable), Dr. Begault explains that Firoozabadi confirms his testimony that harmonic nesting techniques were well-known. Ex. 1043 ¶ 120 (citing Ex. 1069; Ex. 1043 ¶¶ 148–149, 175); *id.* ¶ 151 (citing Ex. 1069, 909). Indeed, Firoozabadi expressly discloses generalizing the concept of harmonic nesting of microphone arrays to circular arrays, stating "[l]inear arrays have been already in use in the field of nested arrays for speech enhancement . . . , but our aim is to generalize the concept of nested microphone arrays to the circular arrays." Ex. 1069, 909.

Specifically with regard to proposed substitute claims 41 and 68, Petitioner includes Firoozabadi in its unpatentability grounds, explaining that Firoozabadi discloses a nested circular microphone array. Pet. Opp. 21. Firoozabadi discloses using a nested design to cover a broad frequency range encompassing 50 to 7,200 Hz (e.g., range of human speech) using sub-arrays, wherein each sub-array is optimized toward a specific frequency octave. *Id.* (citing Ex. 1069, 909; Ex. 1043 ¶¶ 148, 178). Petitioner relies on Firoozabadi's teachings that undesirable spatial aliasing effects can be eliminated using harmonically nested microphones. Ex. 1069, 909. Petitioner also relies on Chou's teaching that harmonic nesting was a well-known concept used to "cover a large frequency range by implementing several subarrays, each designed for a smaller frequency range, typically an octave." Ex. 1014, 2995.

As we discussed for challenged claims 8 and 36, we are persuaded that a skilled artisan would have been motivated to use harmonic nesting in the combined Tiete and Chan microphone assembly, in view of Chou. For the same reasons, we find a skilled artisan would have been motivated to use harmonically nested rings, as recited in proposed substitute claims 41 and 68. Petitioner's additional reliance on Firoozabadi further supports our findings, because Firoozabadi confirms the well-known technique of harmonic nesting could be applied to a circular array, and provides further motivation to combine with Tiete and Chan, as well as Tiete, Chan, anc Chou with Firoozabadi itself, namely the elimination of undesirable spatial aliasing. Pet. Opp. 21–22 (citing Ex. 1069, 909; Ex. 1043 ¶¶ 148, 178). Petitioner also provides additional evidence supporting our finding, namely that Dr. Vipperman confirms nesting of microphone arrays was a well-known technique, and that Liu confirms this also. *Id.* (citing Ex. 1052, 56:17–20; Ex. 1078, 143; Ex. 1043 ¶ 152).

Patent Owner asserts that Firoozabadi fails to disclose more than one ring, let alone multiple rings that are harmonically nested. PO Reply 11 (citing Ex. 2032 ¶¶ 42–43; Ex. 2033, 78:25–79:18). To support this argument, Patent Owner points out that Firoozabadi describes an example in which a single ring circular array was considered. Ex. 2032 ¶ 42 (citing Ex. 1069, 909). Patent Owner argues further that the combination of Tiete, Chan, and Chou fail to cure the deficiency of Firoozabadi. PO Reply 11–12 (citing Ex. 2032 ¶¶ 42–43). Based on the fully developed trial record, we find Patent Owner's arguments unavailing. As we discussed immediately above and for challenged claims 8 and 36, Petitioner relies on Tiete and Chan for disclosure of nested rings, not Chou or Firoozabadi.

(2) "audio component," "communications interface," and "external control device"

Petitioner shows Tiete discloses the recited "audio component," because Tiete discloses a field programmable gate array (FPGA) that receives audio signals from the microphone array and performs processing on the audio signals to generate an audio output. Pet. Opp. 22 (citing Ex. 1005, 1924, 1925, Fig. 4; Ex. 1144 ¶¶ 22, 82, 86).

Petitioner shows Tiete discloses the recited "communications interface" and "electronically coupling a communications interface to the audio processor, the communications interface being configured to allow communications between the audio processor and an external control device," because Tiete discloses an industry standard I^2C interface that allows connection between the FPGA (i.e., the asserted "audio component") and a host platform (i.e., the asserted "external control device"). *Id.* (citing Ex. 1005, 1923; Ex. 1144 ¶¶ 88–89).

Petitioner shows Tiete discloses "wherein the external control device is configured to control at least one of: directionality of the audio signals, noise suppression of the audio signals, muting of the audio signals, or a pickup pattern of the audio signals." Because the proposed substitute claims 41 and 68 each recite "at least one of," it is sufficient for Petitioner to show the prior art teaches controlling one of the enumerated features. Petitioner shows Tiete discloses the recited limitation because Tiete teaches that the host platform (i.e., the asserted "external device") "*can configure* the SoundCompass and request a measurement." Ex. 1144 ¶ 89 (quoting Ex. 1005, 1926) (emphasis added). Among the data that is sent to the host platform as the result of a requested measurement is directionality of audio signals. *Id.* ¶ 88 (citing Ex. 1005, 1923). Accordingly, we credit Dr.

Begault's testimony that the host platform, which Tiete teaches can configure the SoundCompass and request a measurement, can configure the number of discrete angles for the beamforming and otherwise configure SoundCompass for measurements. *Id.* ¶ 88; Opp. 22 (citing Ex. 1005, 1919, 1920, 1926; Ex. 1144 ¶¶ 88–89).

Patent Owner asserts Tiete fails to disclose the recited "external control device" because Tiete discloses "a sound source localization device (e.g., for pointing to a noise source) with a 'host platform.'" PO Reply 11 (citing Ex. 2032 ¶¶ 37–41). Patent Owner does not explain why we should find, based on this alleged distinction between Tiete and the '493 patent, that Tiete fails to teach the "external control device." Dr. Vipperman elaborates, stating that it is "not surprising" that Tiete does not disclose a host platform controlling beamforming function on the grounds that Tiete is directed to a fundamentally different technique (e.g., sound source localization) than the '493 patent (e.g., sound pickup for external communications or reproduction). Ex. 2032 ¶ 40. We find Patent Owner's and Dr. Vipperman's testimony unavailing for the following reasons.

Petitioner and Dr. Begault specifically assert Tiete's host platform can configure the number of discrete angles for the beamforming and otherwise configure SoundCompass for measurements. Pet. Opp. 22 (citing Ex. 1005, 1919, 1920, 1926; Ex. 1144 ¶¶ 88–89). Patent Owner's arguments fail to adequately address this assertion. Patent Owner's declarant, Dr. Vipperman states, incorrectly, that Dr. Begault acknowledges Tiete's host platform "at most can" request a measurement. Ex. 2032 ¶ 39 (citing Ex. 1144 ¶ 89). Contrary to Dr. Vipperman's assertion, Dr. Begault expressly cites to Tiete's disclosure that the host platform "*can configure the SoundCompass and*

request a measurement." Ex. 1144 ¶ 89 (quoting Ex. 1005, 1926) (emphasis added).

Dr. Vipperman also testifies the "orientation of the sensor" referenced in Dr. Begault's declaration is performed not by the host platform, and that the host platform therefore does not control the directionality of audio signals as asserted by Dr. Begault. Ex. 2032 ¶ 39. In support of his testimony that Tiete's host platform does not control the orientation of the sensor, Dr. Vipperman asserts that Tiete discloses that an inertial measurement unit (IMU) controls the orientation of the sensor. *Id.* Contrary to Dr. Vipperman's testimony, Tiete does not disclose the IMU controlling sensor orientation. Tiete explains the IMU determines, but does not state that it controls, the orientation of the microphone sensor orientation. Ex. 1005, 1923. Rather, the IMU is described in Tiete as a sensor mounted on to the PCB that detects when SoundCompass has been moved or repositioned. *Id.* at 1924. Therefore, we find that Tiete, at best, indicates the IMU provides sensed data to a controller, wherein the data is used to determine sensor orientation. We are unpersuaded by Patent Owner's argument that an inertial magnetic sensor would have been used as a controller.

(3) Substitute Claim 42

Petitioner contends that proposed substitute claim 42 is unpatentable as obvious over Tiete, Chan, Chou, Firoozabadi, Lai, and Hald. Pet. Opp. 24–25. Proposed substitute claim 42 amends claim 2 to change its dependency from claim 1 to proposed substituted claim 41. Mot. Amend App'x 1. For the reasons we discussed above for challenged claim 2 and proposed substitute claim 41, Petitioner has shown proposed substitute

claim 42 is unpatentable as obvious over Tiete, Chan, Chou, and Firoozabadi. Petitioner appears to introduce Hald and Lai due to Patent Owner's proposed construction of the term "rotationally offset" "to mean that across the concentric, nested rings, 'no more than any two microphones are axially aligned.'" PO Resp. 16. Petitioner argues Lai teaches harmonically nested rings in which "no more than two microphones are axially or radially aligned." Pet. Opp. 24 (citing Ex. 1067, Fig. 1; Ex. 1043 ¶¶ 171–173). Petitioner also argues that Hald discloses an example of rotationally offset rings, where the rotational offset necessarily results in each positon of a microphone in the line of the array being the same distance from the center, creating a ring. *Id.* at 25 (citing Ex. 1072, 5; Ex. 1043 ¶¶ 184–186).

As we discussed in our claim construction analysis above, we do not adopt Patent Owner's construction of the term "rotationally offset from each other." *See supra* Section II.D. Accordingly, Petitioner need not show that across the concentric, nested rings, no more than any two microphones are axially aligned, and we determine Petitioner has shown proposed substitute claim 42 is unpatentable as obvious over Tiete, Chan, Chou, Firoozabadi, Lai, and Hald.

(4) Conclusion

For the foregoing reasons, having reviewed the fully developed trial record, we determine Petitioner has shown, by a preponderance of the evidence that,

1) substitute claims 41–45, 47–53, 68–71, 73, and 76–80 are unpatentable as obvious over Tiete, Chan, Chou, and Firoozabadi;

2) substitute claims 54 and 75 are unpatentable as obvious over Tiete, Chan, Chou, Firoozabadi, and Sawa;

3) substitute claim 55 is unpatentable as obvious over Tiete, Chan, Chou, Firoozabadi, and Beaucoup;

4) substitute claim 72 is unpatentable as obvious Tiete, Chan, Chou, Firoozabadi, and Meyer; and

5) substitute claim 42 are unpatentable as obvious over Tiete, Chan, Chou, Firoozabadi, Lai, and Hald.

As we discussed above, we do not reach the issue of whether proposed substitute claims 46 and 74 have been shown to be unpatentable, because the contingency for Patent Owner's Motion has not been reached.

b) Substitute Claim 56

Proposed substitute claim 56 depends from proposed substitute claim 41, and replaces challenged claim 16 which depends from claim 1. Proposed substitute claim 56 has been amended to add "wherein each of the plurality of peripheral PCBs has an identical configuration of a respective subset of the plurality of microphones." Mot. Amend App'x 4–5.

Petitioner contends this proposed substitute claim is obvious in view of Tiete, Chan, Chou, Firoozabadi, and McElveen. Pet. Opp. 23. Petitioner argues McElveen teaches that "each of the plurality of peripheral PCBs has an identical configuration of a respective subset of the plurality of microphones." *Id.* We are persuaded by Petitioner's argument because Figure 2 of McElveen shows that each PCB has an identical configuration of microphones. Ex. 1015, Fig. 2. Dr. Vippermann confirms this is the case. Pet. Opp. 23 (citing Ex. 1052, 85:16–22). Dr. Begault asserts that a skilled artisan would have modified the single PCB with the harmonically nested rings of Tiete, Chan, Choo, and Firoozabadi to include the modular configuration of McElveen for the benefits described both in McElveen and Christensen. Ex. 1144 ¶¶ 98–107; Pet. Opp. 23. We credit Dr. Begault's

assertion, because providing such a modification would have resulted in a modular circuit board and modularity is widely adapted because of its ease of manufacturing, repair, scaling, lowering cost, etc., as taught by McElveen and Christensen. Pet. Opp. 23 (citing Ex. 1144 ¶¶ 98–107; Ex. 1015 ¶ 51, Ex. 1013, 2:27–36).

Patent Owner asserts that neither McElveen nor Christensen discloses peripheral PCBs, let alone peripheral PCBs with an "identical configuration" of a subset of the microphones on one of the concentric, nested rings. PO Reply 12 (citing Ex. 2032 ¶ 44). According to Patent Owner, McElveen discloses attaching multiple PCBs together with no arrangement forming a ring, and Christensen fails to disclose PCBs at all. *Id.* To support its argument, Patent Owner relies on the Second Supplemental Declaration of Dr. Vipperman, which, in turn, relies on the [first] supplemental declaration of Dr. Vipperman. Ex. 2032 (citing Ex. 2029 ¶¶ 59–67). Dr. Vipperman asserts that Tiete, Chan, and Sawa each fail to disclose a "plurality of peripheral PCB's" surrounding a "central" PCB for the same reasons discussed in his original declaration addressing challenged claims 16 and 35. Ex. 2020 ¶¶ 61–63. For the same reasons we discussed above for challenged claims 16 and 35, we find Dr. Vipperman's testimony to be unavailing. *Supra* Sec. II.E.12.c.9. Dr. Vipperman also asserts McElveen does not provide a motivation to transform Tiete's monolithic PCB into the "central" and "peripheral" architecture recited in challenged claim 16 and proposed substitute claim 56 for the reasons explained in his original declaration addressing challenged claim 16. Ex. 2020 ¶¶ 64–66. For the same reasons we discussed above for challenged claims 16 and 35, we find Dr. Vipperman's testimony to be unavailing. *Supra* Sec. II.E.12.c.9.

For the foregoing reasons, having reviewed the fully developed trial record, we determine that Petitioner has shown, by a preponderance of the evidence, proposed substitute claim 56 is unpatentable as obvious over Tiete, Chan, Chou, Firoozabadi, and McElveen.

c) Substitute Claims 57–67

Proposed substitute claim 57 amends challenged claim 17 by adding the phrase "arranged in a self-similar configuration" after "an array microphone comprising a plurality of microphones," by including the phrase "and fully encase the" after "a housing configured to support" and before "the array microphone," and by adding the limitations "wherein the sound-permeable screen covers from view the plurality of microphones; and wherein the housing further comprises side rails that secure the front face of the housing to a second face of the housing." Mot. Amend App'x 5. Proposed substitute claims 58–67 depend either directly or indirectly from proposed substitute claim 57 and, therefore, include the subject matter of proposed substitute claim 57. For the reasons that follow, we determine Petitioner has not demonstrated, by a preponderance of the evidence, that proposed substitute claims 57–67 are unpatentable.

(1) Indefiniteness

Petitioner contends the term "self-similar" renders proposed substitute claims 57–67 indefinite. According to Petitioner, the term "self-similar" is not a specific term of art from acoustics or microphone design, and its meaning within the specification of the '493 patent is ambiguous. Pet. Opp. 2–3. Accordingly, it appears Petitioner's argument is not that the term "self-similar" is indefinite outside the context of the '493 patent, but rather is that the term is indefinite when viewed in the context of the '493

Specification. *Id.* Petitioner's declarant, Dr. Begault, testifies that in the '493 patent the term "self-similar" is "equated or contrasted with" a "fractal-like configuration," arguing "the '493 [p]atent does not explain how close to a fractal is 'fractal-like.'" Ex. 1043 ¶¶ 155, 157.

We are not persuaded that the '493 patent's disclosure of "a plurality of microphone transducers selectively positioned in a self-similar or fractal-like configuration, or constellation," Ex. 1001, 3:66–4:1, creates ambiguity as to the term "self-similar." Even if we were to find this disclosure equates or contrasts the term "self-similar" with the term "fractal-like," Dr. Begault acknowledges the term self-similar does not have precisely the same meaning as fractal. Ex. 1043 ¶ 162. As such, a disclosure that something self-similar is fractal-like does not necessarily alter, or create ambiguity as to, the meaning of the term "self-similar," but rather acknowledges there are similarities between self-similar patterns and fractal-like patterns.

Dr. Begault opines that the term "'self-similar' is not a specific term of art from acoustics or microphone design (Ex. 1043 ¶ 157); however, the term appears to have had a well-known meaning. We do not discern any indication the '493 patent intended to deviate from such meaning. For example, "self-similarity" is defined in Merriam-Webster's Collegiate Dictionary as "the quality or state of having an appearance that is invariant upon being scaled larger or smaller." Ex. 3003, 1129. Also, the New Oxford American Dictionary defines "self-similar" as "similar to itself at a different time, or to a copy of itself on a different scale." Ex. 3004, 1586.[20]

[20] In our Preliminary Guidance regarding Patent Owner's first Motion to Amend, we entered into the record the dictionary definitions of "self-similar" discussed above, and we encouraged the parties to enter into the record evidence and argument regarding the meaning of the term "self-

Dr. Begault arrives at a similar understanding, testifying the simplest meaning of "self-similar" "refers to an object that is exactly or approximately similar to a part of itself (i.e., the whole has the same shape as one or more parts, which is also a characteristic of a fractal)." Ex. 1043 ¶ 157 (emphasis omitted). Accordingly, we agree with Patent Owner that a skilled artisan would have understood the '493 patent's Specification to be describing "self-similar" such that it may include fractal-like, configurations or constellations, PO Reply 2, but that the Specification is not adopting a special meaning for this term or creating ambiguity.

For the foregoing reasons, having reviewed the fully developed trial record, we determine Petitioner has not shown, by a preponderance of the evidence, that proposed substitute claims 57–67 are unpatentable as indefinite.

(2) Obviousness over Graham (Ex. 1011), alone or combined with other references, and Obviousness over the Graham Patent (Ex. 1040)

Petitioner contends: 1) proposed substitute claims 57–59 are unpatentable as obvious over Graham (Ex. 1011) [21]; 2) proposed substitute claims 57–59 are unpatentable as obvious over the Graham Patent (Ex. 1040); 3) proposed substitute claim 60 is unpatentable as obvious over

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similar," including for example extrinsic evidence such as dictionary definitions of the term, as allowed by the rules governing this proceeding. Paper 55, 17. However, Petitioner did not address these definitions or introduce any additional definitions along with its Opposition to the Revised Motion to Amend.

[21] Petitioner refers to Graham (Ex. 1011) as the "Graham Publication" in the Opposition to Patent Owner's Revised Motion to Amend, in order to distinguish this reference from other related Graham references. We refer to Ex. 1011 as "Graham," to be consistent with the Petition.

Graham and Bruey; and 4) claims 61–67 are unpatentable as obvious over Graham, Bruey, Herman, and Santiago. Pet. Opp. 6–19.

As we noted above, proposed substitute claim 57 recites "wherein the housing further comprises *side rails that secure* the front face of the housing to a second face of the housing." Mot. Amend App'x 5 (emphasis added). Petitioner contends that we should interpret "side rails that secure the front face of the housing to a second face of the housing" as a side of a structure that attaches the front face to the second face. Pet. Opp. 5–6 (citing Ex. 1144 ¶ 15). Dr. Begault explains "[s]ide rails are mentioned four times in the '493 [p]atent and are illustrated in some figures." Ex. 1144 ¶ 13 (citing Ex. 1001, 5:30–33, 6:14–18, 6:55–58, 6:66–67, Figs. 3–4). He testifies that the examples of side rails in the '493 patent are illustrative, but nothing in the '493 patent requires a particular form of side rails. *Id*. Although the '493 patent does not require a particular form of side rail, proposed substitute claim 57 recites "side rails that secure the front face of the housing to a second face of the housing." The Specification does not define the claim recitation at issue, and we, therefore, accord the phrase "side rails that secure the front face of the housing to a second face of the housing" its ordinary and customary meaning. We discern nothing in the '493 patent to support Petitioner's proposal that we replace the words at issue in proposed substitute claim 57 with the new words in Petitioner's construction.

Petitioner asserts that Graham discloses side rails of a housing that secure the front face to the second face of the housing. Pet. Opp. 11–12 (citing Ex. 1144 ¶¶ 40–52). In support of this assertion, Petitioner provides an illustration created by Dr. Begault showing side rails, but as Patent Owner points out, this is not a figure from Graham, and does not show a side

rail that secures the front face of the housing to the second face of the housing in the manner required by proposed substitute claim 57. PO Reply 7 (citing Ex. 2033, 59:16–20). Dr. Begault acknowledged during his deposition that the figure he created does not specify how the side rails secure to a front face, and testified further that "you can imagine any possible means by which the side rails could be attached to the front." *Id.* (citing Ex. 2033, 59:16–20). Petitioner and Dr. Begault argue, nonetheless, that frames and sides of housings that secure a front and back were well known, as described in Kulicke (Ex. 1122), Zelbacher (Ex. 1123), Oberbroeckling (Ex. 1124), Stewart (Ex. 1126), aluminum Pomona boxes, hobby boxes for PCBs, return air filter grilles for drop ceilings, and Sawa's main casing. Pet. Opp. 12 (citing Ex. 1144 ¶¶ 43–52). According to Dr. Begault, "[t]here is nothing innovative or unique about a fully enclosed enclosure, and there is nothing innovative about a 'side rail' used as a clip or ledge to hold inner membranes or other surfaces or to connect to a front face to a rear face." Pet. Sur-reply 7 (citing Ex. 1144 ¶¶ 41–42). Petitioner argues it would have been obvious, therefore, to modify the housing in Graham to use such well-known structures to affix the rear panel. Pet. Opp. 12. Patent Owner argues that Dr. Begault fails to explain why or how a skilled artisan would have modified Graham in view of the numerous references describing housings and frames. PO Reply 7.

Although Dr. Begault cites numerous references describing frames and housings, we agree with Patent Owner that Dr. Begault does not explain sufficiently why a skilled artisan would have been motivated to apply these teachings to Graham, nor does he explain how they would have been applied to Graham. *Id.* Graham discloses securing microphone array 116 to the back side of ceiling tile 264 using hooks 272. Ex. 1011 ¶ 54, Fig. 2H.

Graham discloses further that microphone array 116 may be appropriately assembled together with ceiling tile 264 using various fasteners known in the art, related art, or developed later. *Id.* ¶ 54. Dr. Begault does not address how or why Graham would have been modified to use, instead of fasteners, a frame and/or housing with side rails that secure.

Despite the well-known teachings Dr. Begault cites, for the reasons discussed above, we find that Dr. Begault does not sufficiently develop the reasoning as to why and how, in light of these teachings, Graham would have been modified to include this feature. The Board generally may not further develop Petitioner's ground of unpatentability against a proposed substitute claim in a motion to amend. *Hunting Titan*, Paper 67 at 4, 25 (concluding the Board only in rare circumstances may raise a ground of unpatentability that a petitioner did not advance or sufficiently develop, against a substitute claim in a motion to amend).

For the foregoing reasons, having reviewed the fully developed trial record, we determine Petitioner has not shown, by a preponderance of the evidence, that proposed substitute claim 57 is unpatentable as obvious over Graham. By virtue of their dependency from proposed substitute claim 57, proposed substitute claims 58–67 include the same "wherein the housing further comprises side rails that secure the front face of the housing to a second face of the housing" limitation. For the same reasons we discussed above, we also determine Petitioner has not shown, by a preponderance of the evidence, that: 1) proposed substitute claims 58 and 59 are unpatentable as obvious over Graham, and 2) proposed substitute claim 60 is unpatentable as obvious over Graham and Bruey; and 3) claims 61–67 are unpatentable as obvious over Graham, Bruey, Herman, and Santiago. Also, for the same reasons we discussed above, Petitioner has not shown claims 57–59 are

unpatentable as obvious over the Graham Patent. Petitioner argues that the Graham Patent discloses "the same subject matter" as Graham, and argues that the Graham Patent discloses an acoustically transparent tile, but Petitioner does not provide any additional argument that addresses why the claimed "side rail" would have been obvious. Pet. Opp. 14–15. Therefore, we also determine Petitioner has not shown, by a preponderance of the evidence, that proposed substitute claims 57–59 are unpatentable as obvious over the Graham Patent.

4. Conclusion

For the foregoing reasons, Patent Owner's Motion is not reached as to proposed substitute claims 46 and 74, is *denied* as to proposed substitute claims 41–45, 47–56, 68–73, 75–80, and 68–80, and is *granted* as to proposed substitute claims 57–67.

III. CONCLUSION

In summary:

Claims	35 U.S.C. §	Reference(s)/Basis	Claims Shown Unpatentable	Claims Not shown Unpatentable
1–7, 9–13, 28–31, 33, 34, 37–40	§ 103	Tiete, Chan	1–5, 7, 9–13, 28–31, 33, 37–40	6, 34
8, 36	§ 103	Tiete, Chan, Chou	8, 36	
14, 16, 35	§ 103	Tiete, Chan, Sawa	14, 16, 35	
15	§ 103	Tiete, Chan, Beaucoup	15	
32	§ 103	Tiete, Chan, Meyer	32	
17, 18, 21, 23–26	§ 103	Graham	17, 18, 21, 23–26	
19, 20	§ 103	Graham, Sawa	19, 20	
22	§ 103	Graham, Berry	22	
27	§ 103	Graham, Beaucoup	27	

Overall Outcome			1–5, 7–33, 35–40	6, 34

Motion to Amend Outcome	**Claims**
Substitute Claims Proposed in the Amendment	41–80
Substitute Claims: Motion to Amend Granted	57–67
Substitute Claims: Motion to Amend Denied	41–45, 47–56, 68–73, 75–80
Substitute Claims: Not Reached	46, 74

IV. ORDER

In consideration of the foregoing, it is hereby

ORDERED that Petitioner has demonstrated by a preponderance of the evidence that claims 1–5, 7–33, and 35–40 of U.S. Patent No. 9,565,493 B2 are *unpatentable*;

FURTHER ORDERED that Petitioner has not demonstrated by a preponderance of the evidence that claims 6 and 34 of U.S. Patent No. 9,565,493 B2 are *unpatentable*;

FURTHER ORDERED that Patent Owner's Revised Motion to Amend (Paper 57) is *granted-in-part*;

FURTHER ORDERED that Petitioner's Motion to Exclude (Paper 76) is *dismissed*;

FURTHER ORDERED that Patent Owner's Motion to Exclude (Paper 77) is *denied-in-part* and *dismissed-in-part*;

FURTHER ORDERED that Patent Owner's Unopposed Motion to Seal (Paper 34) is *granted*;

FURTHER ORDERED that Petitioner's Motion to Seal (Paper 50) is *granted*; and

FURTHER ORDERED that, because this is a Final Written Decision, any party to the proceeding seeking judicial review of the decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

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