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Paper 10
Date: December 7, 2023

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

META PLATFORMS, INC., META PLATFORMS TECHNOLOGIES, LLC, and TWISTED PIXEL GAMES, LLC,
Petitioner,

v.

EIGHT KHZ, LLC,
Patent Owner.

IPR2023-01024
Patent 11,290,836 B2

Before JUSTIN T. ARBES, LYNNE H. BROWNE, and SCOTT RAEVSKY, *Administrative Patent Judges.*

ARBES, *Administrative Patent Judge*.

DECISION
Granting Institution of *Inter Partes* Review
35 U.S.C. § 314

I. INTRODUCTION

A. Background and Summary

Petitioners Meta Platforms, Inc., Meta Platforms Technologies, LLC, and Twisted Pixel Games, LLC (collectively, "Petitioner") filed a Petition (Paper 2, "Pet.") requesting *inter partes* review of claims 8–17 of U.S. Patent No. 11,290,836 B2 (Ex. 1001, "the '836 patent") pursuant to

35 U.S.C. § 311(a). Patent Owner Eight kHz, LLC filed a Preliminary Response (Paper 6, "Prelim. Resp.") pursuant to 35 U.S.C. § 313. Pursuant to our authorization (Ex. 1144), Petitioner filed a Reply (Paper 7, "Reply") and Patent Owner filed a Sur-Reply (Paper 8, "Sur-Reply").

Pursuant to 35 U.S.C. § 314(a), the Director may not authorize an *inter partes* review unless the information in the petition and preliminary response "shows that there is a reasonable likelihood that the petitioner would prevail with respect to at least 1 of the claims challenged in the petition." *See* 37 C.F.R. § 42.4(a) ("The Board institutes the trial on behalf of the Director."). For the reasons that follow, we institute an *inter partes* review as to claims 8–17 of the '836 patent on all grounds of unpatentability asserted in the Petition.

B. Related Matters

The parties indicate that the '836 patent is the subject of *Eight kHz, LLC v. Meta Platforms, Inc.*, No. 6:22-cv-00575 (W.D. Tex.) ("the district court case"). *See* Pet. 65; Paper 5, 2. Petitioner filed petitions challenging unrelated patents asserted in the district court case in Cases IPR2023-01003, IPR2023-01004, IPR2023-01005, IPR2023-01019, IPR2023-01020, IPR2023-01021, IPR2023-01022, and IPR2023-01023.

C. The '836 Patent

The '836 patent discloses "methods and apparatus that improve a user experience during a telephone call or other form of electronic communication." Ex. 1001, col. 2, ll. 8–10. The '836 patent describes various problems associated with "electronically generated binaural sound or three-dimensional (3D) sound rendering." *Id.* at col. 2, l. 11–col. 3, l. 49.

One problem is that "listeners have a difficult time determining a location where the sound originates when th[e] location is close to the listener." *Id.* at col. 2, ll. 11–14. Specifically, "when the location of the origination of binaural sound is convolved to less than one meter from the person (considered to be 'near-field') it may be more difficult for the person to determine a location or direction of a binaural sound," but "a listener may have more success in external localization when the binaural sound is processed to originate from about one meter or more from the person (considered to be 'far-field')." *Id.* at col. 2, ll. 14–23. The '836 patent discloses that "[h]ead related transfer functions (HRTFs) describe how a sound wave changes as it interacts with the torso, head, and pinnae of the listener," and "do not vary substantially in the far-field range" but "vary significantly in the near-field range." *Id.* at col. 2, ll. 24–33. Thus, using near-field HRTFs can result in the listener "perceiv[ing] the sound as originating from the wrong location or be[ing] unable to localize an origin of the sound," and "can be computationally complex and processor-intensive." *Id.* at col. 2, ll. 34–40.

The '836 patent attempts to solve these issues by "convolv[ing] the sound so the listener believes that the sound originates from the sound source when in fact the sound is convolved to a different location" that is "behind" and along a "line-of-sight" with the sound source. *Id.* at col. 4, l. 65–col. 5, l. 11, col. 7, l. 1–col. 8, l. 39, col. 9, ll. 35–37. The '836 patent describes an exemplary arrangement where a handheld portable electronic device (HPED) displays an image of a person near the listener's face, such that near-field HRTFs normally would be used, but the HPED instead uses far-field HRTFs to localize the sound to a coordinate location "behind" the device and along the "line-of-sight" extending from the listener's head to the

image on the display. *Id.* at col. 6, ll. 1–25, col. 8, ll. 31–37. According to the '836 patent, doing so can "trick the listener into believing that the sound originates from the sound source when in fact the sound is convolved to originate from a location that is behind the sound source" because

> listeners are accustomed to hearing sound originate from a physical auditory event, such as at a physical object. Listeners consciously or unconsciously try to visually locate an object or event that corresponds to the sound and to associate or to place the origination of the sound at the object. Thus, even though the sound does not actually originate from the image, the brain ignores or reconciles a difference of position, resulting in the origin of the sound being localized at the image. When coordinates of the localization point occur beyond and behind the image, the sound localizes to the listener at the image.

Id. at col. 6, ll. 26–48.

Figure 5B of the '836 patent is reproduced below.

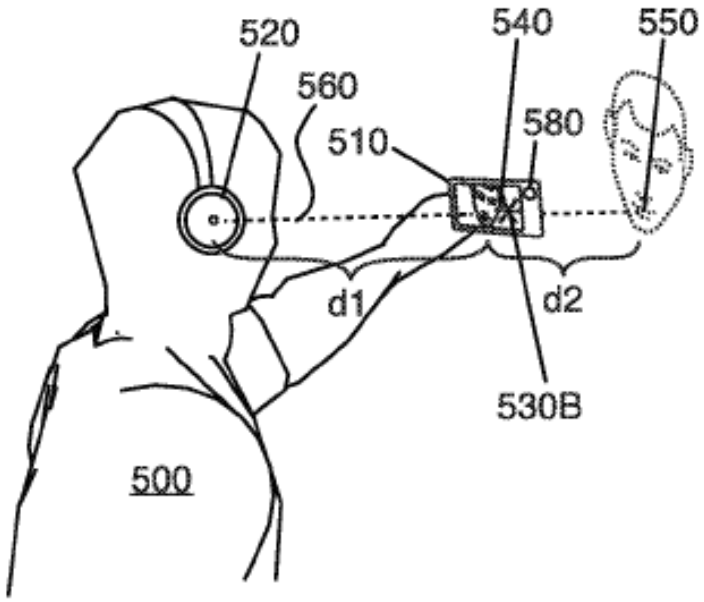

Figure 5B

Figure 5B depicts listener 500 talking with a person shown as image 540 on HPED 510 using electronic device 520 (e.g., headphones). *Id.* at col. 17,

ll. 55–60. Sound localization point (SLP) 530B, shown with an asterisk, "represents an origin of the voice of the user to the listener (e.g., a spot where the voice of the user is heard by the listener to originate)." *Id.* at col. 17, l. 60–col. 18, l. 3. "[A] processor (such as a processor in the HPED 510) convolves the voice of the user to a coordinate location 550 that is behind the HPED 510" and "located on a line-of-sight 560 that extends from the head or face of the listener 500, through the image 540 on the display of the HPED, and to the coordinate location 550." *Id.* at col. 18, ll. 22–29. As shown in Figure 5B, HPED 510 is located "near-field distance" d1 away from listener 500 and coordinate location 550 is selected to be distance d2 away from HPED 510, such that the distance from listener 500 to coordinate location 550 (d1+d2) is a "far-field distance" (i.e., greater than or equal to one meter) and far-field HRTFs can be used. *Id.* at col. 18, ll. 30–55. "The listener 500 will hear the voice of the user as if originating from the location of the smartphone since the coordinate location 550 is aligned with the image 540." *Id.* at col. 18, ll. 56–58.

Figures 6A and 6B of the '836 patent are reproduced below.

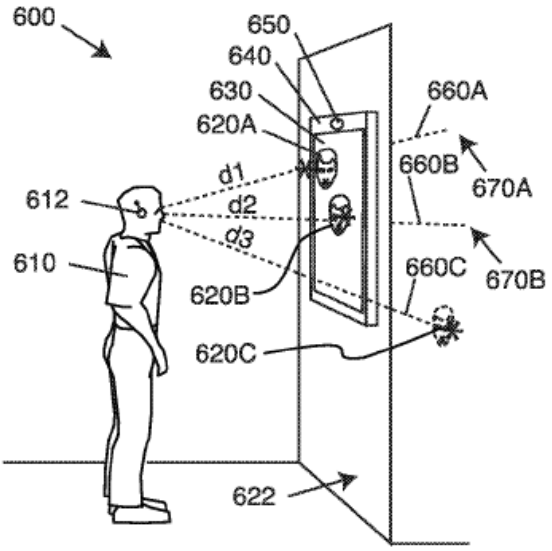

Figure 6A

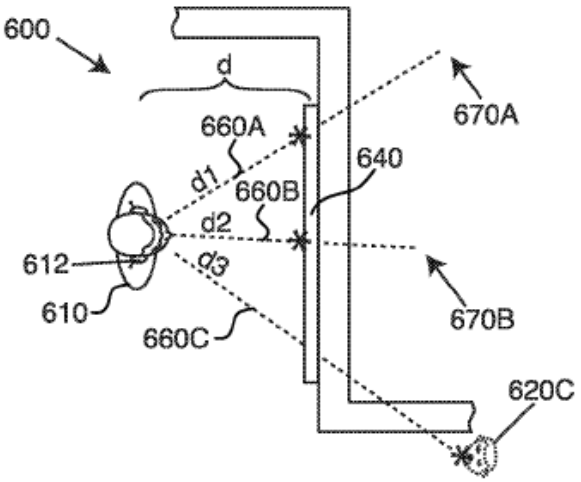

Figure 6B

Figures 6A and 6B depict side and top views, respectively, of "an electronic or computer system 600 in which a listener 610," using electronic device 612 (e.g., headphones) and standing at near-field distance d, "hears voices from three different users whose voices localize externally to the listener 610 as binaural sound to three different images 620A, 620B, and 620C on a display 630 of an electronic device 640." *Id.* at col. 21, ll. 48–52, col. 22, ll. 8–11. Sensor 650 (e.g., a camera) detects, for example, the distance to listener 610 or the gaze of listener 610 with respect to electronic device 640. *Id.* at col. 21, l. 66–col. 22, l. 7.

As shown in Figures 6A and 6B, "listener 610 sees each image 620A, 620B, and 620C along a respective line-of-sight 660A, 660B, and 660C," but "perceives the images at different distances" away, with "[i]mages 620A and 620B appear[ing] to be located at the surface of the display 630" and image 620C "appear[ing] to be located farther away than a wall or virtual wall 622 at which the display 630 is located" (e.g., by using a 3D television display). *Id.* at col. 22, ll. 8–20. "[D]istances d1 and d2 are near-field distances, [so] voices of the users corresponding to images 620A and 620B are convolved with HRTFs having coordinate locations 670A and 670B that are far-field distances" and listener 610 nevertheless perceives the respective voices as originating at their image locations on the display (as described above with respect to Figure 5B, for example). *Id.* at col. 22, ll. 26–29, 33–38, 42–43, Fig. 9. Distance D3, however, "is a far-field distance, [so] the voice of the user corresponding to image 620C is convolved with a HRTF pair having a distance coordinate that matches or corresponds to the far-field distance of d3" and listener 610 perceives the voice as originating at a point behind the display "where the sound is convolved to originate" (i.e.,

conventional processing using far-field HRTFs). *Id.* at col. 22, ll. 29–33, 38–42, Fig. 9.

D. Illustrative Claim

Challenged claims 8 and 15 of the '836 patent are independent. Claims 9–14 depend from claim 8, and claims 16 and 17 depend from claim 15. Claim 8 recites (with letter designations used in the Petition to refer to the various limitations):

> 1. [pre] An electronic device, comprising:
>
> [a] a display that displays an image that occurs within a near-field distance from a head of a user; and
>
> [b] one or more processors that process sound for the image [c] to generate binaural sound that has a sound localization point (SLP) with a coordinate location that occurs at a far-field distance located behind the image and along a line-of-sight from the user to the image while the display displays the image to the user at the near-field distance, [d] wherein the one or more processors include a digital signal processor (DSP) [e] that processes the sound for the image with far-field head-related transfer functions (HRTFs) while the electronic device is located at the near-field distance from the head of the user.

E. Evidence

Petitioner relies on the following prior art:

> U.S. Patent No. 7,876,903 B2, issued Jan. 25, 2011 (Ex. 1009, "Sauk");
>
> U.S. Patent No. 9,226,090 B1, issued Dec. 29, 2015 (Ex. 1007, "Norris");
>
> U.S. Patent No. 10,979,843 B2, filed Apr. 8, 2016, issued Apr. 13, 2021 (Ex. 1010, "Shivappa");

Durand R. Begault, "3-D Sound for Virtual Reality and Multimedia," NASA/TM—2000-209606 (Aug. 2000) (Ex. 1006, "Begault");

V.R. Algazi *et al*., "The CIPIC HRTF Database," IEEE Workshop on Applications of Signal Processing to Audio and Acoustics (2001) (Ex. 1008, "Algazi");

Zhiying Zhou *et al*., "An Experimental Study on the Role of Software Synthesized 3D Sound in Augmented Reality Environments," 16 Interacting with Computers 989 (2004) (Ex. 1011, "Zhou"); and

Daniel J. Finnegan *et al.*, "Compensating for Distance Compression in Audiovisual Virtual Environments Using Incongruence," Proceedings of ACM CHI Conference on Human Factors in Computing Systems (CHI'16) (2016) Ex. 1005, "Finnegan").

F. Prior Art and Asserted Grounds

Petitioner asserts that claims 8–17 of the '836 patent are unpatentable on the following grounds:

Claims Challenged	35 U.S.C. §	Reference(s)/Basis
8–10, 15–17	103	Finnegan[1]
8–10, 15–17	103	Finnegan, Begault
8–10, 15–17	103	Shivappa
8–10, 15–17	103	Shivappa, Zhou
8–10, 13–17	103	Norris
8–10, 13–17	103	Norris, Begault, Algazi
11, 12	103	Norris, Sauk

[1] Petitioner identifies three grounds, one of which has two sub-grounds, with each being based on a particular reference "alone or in view of" one or more other references. *See* Pet. 2. These are appropriately characterized as eight different asserted grounds.

Claims Challenged	35 U.S.C. §	Reference(s)/Basis
11, 12	103	Norris, Begault, Algazi, Sauk

II. ANALYSIS

A. Discretionary Denial Under 35 U.S.C. § 314(a)

Institution of *inter partes* review is discretionary. *See Harmonic Inc. v. Avid Tech., Inc.*, 815 F.3d 1356, 1367 (Fed. Cir. 2016) ("[T]he PTO is permitted, but never compelled, to institute an [*inter partes* review (IPR)] proceeding."); 35 U.S.C. § 314(a) ("The Director *may not* authorize an inter partes review to be instituted unless the Director determines that the information presented in the petition filed under section 311 and any response filed under section 313 shows that there is a reasonable likelihood that the petitioner would prevail with respect to at least 1 of the claims challenged in the petition." (emphasis added)). Patent Owner argues that we should exercise our discretion to deny the Petition in view of the district court case. *See* Prelim. Resp. 52–61; Sur-Reply 1–4. Petitioner disagrees. *See* Pet. 64; Reply 1–2.

The Board has held that the advanced state of a parallel district court action is a factor that may weigh in favor of denying a petition under § 314(a). *See NHK Spring Co. v. Intri-Plex Techs., Inc.*, IPR2018-00752, Paper 8 at 20 (PTAB Sept. 12, 2018) (precedential); Patent Trial and Appeal Board Consolidated Trial Practice Guide (Nov. 2019), 58 & n.2, *available at* https://www.uspto.gov/TrialPracticeGuideConsolidated. We consider the following factors to assess "whether efficiency, fairness, and the merits support the exercise of authority to deny institution in view of an earlier trial date in the parallel proceeding":

1. whether the court granted a stay or evidence exists that one may be granted if a proceeding is instituted;
2. proximity of the court's trial date to the Board's projected statutory deadline for a final written decision;
3. investment in the parallel proceeding by the court and the parties;
4. overlap between issues raised in the petition and in the parallel proceeding;
5. whether the petitioner and the defendant in the parallel proceeding are the same party; and
6. other circumstances that impact the Board's exercise of discretion, including the merits.

Apple Inc. v. Fintiv, Inc., IPR2020-00019, Paper 11 at 5–6 (PTAB Mar. 20, 2020) (precedential). We also consider "several clarifications" made by the Director of the United States Patent and Trademark Office ("USPTO"). *See* USPTO Memorandum, Interim Procedure for Discretionary Denials in AIA Post-Grant Proceedings with Parallel District Court Litigation, 2 (June 21, 2022) ("Director's Memo"), *available at* https://www.uspto.gov/sites/default/files/documents/interim_proc_discretionary_denials_aia_parallel_district_court_ litigation_memo_20220621_.pdf.

The Director's Memo provides that "[c]onsistent with [*Sotera Wireless, Inc. v. Masimo Corp.*, IPR2020-01019, Paper 12 (PTAB Dec. 1, 2020) (precedential as to § II.A) ('*Sotera*')], the PTAB will not discretionarily deny institution in view of parallel district court litigation where a petitioner presents a stipulation not to pursue in a parallel proceeding the same grounds or any grounds that could have reasonably been raised before the PTAB." Director's Memo 3. With our authorization, Petitioner filed a stipulation which stipulates that

> [i]f the PTAB institutes the pending IPR in IPR2023-01024 challenging the patentability of claims 8–17 of the '836 patent, then [Petitioner] will not pursue as to the challenged claims any ground raised or that could have been reasonably raised in the IPR in the above-captioned district court litigation (No. 6:22-cv-00575-ADA).

Reply 1 (quoting Ex. 1141, 3); *see also* Exs. 2015–2017 (Patent Owner's infringement contentions indicating that Patent Owner is asserting only claims 8 and 10 of the '836 patent in the district court case); Ex. 2018, 2 (Petitioner's final invalidity contentions, dated October 18, 2023, indicating the same); Ex. 1143 (Order Granting Joint Motion to Amend Scheduling Order in the district court case indicating that the deadlines to serve final infringement contentions and to amend pleadings, including to "add[] . . . patent claims," have expired).

Patent Owner concedes that Petitioner filed a "*Sotera*-like stipulation" but argues that it is insufficient because it "leaves the door open to a duplication of efforts and the possibility of conflicting decisions." Sur-Reply 1 (citing Ex. 1141, 4 ("This stipulation is not intended . . . to limit [Petitioner's] ability to assert . . . invalidity under 35 U.S.C. §§ 102 and 103 not available in IPR and under 35 U.S.C. §§ 101 and 112[], regardless of whether IPRs are instituted.")). Namely, Patent Owner argues that Petitioner's stipulation carves out "the right to assert overlapping system art in the parallel district court proceeding," such that institution here would not address the risk of "inconsistent outcomes between the PTAB and the district court." *Id.* at 3.

We disagree with Patent Owner, as Petitioner's stipulation comports with the "could have reasonably been raised" language of the Director's Memo. *Compare* Reply 1 (stipulation not to pursue in the district court case

"any ground raised or that could have been reasonably raised in" this proceeding), *with* Director's Memo 3 ("stipulation not to pursue in a parallel proceeding the same grounds or any grounds that could have reasonably been raised before the PTAB"). Patent Owner's argument essentially attacks the reasoning of *Sotera* itself and the Director's Memo, which we are bound to follow. Accordingly, Patent Owner's argument is unavailing.

Patent Owner also urges us not to accept a "late" stipulation. Sur-Reply 3–4. We disagree that Petitioner's stipulation is late. It is within our discretion to permit Petitioner to file a stipulation prior to institution. *See NXP USA, Inc. v. Impinj, Inc.*, IPR2021-01556, Paper 13 at 4 (PTAB Sept. 7, 2022) (precedential).

For the above reasons, we decline to exercise our discretion to deny institution under § 314(a).

B. Legal Standards

A claim is unpatentable for obviousness if "the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains." 35 U.S.C. § 103; *see 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 "the scope and content of the prior art"; "differences between the prior art and the claims at issue"; and "the level of ordinary skill in the pertinent art." *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966). Additionally, secondary considerations, such as "commercial success, long felt but unsolved needs, failure of others, etc., might be utilized to give light to the circumstances

surrounding the origin of the subject matter sought to be patented. As indicia of obviousness or nonobviousness, these inquiries may have relevancy." *Id.* When conducting an obviousness analysis, we consider a prior art reference "not only for what it expressly teaches, but also for what it fairly suggests." *Bradium Techs. LLC v. Iancu*, 923 F.3d 1032, 1049 (Fed. Cir. 2019).

A patent claim "is not proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art." *KSR*, 550 U.S. at 418. An obviousness determination requires finding "both 'that a skilled artisan would have been motivated to combine the teachings of the prior art references to achieve the claimed invention, and that the skilled artisan would have had a reasonable expectation of success in doing so.'" *Intelligent Bio-Sys., Inc. v. Illumina Cambridge Ltd.*, 821 F.3d 1359, 1367–68 (Fed. Cir. 2016); *see KSR*, 550 U.S. at 418 (for an obviousness analysis, "it can be important to identify a reason that would have prompted a person of ordinary skill in the relevant field to combine the elements in the way the claimed new invention does").

"Although the *KSR* test is flexible, the Board 'must still be careful not to allow hindsight reconstruction of references . . . without any explanation as to *how* or *why* the references would be combined to produce the claimed invention.'" *TriVascular, Inc. v. Samuels*, 812 F.3d 1056, 1066 (Fed. Cir. 2016). Further, an assertion of obviousness "cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness." *KSR*, 550 U.S. at 418 (quoting *In re Kahn*, 441 F.3d 977, 988 (Fed. Cir. 2006)); *accord In re NuVasive, Inc.*, 842 F.3d 1376, 1383 (Fed. Cir. 2016) (stating that "conclusory statements" amount to an

"insufficient articulation[] of motivation to combine"; "instead, the finding must be supported by a 'reasoned explanation'"); *In re Magnum Oil Tools Int'l, Ltd.*, 829 F.3d 1364, 1380 (Fed. Cir. 2016) ("To satisfy its burden of proving obviousness, a petitioner cannot employ mere conclusory statements. The petitioner must instead articulate specific reasoning, based on evidence of record, to support the legal conclusion of obviousness.").

C. Level of Ordinary Skill in the Art

Petitioner argues that at the time of the '836 patent (May 2017), a person of ordinary skill in the art would have had "a Bachelor's degree in computer science/engineering, or a related field, with coursework in computer programming, digital signal processing, spatial audio, or virtual/augmented reality, and at least two years of industry experience, or academic research experience, in virtual/augmented reality, audio engineering, or an equivalent," where "[a]dditional education can compensate for less experience, and vice-versa." Pet. 4 (citing Ex. 1003 ¶¶ 45–51). Patent Owner argues that a person of ordinary skill in the art instead would have had "several years of academic and/or professional experience in a technical field relevant to digital audio signal processing, such as electrical engineering, computer engineering, or computer science; and a familiarity with relevant literature and concepts concerning virtual 3D audio processing, which were widely available at the time of disclosure." Prelim. Resp. 5–6. Neither party explains why its proposed definition is appropriate.

Based on the record presented, including our review of the '836 patent and the types of problems and solutions described in the '836 patent and cited prior art, we agree with Petitioner's proposed definition of the level of

ordinary skill in the art and apply it for purposes of this Decision. *See, e.g.*, Ex. 1001, col. 1, ll. 5–18 (describing the general technology of "[t]hree-dimensional (3D) sound localization"), col. 2, l. 24–col. 3, l. 49 (describing the properties and prior uses of HRTFs), col. 5, ll. 14–57 (describing various electronic devices capable of displaying virtual reality (VR) and augmented reality (AR) images). We note, however, that our conclusions herein would be the same regardless of which party's definition is used.[2]

D. Claim Interpretation

We interpret each challenged 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), including construing the claim in accordance with the ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and the prosecution history pertaining to the patent.

37 C.F.R. § 42.100(b). The parties do not propose express interpretations of any claim terms, although Petitioner notes that Patent Owner argued in the district court case that two limitations of claim 8 are not means-plus-function limitations under 35 U.S.C. § 112(f). *See* Pet. 4–5 (citing Ex. 1054, 24–38); Prelim. Resp. 5. The parties agree, however, that two terms in independent claims 8 and 15 are "define[d]" in the Specification of the '836 patent. *See* Pet. 3, 31; Prelim. Resp. 12, 22, 37. Specifically, the term "near-field distance" means a distance less than one meter and the term "far-field

[2] If either party believes that the difference in proposed definitions of the level of ordinary skill in the art impacts the obviousness analysis for the asserted grounds or the admissibility of testimony offered in this proceeding, the party should address the issue in detail in its papers during trial.

distance" means a distance greater than or equal to one meter. *See id.*; Ex. 1001, col. 2, ll. 15–23, col. 27, ll. 23–25; *see also* Ex. 1053, 2 (agreed constructions in the district court case); Ex. 1054, 3 (same). We agree, and interpret the two terms accordingly for purposes of this Decision. We also address one other issue pertaining to the language of limitations 8[a], 8[c], and 8[e] below in Section II.E.3.

No further interpretation of any claim term is necessary to determine whether to institute an *inter partes* review in this proceeding. *See Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017) ("Because we need only construe terms 'that are in controversy, and *only to the extent necessary* to resolve the controversy,' we need not construe [a particular claim limitation] where the construction is not 'material to the . . . dispute.'" (citation omitted) (emphasis added)).

E. Obviousness Grounds Based on Finnegan, and Finnegan and Begault (Claims 8–10 and 15–17)

Petitioner contends that claims 8–10 and 15–17 are unpatentable over Finnegan, alone or in combination with Begault, under 35 U.S.C. § 103, citing the testimony of Agnieska Roginska, Ph.D., as support. Pet. 5–18 (citing Ex. 1003). Patent Owner responds, citing the testimony of Durand R. Begault, Ph.D., and John C. Hart, Ph.D., as support. Prelim. Resp. 8–26 (citing Exs. 2006, 2008). We are persuaded that Petitioner has established a reasonable likelihood of prevailing on its asserted ground based on Finnegan and Begault as to claims 8–10 and 15–17.[3]

[3] Petitioner provides evidence, unchallenged by Patent Owner in its Preliminary Response, that Finnegan and Begault are prior art printed publications under 35 U.S.C. § 102(a). *See* Pet. 5–6 (citing Ex. 1012

1. Finnegan

Finnegan discloses "a study of 3D spatial perception within a virtual reality (VR) head mounted display," involving the phenomenon of "compression" where "humans tend to underestimate the distance between themselves and target objects." Ex. 1005, 1. Finnegan describes the following components used for the experiment:

> We used an Oculus Rift Development Kit 2 [head mounted display (HMD)] and audio was rendered using a custom plugin that we built for the Unity Game Engine. A pair of Sennheiser HD201 Lightweight Over-Ear Binaural Headphones was used as the audio display device. Our plugin integrates the SoundScape Renderer (SSR), a GPL licensed software implementation for binaural audio, with Unity for spatial audio rendering over headphones. Each participant was seated, with their chin resting on a chin rest to prevent head movement during the trials. The machine used to simulate the [virtual environment (VE)] was a Macbook Pro (13-inch, Mid 2012 model) with a 2.9GHz Intel i7 processor, 16GB RAM and an Intel HD Graphics 4000 card, running OS X Yosemite 10.10.3.

Id. at 6 (footnotes and endnotes omitted).

¶¶ 30–76). Based on the record at this time, Petitioner has shown a reasonable likelihood that the references are prior art. *See Hulu, LLC v. Sound View Innovations, LLC*, IPR2018-01039, Paper 29 at 13, 21 (PTAB Dec. 20, 2019) (precedential) ("*Hulu*") ("[A]t the institution stage, the petition must identify, with particularity, evidence sufficient to establish a reasonable likelihood that the reference was publicly accessible before the critical date of the challenged patent and therefore that there is a reasonable likelihood that it qualifies as a printed publication."). Also, we note that the supporting declaration cited by Petitioner (Ex. 1012) includes a number of attached appendices. In future filings, the parties should file such documents as separately numbered exhibits. *See* 37 C.F.R. § 42.63.

Photographs of the device used in Finnegan, reproduced from page 9 of the Petition, are shown below.

The photographs show the "Rift DK2 VR HMD" and a user wearing it. Pet. 9. Participants were given the device, repeatedly shown a target image at two different distances with associated audio, and asked to indicate "whether they perceived the first appearance or second appearance as closer to them." Ex. 1005, 7. Figure 1 of Finnegan is reproduced below.

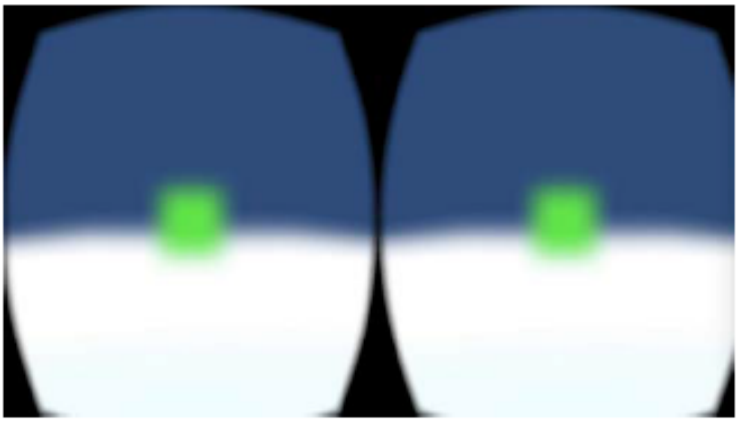

Figure 1 depicts "[a]n example screenshot of what the participants saw inside the headset." *Id.* at 6.

Finnegan's experiment tested image distances at "near (0.5 to 5.5 meters) and far subranges (4.5 to 9.5 meters)," and both "congruent" conditions (i.e., where "both the auditory and visual stimuli were presented at these reference distances") and "incongruent" conditions (i.e., where "the visual stimulus was at the reference distance with the audio stimulus offset

by [an] incongruent positioning function"). *Id.* at 5, 7–8. The experiment was designed to test two hypotheses, one of which was "*H1:* Rendering the audio at an incongruent position further from the observer than the visual stimulus (IV), will result in more accurate distance perception (DV) compared to conditions where both stimuli are at the same position (congruent conditions)." *Id.* at 6. Finnegan describes the results of the experiment and states that "*H1* is supported by the results of our analysis in the far range but not in the near range. Incongruence resulted in more accurate distance estimates when audiovisual targets were presented in the far range." *Id.* at 9, 11.

2. Begault

Begault is a book titled "3-D Sound for Virtual Reality and Multimedia."[4] Ex. 1006. Begault describes various concepts and techniques pertaining to "3-D sound," or "binaural audio," where "the outer ears (the pinnae) are either directly implemented or modeled as digital filters" and "[b]y filtering a digitized sound source with these filters, one can potentially place sounds anywhere in the virtual space about a headphone listener." *Id.* at x (emphasis omitted).[5] According to Begault, "[o]ne might be able to work more effectively within a VR environment if actions were accompanied by appropriate sounds that seemingly emit from their proper locations." *Id.* at 13. Begault explains that "[t]he use of HRTF spectral shaping is typically featured as the key component of a 3-D sound system"

[4] Patent Owner's declarant, Dr. Begault, is the author of Begault. *See* Ex. 1006; Ex. 2006 ¶ 24.

[5] Consistent with the parties' usage, when referencing pages of Begault, we refer to the original page numbering at the bottom-center of the reference.

and "[t]he spectral changes caused by the HRTF are the cues that help externalize sound images, disambiguate front from rear, and impart elevation information; the inclusion of the binaural HRTF is fundamental for a 3-D sound system that relates natural and synthetic spatial hearing." *Id.* at 41, 99. Further, "[c]hanging HRTF spectra as a function of head movement is generally considered to improve overall localization performance. It does not necessarily follow that virtual source movement will improve performance." *Id.* at 99. Begault describes a specific set of HRTFs for "KEMAR, a standard audiological research mannequin manufactured by Knowles Electronics," which involved measurements at "1.4 meters from the KEMAR" and "have been used many times in both 3-D sound applications and localization studies." *Id.* at 118–119, 205.

Finally, Begault discloses that "[w]ithin a virtual reality or multimedia application, 3-D sound processing is almost always best accomplished digitally, using audio DSP chips to manipulate signal sources." *Id.* at 100. "The 3-D audio component of an integrated audio subsystem . . . can contain anywhere from one to as many DSPs as can be accommodated," where "[e]ach is usually assigned a specific function." *Id.* at 101.

3. Claim 8

Petitioner argues that Finnegan, alone or in combination with Begault, teaches the limitations of claim 8. Pet. 7–18. With respect to the preamble, Petitioner contends that the Oculus Rift Development Kit 2 (DK2) HMD, Macbook Pro, and Binaural Headphones disclosed in Finnegan constitute an "electronic device." *Id.* at 9. Patent Owner does not dispute Petitioner's arguments regarding the preamble of claim 8.

With respect to limitation 8[a], "a display that displays an image that occurs within a near-field distance from a head of a user," Petitioner contends that because the lenses on Finnegan's HMD "were well within 1 m from a user's head," as shown in the photograph above of a user wearing the device, the HMD displays images "within a near-field distance from a head of a user." *Id.* at 9–10. Petitioner argues that two recitations in claim 8—"the display displays the image to the user at *the* near-field distance" and "the electronic device is located at *the* near-field distance"—mean that "the electronic device and the displayed image are co-located." *Id.* at 10. We refer to this as "the co-location argument."

Patent Owner responds that the claim language and Specification of the '836 patent contradict Petitioner's co-location argument. Prelim. Resp. 10–14 (citing Ex. 2006 ¶¶ 13–16, 18; Ex. 2008 ¶¶ 17–22, 24). First, Patent Owner argues that "the location of the image and the location of the electronic device are two separate and different limitations of claim 8," with the former specified in limitation 8[a] ("an image that occurs within a near-field distance from a head of a user") and the latter specified in limitation 8[e] ("the electronic device is located at the near-field distance from the head of the user"). *Id.* at 11–12. According to Patent Owner, Petitioner improperly treats them the same despite their different wording (i.e., "occurs within" for "an image" versus "located at" for "the electronic device"). *Id.* Patent Owner contends that although the image and electronic device both must be within one meter, that "does not necessarily mean that the two are co-located." *Id.* at 12 (emphasis omitted).

We disagree based on the current record. Limitations 8[c] and 8[e] recite, respectively, that "the display displays the image to the user *at the near-field distance*" and "the electronic device is located *at the near-field*

distance from the head of the user" (emphasis added). Both refer to the same distance, finding antecedent basis in the earlier recitation of "a near-field distance" in limitation 8[a]. Thus, based on the current record, the plain language of claim 8 appears to require that (1) the image is displayed to the user at a near-field distance from the user's head, and (2) the electronic device is located at the same distance—in other words, they are co-located. Patent Owner discusses limitations 8[a] and 8[e], but fails to account sufficiently for the language of limitation 8[c]. *See id.* at 11–12.

Second, Patent Owner argues that the "location of an image [as recited in claim 8] ought to be construed as the location of the image in the virtual world, as it is perceived (i.e., observed) by the user." *Id.* at 13 (emphasis omitted). Patent Owner relies on a portion of the Specification discussing a virtual chair "observed as two feet away from the wearer of the electronic device" even though the device is located just a few inches away from the user's face, as well as Figures 6A and 6B, which include image 620C "appear[ing] to be located farther away" than the display itself. *Id.* at 13–14 (citing Ex. 1001, col. 3, ll. 39–41, col. 21, ll. 51–52, col. 22, ll. 11–15, col. 27, ll. 3–8) (emphasis omitted).

We again disagree based on the current record. Patent Owner's position would read into the claim a requirement for where the image "appears" or is "visually perceived" by the user, but the claim does not recite any language to that effect. *See id.* (emphasis omitted). Further, although one of the images in Figures 6A and 6B (image 620C) appears as farther away than the display, the Specification expressly states that two of the images (images 620A and 620B) appear to be "located at the surface of the display" itself (i.e., the displayed image and electronic device are co-located). Ex. 1001, col. 22, ll. 8–20; *see also id.* at col. 6, ll. 58–62

(describing "an electronic device" and "an image" both as "located within a near-field distance from the person"), col. 18, ll. 11–38 (describing the arrangement of Figure 5B with near-field distance d1 from listener 500 to HPED 510 that displays image 540, and far-field distance d1+d2 to coordinate location 550 "behind" HPED 510 and within the listener's "line-of-sight"). On this record, Petitioner's reading is consistent with the language of limitations 8[c] and 8[e] and at least the portions of the Specification describing a displayed image and electronic device as both being at a particular near-field distance from the user.[6]

Finally, Patent Owner contends that even if Petitioner's co-location argument is correct, Finnegan still does not teach the limitation because it "comput[es] the desired distance of the auditory stimulus relative to the user as a function of the 'the visual component's position,' . . . not the position of the display." Prelim. Resp. 14–15 (citing Ex. 1005, 5, 7; Ex. 2006 ¶ 18; Ex. 2008 ¶ 24). Thus, according to Patent Owner, "Finnegan does not gather data on the relationship between the location of a display and that of an auditory stimulus; nor does it make any conclusion about that." *Id.* Claim 8, however, does not recite gathering data or making a comparison between the location of the displayed image and the SLP for the auditory

[6] To the extent the parties disagree as to the interpretation of "image," "near-field distance," or any other terms of claim 8, the parties are encouraged to provide in their papers during trial proposed interpretations for the term(s) and cite support in the Specification and/or prosecution history of the '836 patent for their respective interpretations. The parties also are encouraged to explain how the different terminology used in limitations 8[a], 8[c], and 8[e] should be reconciled (i.e., the display displays an image that "occurs within a near-field distance," the display displays the image "at the near-field distance," and the electronic device is located "at the near-field distance").

stimulus. Limitation 8[a] only recites displaying "an image that occurs within a near-field distance from a head of a user," and the lenses on Finnegan's HMD would be well within 1 meter from the user's head, as Petitioner contends. *See* Pet. 9–10.

We also note that Petitioner argues in the alternative that if its co-location argument fails and the "near-field distance" in limitation 8[a] refers to "the distance to the location of a *perceived* image" rather than to the location of the displayed image at the device, Finnegan still teaches the limitation because its images appeared to the user to be 0.5 to 9.5 meters away. *Id.* at 10. Therefore, according to Petitioner, any image displayed at a distance greater than 0.5 meters and less than 1 meter would qualify as a "near-field distance" for purposes of the claim. *Id.* Patent Owner disagrees. Prelim. Resp. 15–17. We need not resolve the dispute over Petitioner's alternative reading of claim 8 at this time, however, because we agree with Petitioner on this record that the claim requires co-location, as explained above.

Next, with respect to limitations 8[b] and 8[d], which recite "one or more processors that process sound for the image" and "include a digital signal processor (DSP)," Petitioner argues that it would have been obvious to use a processor, given Finnegan's disclosure that the Macbook Pro includes an "Intel i7 processor," and to implement the "digital signal processing" disclosed in Finnegan with a DSP. Pet. 11–12 (quoting Ex. 1007, 3, 6). Petitioner further contends that it would have been obvious to use a DSP in Finnegan's system based on Begault's disclosures regarding using "DSPs for processing 3D sound in virtual environments." *Id.* at 7–8, 13–14 (citing Ex. 1006, 100–101). According to Petitioner and Dr. Begault, DSPs "were used for such processing because they are fast, excel at signal

processing tasks like HRTF processing, are reconfigurable and flexible, and are appropriately sized for use in systems like Finnegan's." *Id.* at 8 (citing Ex. 1003 ¶¶ 188–191). Patent Owner does not dispute Petitioner's arguments regarding limitations 8[b] and 8[d].

With respect to limitation 8[c], which recites that the one or more processors "generate binaural sound that has a sound localization point (SLP) with a coordinate location that occurs at a far-field distance located behind the image and along a line-of-sight from the user to the image while the display displays the image to the user at the near-field distance," Petitioner argues that "any incongruent binaural sound that Finnegan positioned at distances of 1 m or greater . . . would be at locations where a listener localizes sound (SLPs with coordinate locations) at 'far-field' distances," "the sounds Finnegan positioned at 'far-field' distances were 'behind' images that were 'concurrently' displayed on a Rift HMD's lenses" within a near-field distance, and a person of ordinary skill in the art would have understood that "Finnegan's images and sounds were presented along a user's line-of-sight," given that Finnegan used a chin rest to secure the user's head in position. *Id.* at 14–16 (citing Ex. 1005, 2, 6, 7). Patent Owner refers to its previous arguments that we addressed above. Prelim. Resp. 18–19. Petitioner also makes an alternative argument regarding a "*perceived* distance to an image" in Finnegan if its co-location argument fails, which we need not address at this time. *See* Pet. 16–17.

With respect to limitation 8[e], which recites that the DSP "processes the sound for the image with far-field head-related transfer functions (HRTFs) while the electronic device is located at the near-field distance from the head of the user," Petitioner argues that a person of ordinary skill in the art "would have known and understood" Finnegan to process sound with

far-field HRTFs because its study used binaural headphones and SoundScape Renderer (SSR) software, which used HRTFs "to reproduce [a] soundfield at the listener['s] ears." *Id.* at 17–18 (quoting Ex. 1029, 3 ("Ahrens"); citing Ex. 1005, 2, 6; Ex. 1003 ¶¶ 237–241) (first alteration in original). Patent Owner responds that Petitioner's argument, and Dr. Roginska's supporting testimony, are conclusory. Prelim. Resp. 19–22. At this stage, we have questions as to whether Finnegan alone teaches or suggests limitation 8[e]. The only supporting evidence cited by Petitioner and Dr. Roginska for how SSR software works, Ahrens, merely discloses the use of HRTFs in general and states that "[a] pair of HRTFs is chosen depending on the position of the virtual sound source." *See* Ex. 1029, 3–4; Pet. 18; Ex. 1003 ¶ 240.

Petitioner, however, makes an alternative argument relying on the combined teachings of Finnegan and Begault. Pet. 18. As explained above, Finnegan's incongruent sound was positioned at far-field distances from the user, even though the associated image was displayed at a near-field distance. *Id.* (referring to Petitioner's earlier analysis of limitation 8[c] and citing Ex. 1003 ¶ 241 ("[T]he 3D sounds Finnegan generated to users were positioned at far-field distances.")). Petitioner points out that Begault teaches "using DSPs to process HRTFs to spatialize sound" and, specifically, the use of well-known KEMAR database far-field HRTFs (e.g., measured at "1.4 meters" away). *Id.* (citing Ex. 1006, 41, 99–101, 118–119, 205); *see also id.* at 7–8, 13–14 (describing the alleged motivation to modify Finnegan's system to use Begault's DSP processing of HRTFs).

Patent Owner makes two arguments in response. First, Patent Owner argues that "Petitioner fails to point to any passage from Begault that discloses, teaches, or suggests use of far-field HRTFs to move a virtual

sound source located in a near-field to a far-field location behind the virtual image source, as claimed," and "fails to offer any evidence showing that any . . . uses of KEMAR's HRTFs [as disclosed in Begault] were similar to how the claim limitation uses far-field HRTFs." Prelim. Resp. 23–24 (emphasis omitted) (citing Ex. 2006 ¶ 24). We disagree on this record, as Petitioner is relying on the combined teachings of Finnegan and Begault—Finnegan for its teaching of an image displayed at a near-field distance but sound processed at an incongruent far-field distance, and Begault for its teaching of DSPs using far-field HRTFs to spatialize sound—not Begault individually. *See* Pet. 18; *Bradium*, 923 F.3d at 1050 ("A finding of obviousness . . . cannot be overcome 'by attacking references individually where the rejection is based upon the teachings of a combination of references.'"); *In re Mouttet*, 686 F.3d 1322, 1333 (Fed. Cir. 2012) (holding that "the test for obviousness is what the combined teachings of the references would have suggested to those having ordinary skill in the art").

Second, Patent Owner asserts that Begault teaches away from the claimed arrangement, citing the following statement in Begault: "Changing HRTF spectra as a function of head movement is generally considered to improve overall localization performance. It does not necessarily follow that virtual source movement will improve performance." Prelim. Resp. 24–25 (quoting Ex. 1006, 99) (emphasis omitted). Patent Owner argues that based on Begault, a person of ordinary skill in the art would not think that the "use of far-field HRTFs to move a near-[field] virtual sound source to a far-field location behind the virtual image source (i.e., incongruent placement) would be workable." *Id.* at 24 (citing Ex. 2006 ¶¶ 24–25).

> A reference teaches 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" in the claim. A reference that "merely expresses a general preference for an alternative invention but does not criticize, discredit, or otherwise discourage investigation into" the claimed invention does not teach away.

Meiresonne v. Google, Inc., 849 F.3d 1379, 1382 (Fed. Cir. 2017) (citations omitted). On this record, we find Begault's statement to be too ambiguous to constitute teaching away. It is unclear, for example, what is meant by "virtual source movement." The second sentence also merely states that it does not "necessarily" follow that such movement would improve performance. And, although he is the author of the reference, Dr. Begault does not provide any further detail as to what the above statement means, simply repeating what is in the Preliminary Response. *Compare* Ex. 2006 ¶ 25, *with* Prelim. Resp. 24. Petitioner has made a sufficient showing at this stage with respect to limitation 8[e], but the parties are encouraged to address the statement in Begault in their papers during trial.

We are persuaded, based on the current record, that Petitioner has shown a reasonable likelihood of prevailing on its assertion that claim 8 is unpatentable over Finnegan and Begault. Accordingly, we institute review "on all of the challenged claims and on all grounds of unpatentability asserted for each claim" and need not determine at this time whether Petitioner's arguments based on Finnegan alone are sufficient. *See* 37 C.F.R. § 42.108(a).

4. Claims 9, 10, and 15–17

Independent claim 15 recites "a display that displays an image that is located within a near-field distance from a head of a user viewing the image" (similar to limitation 8[a])[7] and one or more processors that process sound with HRTFs to generate binaural sound "that has a sound localization point (SLP) with a coordinate location that occurs at a far-field distance located behind the image and along a line-of-sight from the user to the image while the display displays the image to the user at the near-field distance" (similar to limitation 8[c]). The parties refer to their earlier arguments regarding limitations 8[a] and 8[c], which we address above. *See* Pet. 21–22; Prelim. Resp. 25–26; *supra* Section II.E.3. Patent Owner does not argue challenged dependent claims 9, 10, 16, and 17 separately. Prelim. Resp. 26. Petitioner's contentions regarding the combination of Finnegan and Begault are supported by the testimony of Dr. Roginska and are persuasive based on the current record. *See* Pet. 19–25; Ex. 1003 ¶¶ 247–277. On this record, we are persuaded that Petitioner has shown a reasonable likelihood of prevailing on its assertion that claims 9, 10, and 15–17 are unpatentable over Finnegan and Begault, and need not determine at this time whether Petitioner has made a sufficient showing based on Finnegan alone.

[7] We note that unlike claim 8, which recites displaying an image that "occurs within" a near-field distance from the user's head, claim 15 recites displaying an image that "is located within" a near-field distance from the user's head. Accordingly, Patent Owner's arguments regarding the "occurs within" phrasing do not necessarily apply to claim 15. *See* Prelim. Resp. 11–12. The parties are encouraged to address the meaning of each claim's language during trial.

F. Obviousness Grounds Based on Shivappa, and Shivappa and Zhou (Claims 8–10 and 15–17)

Petitioner contends that claims 8–10 and 15–17 are unpatentable over Shivappa, alone or in combination with Zhou, under 35 U.S.C. § 103, and Patent Owner responds. *See* Pet. 48–64; Prelim. Resp. 40–52. We are persuaded that Petitioner has established a reasonable likelihood of prevailing on its asserted ground based on Shivappa and Zhou as to claims 8–10 and 15–17.[8]

1. Shivappa

Shivappa discloses "[s]ystems, devices, and methods for generating spatialized audio signals based on predicted position data." Ex. 1010, col. 2, ll. 65–66.

[8] Petitioner provides evidence, unchallenged by Patent Owner in its Preliminary Response, that Zhou is a prior art printed publication under 35 U.S.C. § 102(a). *See* Pet. 50 (citing Ex. 1012 ¶¶ 102–127). Based on the record at this time, Petitioner has shown a reasonable likelihood that the reference is prior art. *See Hulu*, Paper 29 at 13, 21.

Figure 1 of Shivappa is reproduced below.

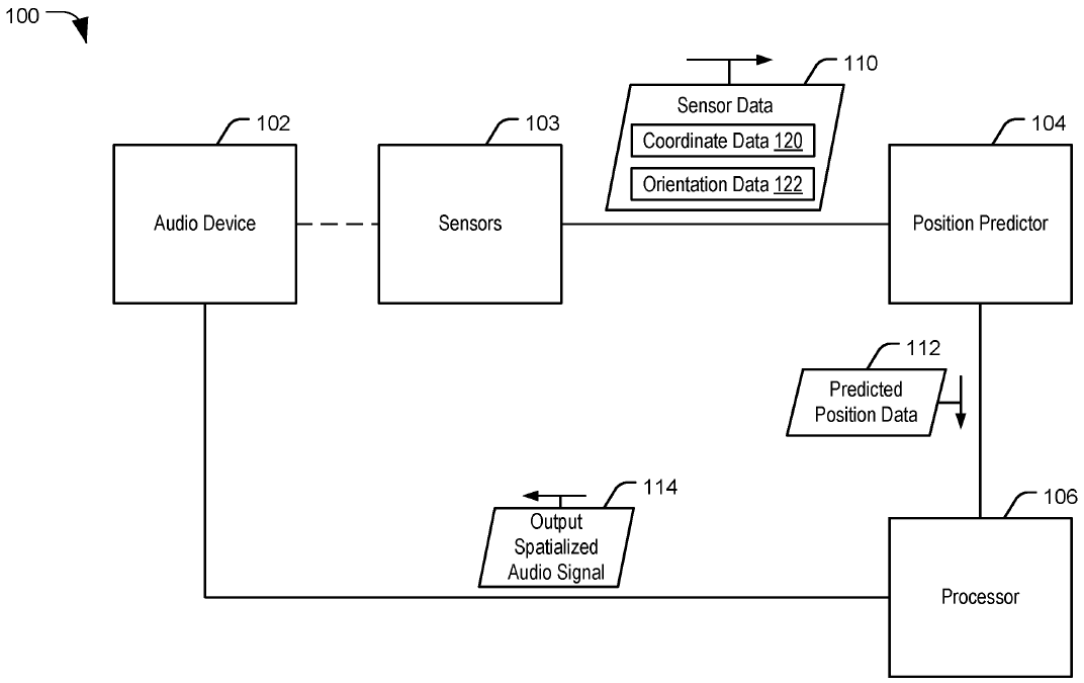

FIG. 1A

Figure 1 depicts audio processing device 100 comprising audio device 102, sensors 103 that determine sensor data 110 (e.g., position data) indicating "a location and an orientation of the audio device 102," position predictor 104 that generates predicted position data 112 based on the position data, and processor 106 that generates output spatialized audio signal 114 "for use in generating an audio output (e.g., an auditory sound)." *Id.* at col. 5, l. 6–col. 8, l. 11. "[A]udio device 102 includes (or is integrated within) a head mounted display (HMD) of a virtual reality (VR) system or an augmented reality (AR) system," which "may include headphones for playing audio in addition to a display screen for displaying visual information." *Id.* at col. 5, ll. 37–42. Processor 106 may be a DSP. *Id.* at col. 27, l. 63–col. 28, l. 5, col. 29, ll. 1–12, Fig. 7 (element 710).

Shivappa discloses that "spatialized audio signals may be rendered using three-dimensional (3D) rendering techniques to cause the audio device 102 to output the auditory sounds." *Id.* at col. 3, ll. 19–31, col. 5, ll. 25–28. "Due to the 3D rendering, a user may perceive the auditory sound as being in 3D, which may enable the user to perceive direction, distance, or both of one or more sound sources corresponding to the auditory sound." *Id.* at col. 5, ll. 30–34. "For example, a user may perceive a sound of a door opening to their right (but not to their left) for an auditory sound of an opening door." *Id.* at col. 5, ll. 34–36. Also, the visual and audio output of the device "may change based on movement of the user (e.g., movement of the user's head)." *Id.* at col. 5, ll. 45–48. "For example, the user may be listening to a concert and may perceive a flute to be playing to the left. If the user turns to the left, the sound may change such that the user perceives the flute to be playing from in front of the user." *Id.* at col. 6, ll. 7–11. The 3D sound rendering in Shivappa may encompass a number of techniques, such as performing "binauralization" by "convolving the audio data . . . with . . . head related transfer functions (HRTFs)." *Id.* at col. 7, l. 60–col. 8, l. 4, col. 23, ll. 46–52, col. 24, ll. 49–57.

Shivappa describes the general operation of the device as follows:

> The audio processing device may determine predicted position data that indicates a predicted position of the audio device (or the user) at a particular (e.g., future) time based on the position data. For example, the audio processing device may store historical position data, and the position data and the historical position data may be analyzed to determine a velocity, an estimated trajectory, or another indication of a predicted movement path. The predicted position data may indicate a predicted position along the predicted movement path (e.g., the trajectory) at a particular time. The particular time may be selected to account

> for a latency (e.g., a delay) associated with processing spatialized audio signals.

Id. at col. 3, ll. 1–13.

2. Zhou

Zhou describes the results of a study on "the effectiveness of 3D sound in the AR context," including "the impact of 3D sound on depth perception in a single-camera AR environment." Ex. 1011, 989.[9] The authors conducted two experiments with human subjects using a HMD with an AR display. *Id.* at 989, 994. "In the first scenario, one participant must use vision only and vision with 3D sound to judge the relative depth of augmented virtual objects. In the second scenario, two participants must co-operate to perform a joint task in a game-based AR environment." *Id.* at 989. Zhou discloses that "[e]xact spatial 3D sound in virtual and augmented environments requires perceptual externalization of the sound source, which can only be brought about by using head related transfer functions (HRTFs)." *Id.* at 991. The experiment generated 3D sound using open source software, namely "OpenAL . . . applying HRTFs." *Id.* at 994, 1013. Various AR markers were placed in the image displayed to the user so that the user could determine their perceived depth in the scene. *Id.* at 994–995. "In [the] first experiment the sound sources [were] always placed around 1.5 m away in the front of the listener." *Id.* at 993. In the second experiment, the listener could move freely in a "3 meter by 3 meter space" and those movements were tracked with a motion tracking system. *Id.* at 993, 997–998, 1006–1007, Figs. 9–11.

[9] Consistent with the parties' usage, when referencing pages of Zhou, we refer to the original page numbering at the top corners of the reference.

Figure 1 of Zhou is reproduced below.

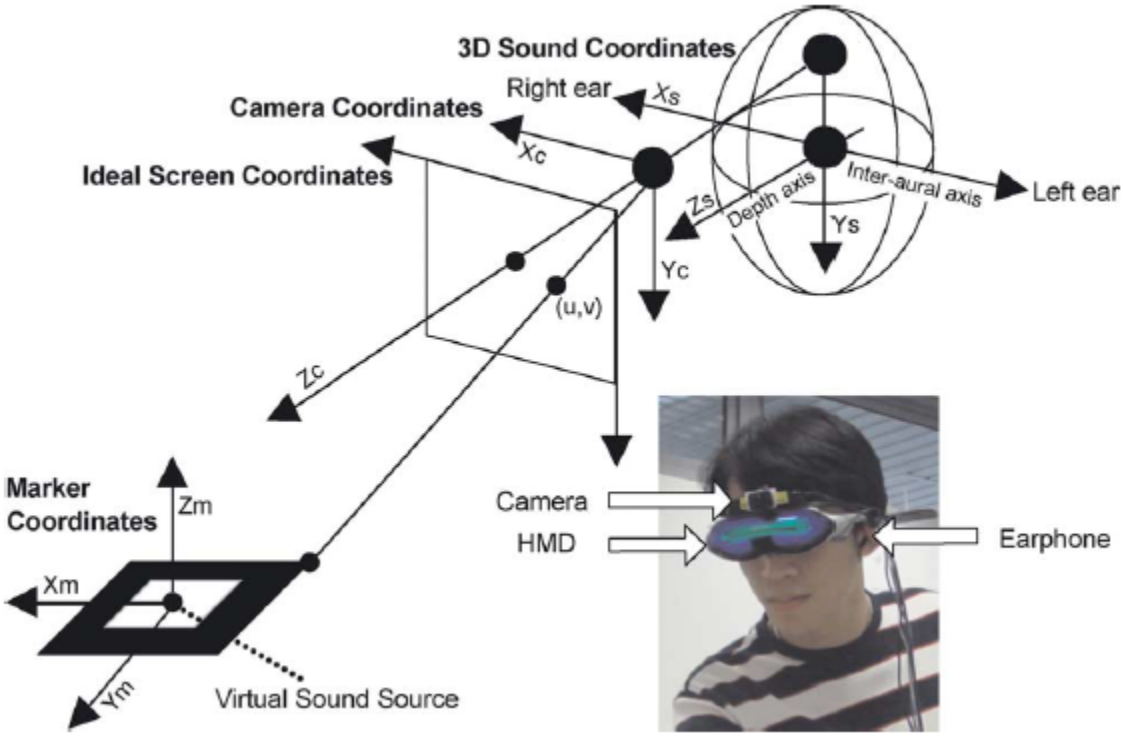

Figure 1 depicts "the physical setting of [the] single camera system where [a] camera is mounted to the front of [the] HMD and 3D sound plays back into the earphones," along with the method of placing the virtual marker in the image displayed to the user. *Id.* at 995.

3. Claim 8

Petitioner argues that Shivappa, alone or in combination with Zhou, teaches the limitations of claim 8. Pet. 48–58. With respect to the preamble, Petitioner contends that Shivappa's audio device 102 with a HMD is an "electronic device." *Id.* at 52. Patent Owner does not dispute Petitioner's arguments regarding the preamble of claim 8.

With respect to limitation 8[a], "a display that displays an image that occurs within a near-field distance from a head of a user," Petitioner contends, consistent with its co-location argument regarding Finnegan, that

a person of ordinary skill in the art would have understood Shivappa's HMD to display images on its lenses well within one meter of the user's head, i.e., "within a near-field distance from a head of a user." *Id.* at 52–53 (citing Ex. 1010, col. 5, ll. 37–53, col. 27, ll. 23–25, col. 28, ll. 25–26, Figs. 2 (depicting the HMD worn on the user's head), 7). Patent Owner repeats its disagreement with Petitioner's co-location argument[10] and contends that Petitioner has no alternative argument based on distance to a "perceived image," as it does for the Finnegan-based grounds. Prelim. Resp. 42–43 (emphasis omitted).

With respect to limitations 8[b] and 8[d], which recite "one or more processors that process sound for the image" and "include a digital signal processor (DSP)," Petitioner argues that Shivappa teaches a processor, which may be a DSP, that performs 3D sound rendering using binauralization and HRTFs, and displays associated virtual images. Pet. 53–54. Patent Owner does not dispute Petitioner's arguments regarding limitations 8[b] and 8[d].

With respect to limitation 8[c], which recites that the one or more processors "generate binaural sound that has a sound localization point (SLP) with a coordinate location that occurs at a far-field distance located behind the image and along a line-of-sight from the user to the image while the display displays the image to the user at the near-field distance," Petitioner argues that Shivappa teaches "virtual images and associated binaural sounds . . . and [a person of ordinary skill in the art] would have known these sounds could and would be located at SLPs with coordinate

[10] Patent Owner refers to this argument multiple times in addressing the asserted grounds. *See* Prelim. Resp. 42–43, 45–46, 50–51.

locations occurring at far-field distances" (i.e., distances greater than or equal to 1 meter), pointing to Shivappa's descriptions of displaying, for example, a "door opening," "person speaking during a teleconference," and "vehicle making noise in a virtual reality video game." *Id.* at 55–56 (quoting Ex. 1010, col. 5, ll. 30–36, col. 8, ll. 42–47). According to Petitioner, an ordinarily skilled artisan "would have understood that Shivappa's binaural sounds would (or obviously would) occur (i) behind associated images presented at near-field distances on Shivappa's HMDs' lenses" and "(ii) along a user's line of sight because the user can look in the direction of the binaural source and its associated image." *Id.* at 56 (citing Ex. 1010, col. 3, ll. 14–31, col. 5, ll. 42–54, col. 24, ll. 49–53). Patent Owner responds that Petitioner's arguments, and Dr. Roginska's supporting testimony, are conclusory, and Shivappa never states expressly that the disclosed sounds (e.g., of a door opening) "should be localized in the far-field." Prelim. Resp. 43–45. At this stage, given the limited description in the reference, we have questions as to whether Shivappa alone teaches or suggests limitation 8[c].

Petitioner, however, makes an alternative argument relying on the combined teachings of Shivappa and Zhou. Pet. 56–57. Petitioner argues:

> Zhou taught "generat[ing] 3D sound," i.e., binaural sound, using open source SDKs that incorporated HRTFs from available databases, and Zhou disclosed positioning binaural sound at far-field distances while associated images were located at near-field distances—namely, on the lenses of an HMD. For example, in its first experiment, Zhou's SDK applied HRTFs to place binaural sounds "around 1.5 m away" from a listener, which is a far-field distance, along the listener's line of sight and while images associated with the sound sources were presented to the listener on the lenses of Zhou's HMD, i.e., at a near-field distance. Similarly, in a second experiment, Zhou tracked co-players "walk[ing] around in a three by three meter region," and placed binaural sounds at the locations of those co-players'

> controllers (their "wands"). [A person of ordinary skill in the art] would have known that such co-players could and would be separated by distances of one meter or more, i.e., far-field distances, in a nine square meter play area. Thus, in this scenario as well, binaural sounds (e.g., the "buzz" of a co-player's airplane) would be positioned at far-field distances (on co-player wands separated by a meter or more) while images were positioned at near-field distances (e.g., the image of an airplane on the lenses of a first co-player's HMD), including while co-players were in each other's lines of sight.

Id. (citations omitted, first two alterations in original). Petitioner further contends that Figure 1 of Zhou, reproduced above, shows the "required configuration of an SLP behind an image along a user's line of sight." *Id.* at 57. According to Petitioner, a person of ordinary skill in the art would have been motivated to combine Shivappa's system that "process[es] HRTFs to produce binaural sound" with "Zhou's teachings of using spatialized 3D audio in AR and VR settings" to improve the user's experience. *Id.* at 51–52. Specifically, an ordinarily skilled artisan would have been motivated to "implement [Zhou's] sound processing using the configurations of far-field SLPs and near-field images" in Shivappa's system to "improve depth perception and enable a more realistic environment and immersive feeling." *Id.* at 58.

Patent Owner makes two arguments in response. First, Patent Owner asserts that Zhou uses a "single camera system [that] allows only for monocular vision, thereby eliminating important cues to visual depth perception," whereas claim 8 recites "a distance to the location of *a perceived image* in the virtual world" and a display that "necessarily provides [a] user with important cues to visual depth perception." Prelim. Resp. 47–48 (citing Ex. 2006 ¶ 32; Ex. 2008 ¶¶ 22, 33–34). As explained above, though, we do not read the "near-field distance" recited in claim 8 as

being the distance to a "perceived image," but rather the distance to the electronic device where the image is displayed to the user. *See supra* Section II.E.3. Patent Owner further contends that a person of ordinary skill in the art "would have had no expectation of success adopting Zhou's HMD to arrive at [limitation 8[c]] because it is well-known in the art that experiments in monocular vision are not applicable to stereo vision head-mounted displays." Prelim. Resp. 47–48 (citing Ex. 1041, 4; Ex. 2006 ¶ 32; Ex. 2008 ¶¶ 33–34). In Petitioner's asserted combination, however, Petitioner relies on Shivappa for the basic components of the system, including the display that displays an image at a near-field distance, and relies on Zhou for the feature recited in limitation 8[c] of placing the SLP for the binaural sound at a far-field distance "behind" the image and along a "line-of-sight" of the user. *See* Pet. 52–53, 56–58. Thus, Petitioner relies on Shivappa's HMD, not Zhou's HMD as Patent Owner contends. *See* Ex. 1010, col. 3, ll. 19–31 (disclosing that Shivappa's VR or AR system allows the user to play a game where a moving car is displayed), col. 5, ll. 42–48 (the system "provide[s] interactive content, such as video games," and "[t]he visuals . . . output by the virtual reality system may change based on movement of the user (e.g., movement of the user's head)"), Fig. 2.

Second, Patent Owner argues that "Petitioner mischaracterizes Zhou, for Zhou does not render a sound behind the virtual image presented to the user." Prelim. Resp. 48–49. Patent Owner contends that Zhou's HMD displays the user's environment captured by the built-in camera with virtual objects (i.e., telephones) superimposed at various real-world markers in that environment, and positions the 3D sound such that it "appears to emanate from the marker." *Id.* (quoting Ex. 1011, 995; citing Ex. 1011, 996, 1000, 1001, Fig. 2; Ex. 2006 ¶ 31; Ex. 2008 ¶ 32) (emphasis omitted). Therefore,

according to Patent Owner, "Zhou does not disclose rendering a binaural sound at a far-field distance from the listener for and behind an image presented to the listener in the near-field, because the audio and visual components of the virtual object are co-located." *Id.* at 49. Patent Owner's argument is premised on Petitioner's co-location argument being incorrect. In other words, Patent Owner reads the "near-field distance" of claim 8 as being the distance to the image as perceived by the user, not the distance to the electronic device that displays it. On this record, we agree with Petitioner that claim 8 recites the latter, given the language of limitations 8[c] and 8[e]. *See supra* Section II.E.3.

Finally, with respect to limitation 8[e], which recites that the DSP "processes the sound for the image with far-field head-related transfer functions (HRTFs) while the electronic device is located at the near-field distance from the head of the user," Petitioner argues that Shivappa teaches "using a DSP to process sound for images, including to generate binaural sound," and Shivappa and Zhou render obvious "a DSP processing sound for images at far-field locations, which [a person of ordinary skill in the art] would have known could and would be rendered with far-field HRTFs," as explained above in connection with limitation 8[c]. Pet. 58. Patent Owner contends that Petitioner's arguments are conclusory. Prelim. Resp. 50–51. We disagree on this record, given Petitioner's detailed explanation regarding the combined teachings of Shivappa and Zhou discussed above in connection with limitation 8[c]. Petitioner has made a sufficient showing at this stage with respect to limitation 8[e].

We are persuaded, based on the current record, that Petitioner has shown a reasonable likelihood of prevailing on its assertion that claim 8 is

unpatentable over Shivappa and Zhou, and need not determine at this time whether Petitioner's arguments based on Shivappa alone are sufficient.

4. Claims 9, 10, and 15–17

With respect to limitations 15[a] and 15[d], the parties refer to their earlier arguments regarding limitations 8[a] and 8[c], which we address above. *See* Pet. 60–61; Prelim. Resp. 51–52; *supra* Section II.F.3. Patent Owner does not argue challenged dependent claims 9, 10, 16, and 17 separately. Prelim. Resp. 52. Petitioner's contentions regarding the combination of Shivappa and Zhou are supported by the testimony of Dr. Roginska and are persuasive based on the current record. *See* Pet. 59–64; Ex. 1003 ¶¶ 406–430. On this record, we are persuaded that Petitioner has shown a reasonable likelihood of prevailing on its assertion that claims 9, 10, and 15–17 are unpatentable over Shivappa and Zhou, and need not determine at this time whether Petitioner has made a sufficient showing based on Shivappa alone.

G. Obviousness Grounds Based on Norris and Combinations with Norris (Claims 8–17)

Petitioner contends, under 35 U.S.C. § 103, that claims 8–10 and 13–17 are unpatentable over Norris;[11] claims 8–10 and 13–17 are unpatentable over Norris, Begault, and Algazi; claims 11 and 12 are unpatentable over Norris and Sauk; and claims 11 and 12 are unpatentable over Norris, Begault, Algazi, and Sauk. Pet. 25–47. Patent Owner responds. Prelim. Resp. 26–40. As explained above, we are persuaded, based on the

[11] Norris is the subject of another petition filed by Petitioner in Case IPR2023-01003.

current record, that Petitioner has shown a reasonable likelihood of prevailing on two of the grounds asserted in the Petition. Accordingly, we institute review "on all of the challenged claims and on all grounds of unpatentability asserted for each claim." *See* 37 C.F.R. § 42.108(a). To provide guidance to the parties regarding the Norris-based grounds, however, we note the following.

Many of Patent Owner's arguments are premised on its disagreement with Petitioner's co-location argument. For example, Patent Owner contends that Petitioner's arguments regarding limitations 8[a], 8[c], and 8[e] are based on its "misconception that [claim 8] requires co-location of the display and the image" and Norris does not teach a near-field distance to the location of a "perceived image" in a virtual space. *See* Prelim. Resp. 28–31, 37 (emphasis omitted). We disagree with Patent Owner on that issue based on the current record, for the reasons explained above. *See supra* Section II.E.3. The difference in how the parties read claim 8 also appears to be reflected in the parties' arguments regarding Figure 20 of Norris. Petitioner contends that the image is displayed at a near-field distance on the wearable electronic device (WED) and the SLP is at a far-field distance "behind the image on the lenses," whereas Patent Owner argues that the SLP occurs at the "virtual," perceived image, not behind that image as the claim requires. *See* Pet. 32–34; Prelim. Resp. 33–34. The parties are encouraged to address the issue in detail during trial.

III. CONCLUSION

Based on the arguments presented in the Petition, we conclude that Petitioner has demonstrated a reasonable likelihood of prevailing with respect to at least one claim of the '836 patent challenged in the Petition.

Accordingly, we institute a trial on all claims and all grounds asserted in the Petition. The Board has not made a final determination under 35 U.S.C. § 318(a) with respect to the patentability of the challenged claims.

IV. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that, pursuant to 35 U.S.C. § 314(a), an *inter partes* review of claims 8–17 of the '836 patent is instituted with respect to all grounds set forth in the Petition; and

FURTHER ORDERED that, pursuant to 35 U.S.C. § 314(c) and 37 C.F.R. § 42.4(b), *inter partes* review of the '836 patent shall commence on the entry date of this Decision, and notice is hereby given of the institution of a trial.

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