

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

In re *Inter Partes* Review of:                   )  
U.S. Patent No. 10,448,184                        )  
Issued: Oct. 15, 2019                               )  
Application No.: 16/442,509                        )  
Filing Date: Jun. 16, 2019                        )

For: **Switching Binaural Sound**

**PETITION FOR *INTER PARTES* REVIEW  
OF U.S. PATENT NO. 10,448,184**

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## TABLE OF ABBREVIATIONS

| Term                                | Abbreviation |
|-------------------------------------|--------------|
| one-dimensional                     | 1D or 1-D    |
| three-dimensional                   | 3D or 3-D    |
| two-dimensional                     | 2D or 2-D    |
| six degrees of freedom              | 6DoF         |
| digital-to-audio converter          | DAC          |
| digital signal processor            | DSP          |
| head mounted display                | HMD          |
| handheld portable electronic device | HPED         |
| head-related transfer function      | HRTF         |
| interaural level difference         | ILD          |
| interaural time difference          | ITD          |
| optical head mounted display        | OHMD         |
| sound localization point            | SLP          |
| sound localization system           | SLS          |
| virtual reality                     | VR           |
| wearable electronic device          | WED          |
| wearable electronic glasses         | WEG          |

**Exhibit List**

| <b>Exhibit</b> | <b>Description</b>                                             |
|----------------|----------------------------------------------------------------|
| 1001           | U.S. Patent No. 10,448,184 (“the ’184 Patent”)                 |
| 1002           | File History for U.S. Patent No. 10,448,184 (“’184 FH”)        |
| 1003           | Declaration of Dr. Agnieszka Roginska (“Roginska”)             |
| 1004           | <i>Curriculum Vitae</i> of Dr. Agnieszka Roginska              |
| 1005           | U.S. Patent No. 9,690,374 (“Clement”)                          |
| 1006           | U.S. Patent No. 9,037,468 (“Osman”)                            |
| 1007           | U.S. Patent No. 7,876,903 (“Sauk”)                             |
| 1008           | U.S. Patent Application Publication No. 2017/0188168 (“Lyren”) |
| 1009           | U.S. Patent Application Publication No. 2018/0373412 (“Reif”)  |
| 1010           | U.S. Patent Application Publication No. 2011/0206209 (“Ojala”) |
| 1011           | U.S. Patent No. 1,624,486 (“Fletcher”)                         |
| 1012           | U.S. Patent No. 1,855,149 (“Jones”)                            |
| 1013           | U.S. Patent No. 7,330,197 (“Kobayashi”)                        |
| 1014           | U.S. Patent No. 7,710,654 (“Ashkenazi”)                        |
| 1015           | U.S. Patent No. 8,520,872 (“Jang”)                             |
| 1016           | U.S. Patent No. 8,520,873 (“Mahabub”)                          |
| 1017           | U.S. Patent No. 9,041,622 (“McCulloch”)                        |
| 1018           | U.S. Patent No. 9,367,811 (“Ramachandran”)                     |
| 1019           | U.S. Patent No. 9,544,706 (“Hirst”)                            |
| 1020           | U.S. Patent No. 9,578,440 (“Otto”)                             |
| 1021           | U.S. Patent No. 9,674,507 (“Pirchheim”)                        |
| 1022           | RESERVED                                                       |
| 1023           | U.S. Patent No. 9,767,618 (“Najaf-Zadeh”)                      |
| 1024           | RESERVED                                                       |
| 1025           | U.S. Patent No. 10,070,239 (“Romigh”)                          |
| 1026           | RESERVED                                                       |

| Exhibit | Description                                                                                                                                                                                                                                                         |
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| 1027    | U.S. Patent No. 10,095,031 (“Katz”)                                                                                                                                                                                                                                 |
| 1028    | File History for U.S. Patent Application 16/106,140                                                                                                                                                                                                                 |
| 1029    | U.S. Patent No. 10,509,466 (“Miller”)                                                                                                                                                                                                                               |
| 1030    | U.S. Patent Application Publication No. 2012/0183161 (“Agevik”)                                                                                                                                                                                                     |
| 1031    | U.S. Patent Application Publication No. 2016/0124502 (“Sawyer”)                                                                                                                                                                                                     |
| 1032    | U.S. Patent Application Publication No. 2016/0292924 (“Balachandreswaran”)                                                                                                                                                                                          |
| 1033    | U.S. Patent Application Publication No. 2017/0105083 (“Nair”)                                                                                                                                                                                                       |
| 1034    | U.S. Patent Application Publication No. 2017/0115488 (“Ambrus”)                                                                                                                                                                                                     |
| 1035    | Korean Patent Application Publication No. KR 10-2011-0022252, including English Translation and Certification (“Moon”)                                                                                                                                              |
| 1036    | Christoph Anthes et al., <i>State of the Art of Virtual Reality Technology</i> , 2016 IEEE Aerospace Conf. 1-19 (Mar. 2016) (“Anthes”)                                                                                                                              |
| 1037    | <i>Average Cost of RAM per Gigabyte Chart</i> , HumanProgress (“HumanProgress”)                                                                                                                                                                                     |
| 1038    | Durand R. Begault, <i>3-D Sound for Virtual Reality and Multimedia</i> (NASA/TM-2000-209606) (Aug. 2000) (“Begault”)                                                                                                                                                |
| 1039    | Tom Emrich, <i>Virtual Reality North: A Look at the Major VR Players in Canada</i> , betakit.com (July 15, 2015), betakit.com/virtual-reality-north-a-look-at-the-major-vr-players-in-canada/ (“Emrich”)                                                            |
| 1040    | Braxton Boren, <i>History of 3D Sound</i> (Am. Univ., Wash. D.C. 2018), <a href="https://dra.american.edu/islandora/object/auislandora%3A77787/datastream/PDF/view">https://dra.american.edu/islandora/object/auislandora%3A77787/datastream/PDF/view</a> (“Boren”) |

| Exhibit | Description                                                                                                                                                                                                                                                        |
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| 1041    | Douglas S. Brungart et al., <i>The Interaction Between Head-Tracker Latency, Source Duration, and Response Time in the Localization of Virtual Sound Sources</i> , Proc. ICAD 04- 10th Meeting Int’l Conf. Auditory Display 1-7 (July 6-9, 2004) (“Brungart 2004”) |
| 1042    | Douglas S. Brungart et al, <i>The Detectability of Headtracker Latency in Virtual Audio Displays</i> , Proc. ICAD 05-11th Meeting Int’l Conf. Auditory Display 37-42 (July 6-9, 2005) (“Brungart 2005”)                                                            |
| 1043    | E. Colin Cherry, <i>Some Experiments on the Recognition of Speech, with One and with Two Ears</i> , 25 J. ACOUSTICAL SOC’Y AM. 975 (1953) (“Cherry”)                                                                                                               |
| 1044    | Christof Faller, <i>Coding of Spatial Audio Compatible with Different Playback Formats</i> , AES 117th Convention 1-12 (Oct. 28-31, 2004) (“Faller”)                                                                                                               |
| 1045    | Mohammad Dashti et al., <i>Traffic Management: A Holistic Approach to Memory Placement on NUMA Systems</i> , ASPLOS 1-13 (Mar. 16-20, 2013) (“Dashti”)                                                                                                             |
| 1046    | S.S. Fisher et al., <i>Virtual Interface Environment Workstations</i> , 32 Proc. Hum. Factors Soc’y 32nd Ann. Meeting–1988 91-95 (Feb. 1988) (“Fisher”)                                                                                                            |
| 1047    | Wolfgang Fohl et al., <i>A System-On-Chip Platform for HRTF-Based Realtime Spatial Audio Rendering With an Improved Realtime Filter Interpolation</i> , 4 INT’L J. ADVANCES INTELLIGENT SYS. 309 (2011) (“Fohl”)                                                   |
| 1048    | Mats Liljedahl, <i>Sound for Fantasy and Freedom in GAME SOUND TECHNOLOGY AND PLAYER INTERACTION: CONCEPTS AND DEVELOPMENTS</i> 22 (Mark Grimshaw ed., 2011) (“Grimshaw”)                                                                                          |
| 1049    | Eric Growney & Agnieszka Roginska, <i>Effect of Spatial Audio Processing on Attention Redirection and Speech Intelligibility in Multi-Talker Communication</i> , AES 152nd Convention 1-10 (May 2022) (“Growney”)                                                  |
| 1050    | Maxim Liadov, <i>A New Generation of Xtreme Fidelity Processors and Sound Cards</i> , iXBT Labs (Aug. 22, 2005) (“Liadov”)                                                                                                                                         |

| Exhibit | Description                                                                                                                                                                                            |
|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1051    | JESSE SCHELL, <i>THE ART OF GAME DESIGN: A BOOK OF LENSES</i> (2008) (“Schell”)                                                                                                                        |
| 1052    | Christoph Lameter, <i>Local and Remote Memory: Memory in a Linux/NUMA System</i> , SGI (June 20, 2006) (“Lameter 2006”)                                                                                |
| 1053    | Christoph Lameter, <i>NUMA (Non-Uniform Memory Access): An Overview</i> , ACMqueue 1-12 (2013) (“Lameter 2013”)                                                                                        |
| 1054    | Matteo Marucci et al., <i>The Impact of Multisensory Integration and Perceptual Load in Virtual Reality Settings on Performance, Workload and Presence</i> , 11 NATURE SCI. REPS. 1 (2021) (“Marucci”) |
| 1055    | Joel D. Miller et al., <i>Latency Measurements of a Real-Time Virtual Acoustic Environment Rendering System</i> , Proc. 2003 Int’l Conf. Auditory Display 111-114 (July 6-9, 2003) (“Miller”)          |
| 1056    | Francisco Cheng, <i>Mobile Processors 101: Why Smartphones are Smarter with an All-In-One Processor</i> , QUALCOMM ONQ BLOG (June 12, 2013) (“Cheng”)                                                  |
| 1057    | Masayuki Morimoto & Yoichi Ando, <i>On the Simulation of Sound Localization</i> , (E) 1 J. ACOUSTIC SOC’Y JAPAN 167 (1980) (“Morimoto”)                                                                |
| 1058    | RESERVED                                                                                                                                                                                               |
| 1059    | Stephan Paul, <i>Binaural Recording Technology: A Historical Review and Possible Future Developments</i> , 95 ACTA ACUSTICA UNITED WITH ACUSTICA 767 (2009) (“Paul”)                                   |
| 1060    | Ben Kuchera, <i>Google Cardboard Adds ‘Inexpensive’ Spatial Audio to its SDK</i> , POLYGON (Jan. 13 2016, 12:00pm PST) (“Kuchera”)                                                                     |
| 1061    | Paul Sauk & Duane Satorius, <i>Creating a Multi-Dimensional Communication Space to Improve the Effectiveness of 3-D Audio</i> , IEEE Military Comm’cns Conf. 1-7 (Oct. 29-31, 2007) (“Sauk 2007”)      |
| 1062    | Mel Slater & Martin Usoh, <i>Presence in Immersive Virtual Environments</i> , IEEE Virtual Reality Ann. Int’l Symp. 90-96 (Sept. 18-22, 1993) (“Slater”)                                               |

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| 1063    | Jaka Sodnik & Sašo Tomažič, <i>Spatial Auditory Human-Computer Interfaces</i> , SPRINGER BRIEFS COMPUT. SCI. (2015) (“Sodnik”)                                                                                                                                                                                                                               |
| 1064    | Paul James, <i>Sulon Cortex ‘Augmented Virtual Reality’ Headset, Interview with Don Henderson</i> , ROAD TO VR (Feb. 5, 2015) (“James”)                                                                                                                                                                                                                      |
| 1065    | Mona Lalwani, <i>Surrounded by Sound: How 3D Audio Hacks Your Brain</i> , THE VERGE (Feb. 12, 2015, 10:30am) <a href="https://www.theverge.com/2015/2/12/8021733/3d-audio-3dio-binaural-immersive-vr-sound-times-square-new-york">https://www.theverge.com/2015/2/12/8021733/3d-audio-3dio-binaural-immersive-vr-sound-times-square-new-york</a> (“Lalwani”) |
| 1066    | Dave Smith, <i>Three-Dimensional Audio Makes Virtual Reality So Much Better It’s Crazy</i> , BUS. INSIDER (Apr. 3, 2015, 1:06 PM), <a href="https://www.businessinsider.com/virtual-reality-the-importance-of-3d-positional-audio-2015-4">https://www.businessinsider.com/virtual-reality-the-importance-of-3d-positional-audio-2015-4</a> (“Smith”)         |
| 1067    | JASON JERALD, <i>THE VR BOOK: PERCEPTION AND INTERACTION DESIGN FOR VIRTUAL REALITY</i> (2015) (“VR Book”)                                                                                                                                                                                                                                                   |
| 1068    | Elizabeth M. Wenzel et al., <i>Development of a Three-Dimensional Auditory Display System</i> , 20 SIGCHI BULL. 52 (Oct. 1988) (“Wenzel 1988a”)                                                                                                                                                                                                              |
| 1069    | Elizabeth M. Wenzel et al., <i>A Virtual Display System for Conveying Three-Dimensional Acoustic Information</i> , Proc. Hum. Factors Soc’y 32nd Ann. Meeting 86-90 (1988) (“Wenzel 1988b”)                                                                                                                                                                  |
| 1070    | RESERVED                                                                                                                                                                                                                                                                                                                                                     |
| 1071    | Elizabeth M. Wenzel et al., <i>Localization with Non-Individualized Virtual Acoustic Display Cues</i> , Proc. SIGCHI Conf. Hum. Factors Comput. Sys. 351-59 (Apr. 1991) (“Wenzel 1991”)                                                                                                                                                                      |
| 1072    | Elizabeth M. Wenzel, <i>Localization in Virtual Acoustic Displays</i> , 1 PRESENCE TELEOPERATORS VIRTUAL ENV’TS 80 (Feb. 1992) (“Wenzel 1992”)                                                                                                                                                                                                               |
| 1073    | Qualcomm, <i>What’s So Special About the Digital Signal Processor?</i> , QUALCOMM ONQ BLOG (Dec. 5, 2013) (“OnQ”)                                                                                                                                                                                                                                            |

| Exhibit | Description                                                                                                                                                                                 |
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| 1074    | Frederic L. Wightman & Doris J. Kistler, <i>Headphone Simulation of Free-Field Listening. II: Psychophysical Validation</i> , 85 J. ACOUSTIC SOC'Y AM. 868 (1989) ("Wightman")              |
| 1075    | Jiann-Rong Wu et al., <i>Head Motion and Latency Compensation on Localization of 3D Sound in Virtual Reality</i> , Proc. ACM Symp. Virtual Reality Software Tech. 15-20 (Sept. 1997) ("Wu") |
| 1076    | Dmitry N. Zotkin et al., <i>Customizable Auditory Displays</i> , PROC. 2002 Int'l Conf. Auditory Display 1-10 (July 2-5, 2002) ("Zotkin")                                                   |
| 1077    | Gr. Brit. Provisional Patent Specification No. 394,325 ("Blumlein")                                                                                                                         |
| 1078    | Linley Gwennap, <i>Qualcomm Extends Hexagon DSP</i> , MICROPROCESSOR REP. 1-4 (Aug. 26, 2013) ("Gwennap")                                                                                   |
| 1079    | Stanley P. Lipshitz, <i>Stereo Microphone Techniques.....Are the Purists Wrong?</i> 34 J. AUDIO ENG'G SOC'Y 716 (1986) ("Lipshitz")                                                         |
| 1080    | U.S. Patent No. 9,851,786 ("Pedrotti")                                                                                                                                                      |
| 1081    | U.S. Patent No. 9,787,846 ("Srinivasan")                                                                                                                                                    |
| 1082    | U.S. Patent Application Publication No. 2015/0094142 ("Stafford")                                                                                                                           |
| 1083    | U.S. Patent Application Publication No. 2019/0043259 ("Wang")                                                                                                                               |
| 1084    | Plaintiff's Second Supplemental Infringement Contentions, Exhibit 22, <i>Eight kHz, LLC v. Meta Platforms, Inc.</i> , No. 6:22-cv-00575 (W.D. Tex. Mar. 3, 2023)                            |
| 1085    | Oculus Connect 5 Spatial Audio for Oculus Quest and Beyond video clips (May 12, 2023)                                                                                                       |
| 1086    | Oculus Connect 5 Spatial Audio for Oculus Quest and Beyond video clip transcriptions (May 12, 2023)                                                                                         |
| 1087    | Oculus Connect 5 Keynote Day 01 video clips (May 16, 2023)                                                                                                                                  |
| 1088    | Oculus Connect 5 Keynote Day 01 video clip transcriptions (May 16, 2023)                                                                                                                    |

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| 1089    | Defendants’ Opening Claim Construction Brief, <i>Eight kHz, LLC v. Meta Platforms, Inc.</i> , No. 6:22-cv-00575 (W.D. Tex. Apr. 12, 2023), ECF No. 83                                                     |
| 1090    | Plaintiff’s Claim Construction Reply Brief, <i>Eight kHz, LLC v. Meta Platforms, Inc.</i> , No. 6:22-cv-00575 (May 3, 2023), ECF No. 92                                                                   |
| 1091    | Declaration of Durand R. Begault, Ph.D. in Support of Plaintiff’s Reply Claim Construction Brief, <i>Eight kHz, LLC v. Meta Platforms, Inc.</i> , No. 6:22-cv-00575 (W.D. Tex. May 3, 2023), ECF No. 92-7 |
| 1092    | Plaintiff’s Second Supplemental Infringement Contentions, Exhibit 23, <i>Eight kHz, LLC v. Meta Platforms, Inc.</i> , No. 6:22-cv-00575 (W.D. Tex. Mar. 3, 2023)                                          |
| 1093    | U.S. Patent No. 5,173,944 (“Begault ‘944”)                                                                                                                                                                |
| 1094    | U.S. Patent No. 5,438,623 (“Begault ‘623”)                                                                                                                                                                |
| 1095    | Deposition transcript of Durand Begault, Ph.D., <i>Eight kHz, LLC v. Meta Platforms, Inc.</i> , No. 6:22-cv-00575 (W.D. Tex. May 22, 2023) (“Begault Dep.”)                                               |

## **I. Introduction**

Petitioners Meta Platforms, Inc., Meta Platforms Technologies, LLC, and Twisted Pixel Games, LLC request *inter partes* review (“IPR”) of all claims of USP 10,448,184 (“’184 patent”) (Ex.1001). The Patentee of record is Eight kHz, LLC (“Patentee”).

The challenged claims are directed to wearable head mounted displays (HMDs) that provide binaural sound in a virtual environment using head-related transfer functions (HRTFs). “Binaural audio ... provide[s] the listener with a three dimensional virtual audio environment,” i.e., the user can perceive “sound[s] emanating from different spatial locations outside the listener’s head.” Sauk 1:15-21 (Ex.1007); ’184 patent 2:18-24. Binaural audio may be generated using HRTFs, which are based on how a listener’s ear receives sound from a certain point in space. HRTFs capture sound localization cues created by how sound reflects, diffracts, and is generally filtered by a person’s head, face, and external portions of the ears (“pinna”) based on the sound’s direction. Roginska (Ex.1003) ¶¶ 50-56. Binaural sound and HRTFs were known for decades before the priority date of the alleged inventions. *E.g.*, Sauk 1:15-49; Osman (Ex.1006) 4:6-5:39; Ex.1068 52-57; Ex.1069 86-90; Ex.1071 351-359; Roginska ¶¶ 49-65.

The ’184 patent claims also recite alerting the user when the user is leaving the virtual environment by, e.g., reducing the volume and/or the audio cues in the

binaural sound. But that, too, was known in the art long before the time of the alleged invention. *See, e.g.*, Clement (Ex.1005) 9:20-31, 12:66-13:10, Fig. 11 (reducing the volume); Sauk 11:26-40; Ex.1061 2-3; Roginska ¶¶ 70-73.

Untethered from the '184 patent specification, the challenged claims represent Patentee's effort to cover Petitioner's accused virtual reality (VR) system. Indeed, nothing in the specification provides any indication that Patentee possessed this alleged invention prior to the actual filing date of the '184 patent, on June 16, 2019. Its immediate parent application lacks sufficient disclosure of alerting a user when the user is leaving the environment. Its claims are therefore also unpatentable in view of an earlier publication in the same patent family (Lyren, Ex.1008) combined with additional teachings (in Reif, Ex.1009) regarding alerting users when they leave an environment.

Accordingly, the Board should institute review and find all challenged claims unpatentable.

## **II. Identification of Challenges (37 C.F.R. § 42.104(b))**

- **Ground 1:** Claims 1, 3-4, 6-10, and 14-19 are unpatentable under 35 U.S.C. § 103 over Clement (Ex.1005) with Osman (Ex.1006) and Sauk (Ex.1007).
- **Ground 2:** All claims are unpatentable under § 103 over Lyren (Ex.1008) with Reif (Ex.1009).

### **III. Background**

#### **A. Overview of the '184 Patent and the Technology**

The patent's claims relate to a HMD or other wearable electronic device (WED) that provides binaural sound using HRTFs to generate audio localized to a virtual image displayed by the HMD/WED. The device also warns the user when the user is leaving a virtual environment by reducing the volume and/or altering the processing of the binaural sound. '184 patent cl.1. None of this was new. Roginska ¶¶ 41-73.

#### **1. Head-Mounted Display**

HMDs at the time of the alleged invention already used displays and earphones to render 3D virtual environments, allowing users to move around in a virtual environment with six degrees of freedom (6DoF). Ex.1034 [0074]-[0078] (describing a “head tracking system that utilizes one or more motion sensors, such as sensors 708 on HMD device 700, to capture pose data and thereby enable position tracking, direction and orientation sensing, and/or motion detection of the user's head and/or HMD device 700.”); *see also* Ex.1017 8:17-39 (describing inertial sensors for tracking a HMD); Ex.1032 [0063], Fig. 5 (describing an HMD with inertial measurement or position tracking); Ex.1018 2:29-3:2 (describing HMDs with positioning sensors), 12:10-23 (describing visual mapping, localization, and tracking); Ex.1021 1:18-29 (describing systems for tracking the position and orientation), 3:18-52 (HMD with 6DoF head tracking); Ex.1027 Fig. 2, 5:16-23

(describing a VR headset with a mapping module); Osman 5:29-62 (describing tracking of ear position). HMDs at that time also tracked head movements to determine head orientation and gaze direction. Ex.1034 [0080]-[0082]; Roginska ¶¶ 43-48. Indeed, Dr. Durand Begault—the author of Begault (Ex.1038) and Patentee’s expert in the parallel district court action—confirmed that such HMDs with binaural sound were known long before the alleged inventions, as early as 1988. Ex.1095 42:2-19 (“[Q:] [I]n 1988, the VIEW system and the Convolvotron system already existed; is that fair? A. Yes. ... Q. And the system already had an HMD ..., right? ... [A.] Yes. [Q.] And you said the system also used 3D audio, fair? ... A. Yes.”).

## **2. Binaural Sound**

Binaural sound was also used at the time of the alleged invention to enhance realism and the sense of presence in VR environments. *See, e.g.*, Ex.1067 239-240 (“Auditory cues play a crucial role in everyday life as well as VR, including adding awareness of surroundings [and] conveying a variety of complex information. ... For more realistic audio and where auditory cues are especially important, [spatialized audio] can be used.”); Ex.1038 13-14 (“3-D sound can contribute to the sense of immersivity in a 3-D environment. One 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.”); Roginska ¶ 65; Ex.1095

233:2-237:4 (improving “sense of immersivity” and “sense of motion” in VR with binaural sound), 242:13-243:3 (binaural sound “imperative” for maintaining “sense of realism” in VR).

Binaural sound was commonly created using digital filters, such as HRTFs, that simulate the effect of a listener’s outer ears, body, and head, on sound. Ex.1067 240; Ex.1038 41. Two HRTFs—one for each ear—were used to synthesize binaural sound with directionally dependent audio cues so that the listener perceives the sound as coming from a particular point in space. Ex.1038 41; Ex.1067 240; Roginska ¶¶ 49-65. Dr. Begault conceded that using HRTFs to produce binaural sound was known prior to 2014 (i.e., before the earliest possible priority date of the ’184 patent). Ex.1095 135:6-25.

Binaural sound provides audio cues for localization including temporal cues (the interaural time difference (ITD) due to spacing between the ears), spectral cues (interaural level difference (ILD) due to shadowing of sound around the head), and spatial cues (ITDs and ILDs or HRTFs). *See, e.g.*, ’184 patent 3:10-17; Roginska ¶ 54.

### **3. Transitioning from a VR Environment**

It was also known to alert and/or otherwise transition users between VR environments or from a VR environment back to the real world by, e.g., fading out the audio and/or video environment (and optionally fading in the real world).

Clement 2:43-62, 9:20-31 (“[T]he transition may include a fade of sound content.”); Ex.1015 1:57-2:11; Roginska ¶¶ 70-72.

Other audio cues were also used to alert the user, such as switching the sound processing “from binaural to monophonic or stereophonic” to “remove[] any localization cues for that audio” (Sauk 11:26-41), or otherwise changing from one audio processing method to another (Ex.1033 [0194]-[0224]). *See also* Ex.1015 4:56-5:10; Clement 9:20-31; Roginska ¶ 73.

### **B. Prosecution History**

The ’184 patent issued on October 15, 2019, about four months after it was filed. The only Office Action was based on obviousness-type double-patenting over co-pending Application No. 16/401,242, which issued as USP 10,368,179. The prior art asserted in this Petition was not cited or considered by the PTO. Ex.1002 (’184 FH).

### **C. Person of Ordinary Skill in the Art (“POSA”)**

A POSA in the relevant timeframe (2015 to 2019) would have had a Bachelor’s degree in computer science/engineering, music technology, or a related field, and at least two years of industry experience, or academic research experience, in virtual/augmented reality, audio engineering, or an equivalent. Additional education can compensate for less experience, and vice-versa. Roginska ¶¶ 34-36.

**D. Claim Construction**

The prior art relied on in this Petition discloses the subject matter of the challenged claims under any reasonable construction, including their plain meaning.

Additionally, Patentee contends in district court that the “processing, by a [DSP]” step (i.e., Element 14[c]),<sup>1</sup> should be construed by its plain meaning and “[s]ection 112(f) does not apply.” Ex.1090 24-38. Solely for the purposes of this IPR, Petitioner adopts Patentee’s plain-meaning construction.<sup>2</sup>

**IV. Ground 1: Claims 1, 3-4, 6-10, and 14-19 Are Unpatentable Over Clement, Osman, and Sauk**

**A. Overview of the Prior Art**

**1. Clement (Ex.1005)**

USP 9,690,374 (Clement) is 35 U.S.C. § 102(a)(2) prior art because it was filed April 27, 2015, before the ’184 patent’s earliest claimed priority date.

Clement teaches an “audio visual system generating a virtual immersive experience” through a HMD and a system that tracks the user’s physical movement. Clement Abstract, Figs. 1A-1C, 3A-3C, 4:6-49. “[I]n an immersive experience” such

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<sup>1</sup> See Claim Listing Appendix for claim language and labels.

<sup>2</sup> Petitioners reserve the right to argue alternative constructions in other proceedings, including that claims are indefinite where such a defense is available—and does so in the co-pending district court case.

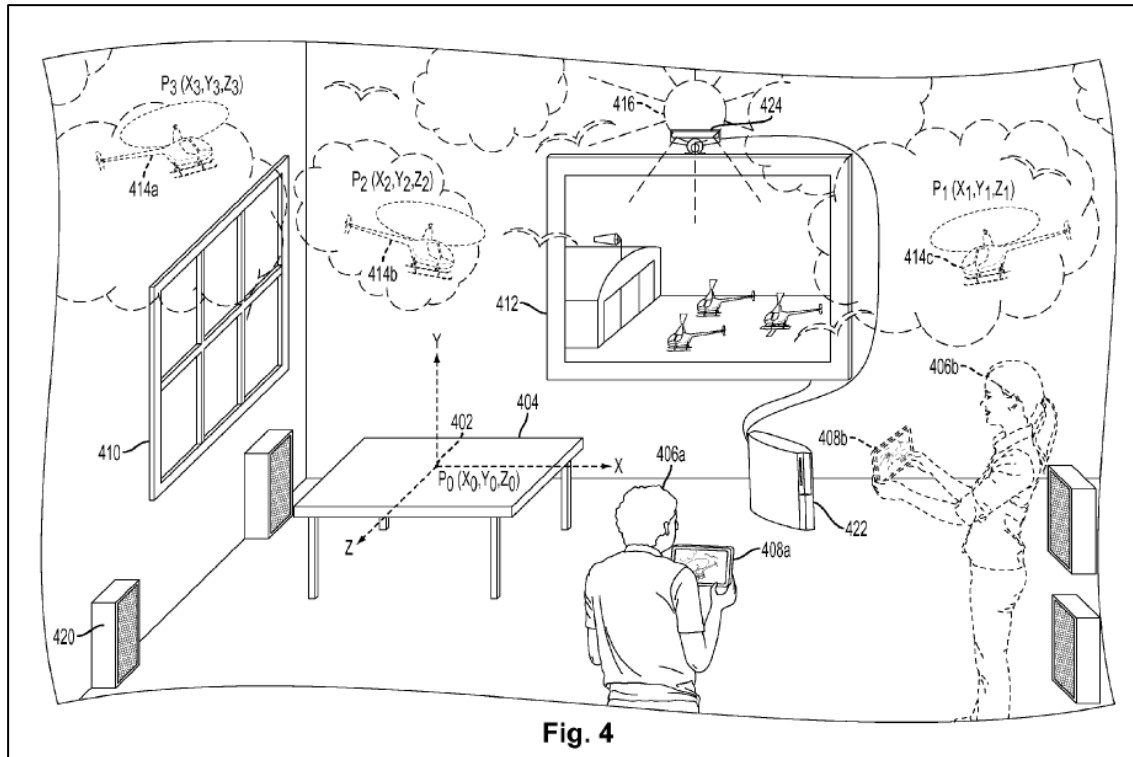
as a VR system, “a relatively clear boundary may exist between the ... ‘virtual’ world[] or ... the ‘real’ world.” Clement 1:11-16. Thus, a “smooth, or graceful, transition ... from the virtual world to the real world as the user encounters a boundary of the virtual world[] may avoid the disorientation and motion sickness which may occur as a user continues to move in the real world[] while motion appears to have stopped upon reaching the boundary of the virtual world.” Clement 2:43-63. To that end, Clement’s HMD initiates a transition process when the user is approaching the boundary of the virtual environment. Clement 7:4-16, 4:15-7:3, 12:20-13:10, Figs. 3A-3C, 11; Roginska ¶¶ 74-77.

Clement uses a transition profile to describe the user’s transition from the virtual to the real world, e.g., the virtual environment’s audio and video fade out during transition. Clement 9:20-31, 12:66-13:10, Fig. 11. Once the user completes the transition and is outside the virtual area, the user will no longer see or hear images or sounds from the virtual environment and will be left with, for instance, a transparent display and actual sounds from the real world. Clement 12:20-13:10, Fig. 11; Roginska ¶ 77.

## **2. Osman (Ex.1006)**

USP 9,037,468 (Osman) is §§ 102(a)(1) and (a)(2) prior art because it was filed May 23, 2012 and issued May 19, 2015, before the ’184 patent’s earliest claimed priority date.

Osman describes a system that presents an “augmented-reality environment with realistic delivery of sound.” Osman 8:65-66. The system “track[s] the location where the sound is to be originated, as well of the current location of the user, in order to project the sound as if the sound were coming from the simulated sound origin, which is within a three-dimensional space.” Osman 1:60-64. For example, players 406a and 406b are in remote locations while playing the same game where virtual objects are positioned using a shared coordinate system. Osman 9:6-17.



Osman Fig. 4; Roginska ¶¶ 78-81.

“A pair of HRTFs for the ears may be utilized to synthesize a binaural sound that seems to come from a particular point in space.” Osman 4:48-67 (HRTFs “characterize[] how an ear receives a sound from a point in space.”). “Sound

projection provides a compelling experience for the user” because the user feels “that the sound is coming from a particular point in space.” Osman 5:63-6:5; Roginska ¶ 79.

### **3. Sauk (Ex.1007)**

USP 7,876,903 Sauk is §§ 102(a)(1) and (a)(2) prior art because it was filed July 7, 2006 and issued January 25, 2011, before the ’184 patent’s earliest claimed priority date.

Sauk teaches a “multi-dimensional communication space” where the audio format (or “dimension”) of a sound (i.e., binaural, stereo, or mono) signifies the importance of that sound. Sauk Title, 11:25-40. In particular, an audio environment operating in “Selective Relevance Mode” provides “a plurality of audio dimensions such as 3-D (binaural), 2-D (stereophonic), and 1-D (monophonic).” Sauk 11:25-40. Because users can perceive audible differences between these different dimensions, “changing an audio format for sounds from binaural to monophonic or stereophonic audio signifies a different level of relevancy or importance for such audio.” Sauk 11:25-40. Thus, as certain sounds become less relevant to the user, the system can “change the less relevant audio [from binaural (3-D)] to a monophonic (1-D) or stereophonic (2-D) dimension.” Sauk 11:25-40. And as audio processing changes from binaural to monophonic or stereophonic audio, localization cues can be removed and the level (volume) adjusted. Sauk 11:25-40; Roginska ¶¶ 82-83.

**B. Overview of the Combination – Motivation to Combine**

A POSA implementing Clement the relevant time would have arrived at the claimed invention. As will be explained in detail, Clement discloses an HMD that provides a fully immersive audio-visual VR experience that includes “virtual audio content.” Clement 1:24-30 (“audio visual system configured to generate a virtual immersive experience”); 9:20-31 (delivering “virtual audio content”). Clement does not explain how to generate such audio content, leaving those details to the POSA’s knowledge. A POSA implementing Clement would have known that binaural sound may be created using HRTFs, and would also have turned to Osman for details on how to implement them in an HMD like Clement’s. Roginska ¶¶ 96-110.

Clement further discloses warning or alerting users that they are leaving the virtual environment by, e.g., fading out the virtual audio. Clement 9:20-31, 12:66-13:10. A POSA implementing Clement would have looked for other warnings to give users the best experience in different situations, such as those taught by Sauk. Roginska ¶¶ 111-115.

**1. Clement and Osman: using HRTFs in an HMD**

Clement and Osman are analogous art—each is directed to presenting VR environments where players interact with virtual objects in a physical operating space. Clement Abstract, 1:5-20; Osman 8:65-11:3, Fig. 4. Osman’s binaural sound is directly pertinent to Clement’s use of sound in VR environments. Adding Osman’s

binaural sound to Clement's VR system amounts to no more than applying known techniques (e.g., HRTF processing) to a known device (Clement's HMD) ready for improvement to yield predictable results (spatialization of sound and thus a more immersive and realistic VR experience). Roginska ¶¶ 106-109.

Clement teaches generating a VR environment using an "audio visual system" to generate an "immersive experience," Clement 1:1-67, but it provides little detail regarding any particular sound processing—leaving those implementation details to the POSA's skill and knowledge. POSAs would have known how to provide realistic, immersive virtual sound to match the environment. For example, Osman teaches enhancing the realism of sound delivered to users by simulating the source of sound, i.e., creating binaural sound. Osman 4:37-67; Roginska ¶¶ 97-98, 106-107.

POSAs would have implemented Clement's HMD with Osman's binaural sound for several reasons. First, Clement expressly discloses an "audio visual system" that "generate[s] a virtual immersive experience," including "audio content associated with the virtual world." Clement 1:24-30, 9:20-31. A POSA would have further understood that doing so enhances realism, or the sense of "presence," for users, making the experience more fully immersive. A virtual environment and its images seem more realistic when they have a realistic sound aspect. Conversely, when sound does not match the imagery, the optical illusion begins to break down, creating disbelief and detracting from the users' sense of presence. This sense of

presence is important in VR—it makes VR compelling, effective, and immersive. Osman 1:24-43; Ex.1065; Ex.1066. Further, binaural sound was used to enhance users’ perception of space, distance, and size within the virtual environment. “An accurate spatial reproduction of sound can significantly enhance 3D perception,” enabling users to better identify and localize objects. Ex.1063 54; Osman 6:42-53. Indeed, “[h]igh-quality virtual audio scene rendering *is a must* for emerging virtual and augmented reality applications.” Ex.1076 Abstract (emphasis added); Roginska ¶¶ 99-101.

Also, binaural sound was a computationally efficient way of achieving these goals—enabling POSAs to enhance users’ presence, spatial perception, and performance in virtual environments. Ex.1038 11; Ex.1060; Ex.1051 4; Ex.1048 34; Roginska ¶¶ 102-105.

A POSA would have had a reasonable expectation of success. Clement and Osman each disclose wearable electronic devices (e.g., headphones (Osman) or HMD (Clement)) and location-sensing and other sensing abilities. Osman 10:17-26, 11:23-42, 12:1-14; Clement 2:63-4:48, 7:4-16, Figs. 1A-1C. Implementing the audio processing described in Osman’s generic portable device in Clement’s HMD in particular would have been well within a POSA’s skill. Ex.1017 21:21-38 (describing an HMD that includes a binaural sound engine); Clement 3:30-4:48, 14:3-23; Fig. 2; Roginska ¶¶ 108-110.

**2. Adding Sauk: using other audible differences to alert the user**

Sauk is also analogous art, addressing virtual environments like Clement and Osman, and in particular, providing binaural sound. Sauk 2:34-41; Clement Abstract, 1:5-20; Osman 8:65-11:3, Fig. 4; Roginska ¶¶ 111-115.

Clement discloses warning the user that the user is leaving the virtual world, by, e.g., “fad[ing] out [the] virtual audio” (Clement 9:20-31), and a POSA implementing Clement would have looked to Sauk for additional teachings regarding binaural sound, including signaling the importance of things or events to provide flexibility and additional options for different conditions in, e.g., virtual gameplay, thus ensuring a suitable warning regarding the transition (e.g., leaving a virtual room while remaining in the virtual environment vs. completely leaving the environment). For example, Clement discloses “warning” the user to avoid an obstacle or wall by transitioning from the virtual environment and using, e.g., an “audible indicator.” Clement 7:28-8:35. Clement gives only the example of a buzzer, but a POSA would have known that other options are available and maybe preferable. For example, Sauk teaches changing from binaural to stereo or monophonic sound to signal “relevancy or importance,” such as warning of a “hazard.” Sauk 11:26-40, 12:33-51 (warning of a hazard); Roginska ¶¶ 111-113.

A POSA would have had a reasonable expectation of success in incorporating Sauk’s teachings in Clement and Osman. All three are implemented in wearable

electronic devices with location and other sensing abilities. Osman 10:17-26, 11:23-42, 12:1-14; Clement 2:63-4:48, 7:3-16, Figs. 1A-1C; Sauk 4:33-5:5, 7:24-8:33; Roginska ¶¶ 109, 114-115. Implementing Sauk’s processing in Clement’s HMD in particular would have been well within a POSA’s skill. Roginska ¶¶ 114-115.

**C. Independent Claim 14<sup>3</sup>**

Claim 14 is the broadest claim, and therefore this Petition will address it first.

**1. 14[pre]: a method executed by electronic devices**

To the extent the preamble is limiting, the combination teaches it. Clement Abstract, 2:43-4:14, Figs. 1-3; Osman Abstract, Figs. 1-7; Sauk Abstract, Fig. 5; Roginska ¶¶ 314-315, 116-119.

**2. 14[b]: displaying a virtual image in an environment<sup>4</sup>**

Clement teaches this element. Clement’s HMD (which is a WED worn on the head of a user) displays an “immersive VR environment” in which “[m]ovement of the user in the real world may be translated into corresponding movement in the environment generated in the virtual world.” Clement 2:3-3:19, 4:6-14, 6:7-22, Figs. 1A, 1B, 1C, 2; Roginska ¶¶ 314-315, 131-133.

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<sup>3</sup> See Claim Listing Appendix for claim language and labels.

<sup>4</sup> Element 14[a] is discussed next.

Clement's HMD displays a virtual image in a 3D virtual environment (which Clement calls the "virtual world"). Clement 2:44-3:19, 8:36-59, 8:60-9:6, 9:20-31, Figs. 7-9 (illustrating the display of virtual environments with virtual images by the HMD), cls.4, 13, 17, 18, 21; Roginska ¶¶ 133-135.

Notably, Osman likewise teaches displaying virtual images in an environment, including "helicopters 414a-414c, clouds, birds, sun 416, etc.," albeit on a generic portable device rather than a HMD in particular. Osman 9:49-56; *see also* Osman 8:65-10:32, Fig. 4; Roginska ¶¶ 136-137; *see also* Motivation to Combine section above.

### **3. 14[a]: storing HRTFs**

The combination teaches this element. Clement's HMD is a WED worn on a head of a user. Clement 2:3-8 (HMD is "worn ... on a head of the user to generate an immersive VR environment."), 2:43-47, Figs. 1A, 1B, 1C, 2; Roginska ¶¶ 314-315, 75, 120-122.

Clement's HMD generated virtual audio content associated with its virtual world and delivered it to its user. Clement 1:24-30 ("audio visual system configured to generate an virtual immersive experience"); 2:63-3:6 ("speakers mounted in headphones coupled on the frame"); 9:20-31 (delivering "audio content associated with the virtual world" also called "virtual audio content").

A POSA implementing Clement’s system (including its virtual audio) would have used immersive, binaural sound as taught by Osman—including its use of HRTFs—to make the virtual environment compelling and effective. *See* Motivation to Combine section, above; Roginska ¶¶ 96-110.

Osman stored its HRTFs in memory, consistent with common practice at the time. In particular, Osman used either standard HRTFs or individualized HRTFs calibrated to the user to generate localized sound. Osman 5:19-28. Osman’s system includes “processor 732, which is coupled to memory 734” and “[s]ound localization computer program 736 [which] resides in memory 734.” Osman 12:14-27, Fig. 7; Roginska ¶¶ 79, 123 (explaining that computer programs 736 also may reside on the hard drive, but are loaded into memory when executed).

Osman also teaches that calibration methods may be used to customize HRTFs for a particular user, a process that also relies on HRTFs stored in memory. Osman 5:19-28, 14:29-50; 14:51-19:36, Figs. 9A-9B, 10A-10B, 11-12. HRTFs are stored in memory at database 710, which “includes a plurality of sound localization functions associated with a plurality of different users,” and fetched for a particular user. Osman 13:10-18, Fig. 7; Roginska ¶ 124.

This practice of retrieving particular HRTFs from a database for particular users, and then storing the HRTF in use in local memory was common at the time. Ex.1019 8:13-23 (“client devices ... may store ... HRTF[s] in an HRTF cache”),

Fig. 5; Ex.1025 cl.1 (claiming “[a] system for generating a personalized Head-Related Transfer Function”), 6:52-56 (“the memory 36 may include ... combination caches”); Ex.1047 312 (describing storing filters for HRTFs in RAM); Ex.1053 1 (“[A]ccesses from a single processor to local memory ... have lower latency compared to remote memory accesses .... Proper placement of data will increase the overall bandwidth and improve the latency to memory.”); Ex.1075 1 (reducing latency in VR to improve realism and avoid motion sickness); Roginska ¶¶ 125-129. Indeed, Dr. Begault conceded that storing HRTFs in memory was known. Ex.1095 206:11-16 (“Q. Before 2014, were people of skill in the art storing HRTFs in memory? A. Yes, they were.”).

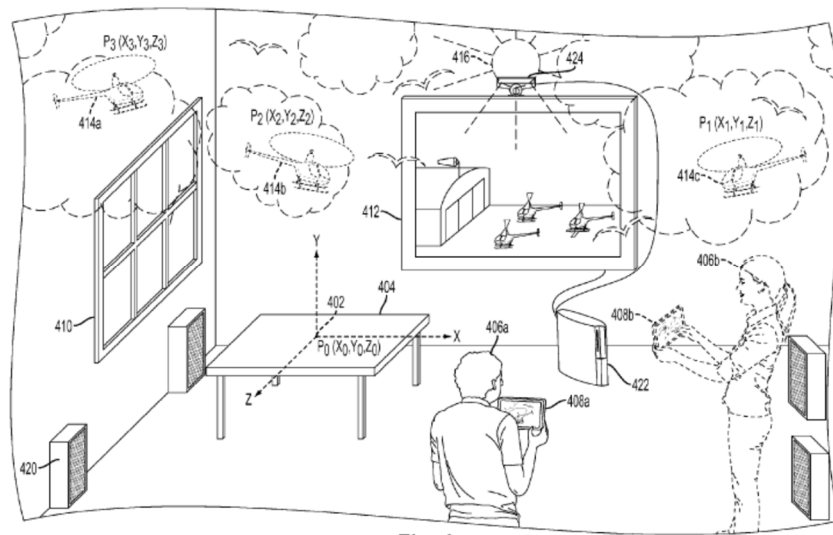
Accordingly, a POSA would have followed Osman’s teachings and stored the HRTFs in use in memory, as required by the claim. Although not required for this claim, that memory would have been in the HMD because that is where the processing takes place, as taught by Clement and Osman. *See* Motivation to Combine section above (motivation to implement Osman’s audio processing in Clement’s HMD); Roginska ¶¶ 126-130.

**4. 14[c]: a DSP processing sound using HRTFs to generate binaural sound that externally localizes to the user at the virtual image**

Osman teaches this element, and as already discussed a POSA would have implemented Osman’s processing in an HMD such as Clement’s.

As alluded to previously, HRTFs, such as Osman's, are used to generate binaural sound that is provided to the user. Osman 4:37-67; Ex.1038 40-41, 49-50. An HRTF "characterizes how an ear receives a sound from a point in space," and "[a] pair of HRTFs for the ears may be utilized to synthesize a binaural sound that seems to come from a particular point in space." Osman 4:37-67; *see also* '184 patent 3:52-58; Roginska ¶¶ 314-315, 79-81, 138-153.

Osman further discloses a 3D environment that includes virtual objects, including helicopters 414a-414c, clouds, birds, sun 416, as well as virtual player 406b. Osman 8:65-10:2. Those virtual objects "can be located anywhere in space," Osman 9:49-65, including in empty space, i.e., where no physical, real objects exist, as shown below.



Osman Fig. 4 (illustrating virtual objects located in empty space); *see also* '184 patent 11:18-31; Roginska ¶¶ 81, 150-151. To do so, Osman "tracks the location of

the ears of the player 406a.” Osman 10:3-33. “When sounds are generated in the game (e.g., the sound of a helicopter flying)” the system “determines the coordinates in the virtual space of the sound origin.” Osman 10:3-33. It then “determines the relative location between the sound origin and the ears perceiving the sound” and uses HRTFs “to convert the sound into a localized sound that appears to the user as coming from the sound origin.” Osman 10:3-33; *see also id.* 4:15-67 (using “convolution” to generate the binaural sound).<sup>5</sup> The localized sound provides “an acoustic clue to the user regarding the virtual location in space of the virtual object.” Osman 10:3-33; Roginska ¶ 152. As Dr. Begault wrote in Ex.1038 and confirmed in the district court action, “in virtual reality and multimedia applications, most sounds are somehow connected to visual events.” Ex.1038, 95; Ex.1095 244:16-245:12, 236:2-24.

Osman also teaches adjusting the volume of a sound as a related virtual object moves to help externally localize the sound, i.e., to make the sound appear to

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<sup>5</sup> Patentee admits in district court that, even if this step is construed under § 112(f), it may be performed using an “algorithm” called “convolution,” a “well-known mathematical operation.” Ex.1091 ¶¶ 15-16; Ex.1095 59:4-16 (“many references”—“in the 1990s”—“discuss[ed] using convolution processes to process [HRTFs] with [DSPs] for binaural audio”).

emanate from a point in space outside of the user’s head. For example, if a user fires a game cannon, a sound effect simulates the sound with the volume increasing as the cannonball gets closer to the user. Osman 10:33-11:3; Roginska ¶¶ 149-151.

Osman teaches performing audio processing to generate binaural sound that externally localizes using “special purpose processor” that may be “designed or programmed to perform only one function” (Osman 12:15-27, 12:55-67), which a POSA would have understood to be or include a digital signal processor (DSP), or at the very least, found it obvious to use one in view of the POSA’s knowledge and also as taught by Sauk. Sauk 7:24-28 (using “one or more digital signal processors”). Using DSPs for such HRTF processing was well-known, common, and routine—as Patentee admitted in district court. Ex. 1091 ¶¶ 15-16 (this claim term recites “known audio DSP structures within the art” using “common industry programming techniques or software libraries for audio processing” and well-known operations such as “convolution”); Ex.1090 36 (“a DSP ... would be known to a POSA” and is used “for its typical intended purpose”); Ex.1093 6:51-56; Ex.1094 5:6-26, 8:4-15; Ex.1038 20, 109-116, 165-170 (DSP for HRTF processing), 185-187 (same); Ex.1016; Ex.1020; Ex.1072 88-89, 92-93 (describing the Convolvotron); Roginska ¶¶ 138-148. Indeed, Dr. Begault admitted his own pre-2014 patents (e.g., Exs. 1093, 1094) disclosed processors processing sound with HRTFs to generate binaural sound. Ex.1095 135:6-25.

POSAs understood that “3-D sound processing is almost always best accomplished digitally, using audio DSP chips to manipulate signal sources.” Ex.1038 100. It would have been obvious to at least try that common, “almost always” best practice here, especially given a DSP’s advantages for this type of processing. Roginska ¶¶ 138-148 (explaining DSP were optimized for this type of processing, and performed it very quickly and efficiently using little power or physical space—making DSPs ideal for implementing Osman’s processing in an HMD such as Clement’s); Ex.1091 ¶ 15. And Dr. Begault conceded POSAs would have known how to implement systems performing Element 14[c]. Ex.1095 212:24-213:13.

**5. 14[d]: alerting the user that the user is leaving the virtual image in environment by altering processing and reducing the sound’s volume**

Clement teaches this element. Clement’s HMD (which is a WED worn on the head) “include[s] a sensor that detects ... the user’s proximity to a boundary of the tracking area 320, or that the user is within a threshold distance of a boundary of the tracking area 320.” Clement 7:4-16, 7:28-8:90, 8:36-43, 12:20-29, Figs. 10-11; *see also* Clement 3:20-41; 3:42-5:54, 6:7-57, Figs. 1A-1C, 2, 3A-C. Indeed, such tracking techniques were well-known in art. Ex.1080 4:49-5:24; Roginska ¶¶ 316-318, 154-161; Ex.1095 250:2-9 (systems in the 1980s used tracking techniques); 229:25-230:10 (prior art sensors and tracking). And “[t]he specification ... is entirely silent on how to [perform this], suggesting that a [POSA] was more than capable of

selecting between the known methods of accomplishing this.” *See Uber Techs., Inc. v. X One, Inc.*, 957 F.3d 1334, 1339 (Fed. Cir. 2020); *In re Epstein*, 32 F.3d 1559, 1568 (Fed. Cir. 1994).

Clement’s HMD confirms, based on the user’s direction, speed, and/or acceleration, that the user is approaching the boundary, to determine when the user is leaving the environment. Clement 12:30-13:10, Figs. 10-11; Roginska ¶¶ 75-76, 158-159.

When Clement’s HMD determines that the user is “approaching/nearing the boundary” (i.e., leaving the environment), Clement alerts or warns the user by initiating a “transition” that may, for example, “fade out” the virtual audio (including the audio that localizes to the user at the virtual image), i.e., reduce its volume as recited in the claim. Clement 9:20-31, 12:30-13:10, 5:55-6:6 (“when the user A is within a predetermined distance, or threshold, of a boundary or edge of the tracking area 320 ... the system may issue a warning or indicator”), Fig. 11 (step 1058), cls.4, 13, 21; *see also* Clement 5:12-16, 7:56-8:35; Sauk 11:40-41 (reducing the “decibel level”); Roginska ¶¶ 76-77, 162-170; Ex.1095 210:20-211:12 (“Q. And you heard

of [virtual boundaries] before 2014? A. Yes.”).<sup>6</sup> In the combination, this audio (that has its volume reduced) is the binaural sound generated in 14[c] above.

Further, a POSA would have known that other alerts may be more effective and needed in some situations to address the relevancy or immediacy of the transition, and others less so. *See* Motivation to Combine section, above (discussing, *inter alia*, Clement providing warning of hazards such as obstacles and Sauk’s disclosures of various methods of doing so). Particularly relevant here, Clement teaches warning the user when the user is leaving and transitioning out of the environment because the user is heading towards a real wall in the real world, as opposed to a less important transition when the user is not headed towards danger. Clement 7:28-8:35. One way to inform the user of the immediacy or relevance of the transition is to provide an additional audible indication, such as altering the processing of the binaural sound such as converting the “binaural [audio] to monophonic or stereophonic audio [to] signif[y] a different level of relevancy.” Sauk 11:25-41. Indeed, Dr. Begault conceded that switching from binaural to stereo or

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<sup>6</sup> Notably, Patentee contends in district court that “reducing the volume of the binaural sound” “when the user backs too far away from the virtual image of the game character” is “alert[ing] the user” that the user is “leaving the virtual image in the environment.” Ex.1092 9.

mono sound to serve as an alert was known. Ex.1095 208:20-209:8 (“Q. And could [systems prior to 2014] switch sounds from binaural audio to stereo audio or monaural audio as a form of alert? ... A. Yes.”). A POSA would have implemented that technique here to provide various levels of transitions/warnings to ensure user safety. Roginska ¶¶ 171-183.

And again, the specification is entirely silent on how to perform this step, suggesting that a POSA was more than capable of selecting a known method to perform this step. *Uber Techs.*, 957 F.3d at 1339.

\* \* \*

Accordingly, the Clement combination renders obvious claim 14.

#### **D. Dependent Claims 15-19**

These claims are unpatentable for the same reasons as claim 14 and as further explained below.

These claims each further recite modifying the alert discussed in Element 14[d] above. Element 14[d] requires reducing the binaural sound’s volume, e.g., fading the audio out as taught in Clement, and altering processing of the binaural sound. The claims further recite alerting the user that the user is leaving the environment by degrading that sound in various ways. Each will be addressed in turn.

**1. Claim 15: changing ITDs, ILDs, or HRTFs**

This claim recites that the altering of Element 14[d] is changing at least one of ITDs, ILDs, or HRTFs.

The combination teaches this for the reasons explained with respect to element 14[d]. ITDs refers to the time delay between sounds reaching the two ears due to spacing between the ears, and ILDs refers to the sound level difference due to shadowing of sound around the head. '184 patent at 3:43-58. Binaural sound is derived from audio cues including ITDs, ILDs and HRTFs to provide localized sound. '184 patent 3:43-58. Converting the binaural sound to stereo or mono changes (removes) the inserted ITDs, ILDs, and HRTFs in the binaural sound. Roginska ¶¶ 319-321, 171-185; Sauk 11:35-40 (“This process also removes any localization cues for that audio.”).

**2. Claim 16: stopping HRTF processing**

This claim recites alerting the user by stopping the DSP's HRTF processing of the binaural sound. Clement teaches degrading the sound by fading it out (reducing its volume) as discussed above with respect to Element 14[d]. After the binaural sound is sufficiently faded, it is no longer processed. Roginska ¶¶ 322-323, 138-153.

Further, the combination teaches stopping HRTF processing for the reasons explained with respect to element 14[d]. The DSP (*see* Element 14[c]) alters its

processing to provide stereo or mono audio, as discussed. One way that the DSP may do so is to stop the DSP's processing of the binaural sound with HRTFs. As discussed for Element 14[c], HRTFs are used to generate processed binaural sound for the user. If the DSP stops processing the sound with the HRTFs, unprocessed stereo or mono audio will be provided instead. Roginska ¶¶ 324, 141-153.

### **3. Claim 17: removing ITDs**

This claim recites alerting the user by removing ITDs.

The combination teaches this for the reasons explained with respect to Element 14[d] and claim 15. Converting the audio to stereo or mono removes the inserted ITDs in the binaural sound. Roginska ¶¶ 325, 171-185; Sauk 11:35-40 (“This process also removes any localization cues for that audio.”).

### **4. Claim 18: eliminating spatial cues**

This claim recites alerting the user by eliminating spatial cues in the binaural sound.

The combination teaches this for the reasons explained with respect to element 14[d], claims 15 and 17. Spatial cues (ITDs, ILDs, and HRTFs) are examples of audio cues in binaural sound, and these as well as other cues (such as filtering based on the orientation of the head) are removed in stereo and audio sound presented in earphones. Roginska ¶¶ 326-328, 171-185; Sauk 11:35-40 (“This process also removes any localization cues for that audio.”).

**5. Claim 19: alerting by switching from binaural to stereo or mono**

This claim recites alerting the user by switching to stereo or mono sound. The combination teaches this for the same reasons explained with respect to Element 14[d]. Roginska ¶¶ 329, 316-318.

**E. Independent Claim 7**

Independent claim 7 is generally similar to claim 14, except that it alerts the user by “altering processing of the sound by the DSP to degrade a spatial cue and to lower a volume of the sound playing to the user.” It is unpatentable for the same reasons and as further explained below.

**1. Elements 7[pre] to 7[c]**

These elements are taught by the combination for the same reasons discussed above for corresponding Elements 14[pre] to 14[c].

Notably, there is no relevant distinction between displaying “with” the WED as recited in Element 14[b] and displaying “by” the WED as recited Element 7[b] or between playing and localizing to the user in Element 7[c] compared to merely localizing. Roginska ¶¶ 331-333, 190-191.

**2. 7[d]: alerting the user by degrading a spatial cue and lowering the volume**

This element recites alerting the user that the user is leaving the environment, like Element 14[d], but does so by “altering processing of the sound by the DSP to degrade a spatial cue and to lower a volume of the sound playing to the user.”

“Spatial cues are ITDs and ILDs or head-related-transfer-functions (HRTFs).” ’184 patent 3:10-17.

This is taught by the combination for the same reasons discussed above for Element 14[d] and claims 15-19. Clement teaches degrading the sound by fading it out (reducing its volume) as discussed above with respect to Element 14[d]. In addition and in the alternative, converting the audio to stereo or mono removes the inserted ITDs, ILDs, and HRTFs in the binaural sound. Roginska ¶¶ 334-336, 171-183; *see also* Sauk 11:35-40 (“This process also removes any localization cues for that audio.”).

#### **F. Dependent Claims 8-10**

These claims are unpatentable for the same reasons as claim 7 and as further explained below.

##### **1. Claim 8: spatial cue is an ITD**

This claim recites that the degraded spatial cue includes an ITD. The combination teaches this for the same reasons explained with respect to Element 14[d] and claims 15-17 above. Roginska ¶¶ 337, 334-336.

##### **2. Claim 9: character voice in stereo**

This claim recites switching a character’s voice from binaural to stereo when the character is no longer displayed.

The combination teaches this. *First*, the combination contemplates performing the claimed methods while playing a computer game, as POSAs knew

that such VR systems were commonly used for games. *E.g.*, Osman 1:34-43, 6:6-7:3; Ex.1080 1:14-2:12; Roginska ¶¶ 338, 195-196.

And as already discussed, Sauk teaches converting binaural sound to stereo to signify relevance. Sauk 11:25-41. A POSA would have understood that a character is often less relevant when it leaves the environment or is no longer displayed. Roginska ¶ 197 (discussing, e.g., Ex.1015 2:32-59, 3:39-51, 4:20-24, 6:39-7:2, 7:38-63, 8:25-9:3, Fig. 2 and virtual games). Accordingly, a POSA would have switched the vanished character's audio to stereo to conserve processing resources, indicate a change in relevance, and direct the user's attention to sounds that the user is facing. Roginska ¶¶ 197-200.

### **3. Claim 10: alerting the user by switching binaural to stereo**

This claim recites alerting the user by switching to stereo sound. This is taught for the reasons discussed for Element 14[d] and claim 19 above. Roginska ¶¶ 339, 201, 192-193, 171-189.

## **G. Independent Claim 1**

Independent claim 1 is unpatentable for the same reasons as claim 14, and as further explained below.

### **1. Elements 1[pre] to 1[c]**

These elements are taught by the combination for the reasons explained with respect to Elements 14[pre] to 14[c]. As explained in those sections, the combination

teaches or renders obvious implementing the claimed processing in a DSP located in the WED/HMD and storing the HRTFs.

Notably, Element 1[c]’s recitation of binaural sound “that plays to the user and that externally localizes in empty space at the virtual image” (instead of “that externally localizes to the user at the virtual image in the environment”) does not change the analysis. Roginska ¶¶ 341-344.

**2. 1[d]: warning the user that the user is leaving the environment by altering a spectral cue and reducing the sound’s volume**

This element recites warning the user that the user is leaving the environment by filtering the binaural sound with the DSP to alter a spectral cue and lowering a volume. Spectral cues include ILDs. ’184 patent 3:10-17 (“Spectral cues arise from an interaural level difference (ILD) due to shadowing of sound around the head.”); Roginska ¶ 54.

This is taught by the combination for the same reasons discussed above for Element 14[d] and claims 15 and 17-19. As explained there, converting the audio to stereo or mono removes ILDs from the binaural sound. Roginska ¶¶ 345-347, 171-183; *see also* Sauk 11:35-40 (“This process also removes any localization cues for that audio.”). Further, Clement teaches that its intent is to “warn[]” the user as the user leaves the environment. Clement 5:17-40, 7:56-8:35.

## **H. Dependent Claims 3, 4 and 6**

These claims are unpatentable for the same reasons as claim 7 and as further explained below.

### **1. Claim 3: leaving virtual area**

This claim further recites that the warning occurs when the user leaves a virtual area where the virtual image is located while remaining in the 3D virtual environment.

The combination teaches, or at least would have rendered obvious, this claim element for the reasons explained above with respect to Element 1[d], and as further explained here.

In particular, a POSA would have understood that transitions between virtual areas were commonplace in VR environments. For example, in the VR game, “Second Life,” the character of a user will “shift[] between various virtual spaces” and when it does so “the image viewed by the user and the sound heard by the user should change according to the shift between spaces.” *See, e.g.*, Ex.1015 1:57-2:12;<sup>7</sup>

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<sup>7</sup> To the extent a prior-art reference is needed for this well-known game feature, Ex.1015 is prior art under § 102(a)(1) and (a)(2) because it was filed August 14, 2009 and issued August 27, 2013, before the '184 patent's earliest claimed priority date.

Roginska ¶¶ 206-207, 70-71 (other examples). Clement teaches, e.g., fading out the virtual environment's audio while fading in the real world's audio. Clement 9:20-31, 12:30-13:10. The same was done for transitioning between areas instead of environments. *See, e.g.*, Ex.1015 Abstract (“a volume of sound in a first space is gradually decreased while a volume of sound in a second space is gradually increased.”), 2:15-5:21; Roginska ¶¶ 75-77, 207-209.

And for the similar reasons described with respect to Element 1[d], a POSA would have signaled the immediacy or the relevance of the transition by also altering audio cues. Roginska ¶¶ 348, 171-183, 208-209.

**2. Claim 4: switching to stereo when the user is faced away from a virtual image**

This claim further recites that the HMD tracks the position of the user's head, and when the user faces away from the virtual image in the environment such that the image is no longer visible, switching the sound from the image to stereo.

The combination teaches this. In particular, Clement teaches tracking “the location of the players face, or ears.” Clement, 7:62-8:11, 12:36-55, 16:27-35. Osman also discloses tracking the position of the user's head using, e.g., “headphones with a magnetometer.” Osman 16:27-35. Osman explains tracking the user's head because binaural sound is generated based on the position of the user's ears. Osman 5:19-28, 7:62-8:11: (“Once the position of the user's ears is determined, sound localization is done on the sound, according to the origin of the sound, and

the position of the ears.”); 10:27-33 (“The sound localization algorithm uses the HRTF of the user, as well as the current location of the user’s ears to generate the localized sound for the earphones. The acoustic signals for the localized sound ... provide an acoustic clue to the user regarding the virtual location in space of the virtual object.”), 12:47-54 (“Sound Projection module 716” generates the binaural sound’s cues based in part on the position of the user’s head); Roginska ¶¶ 210-212. The user’s head position was crucial in Osman because, as was known to POSAs, binaural sound processing is based on the position of the user’s head relative to the sound. Roginska ¶¶ 349, 210-212; Ex.1038 8, 132-136, 167-172.

Implementing Osman’s head-tracking in an HMD was well within the POSA’s skill, using, e.g., Osman’s accelerometer, gyroscope, magnetometer, GPS, and/or compass with Clement’s HMD (to the extent not already included) to locate the position of the user’s HMD and localize sound. Osman 8:56-64, 10:54-11:42, 19:48-67; Ex.1038 8, 132-136, 167-172; Roginska ¶¶ 43-48, 210-212.

In addition, Sauk teaches switching binaural audio to stereo to signify relevance, as recited by the claim. Sauk 11:26-41. A POSA implementing the HMD would have understood that virtual images of objects behind the user (i.e., the user’s face is directed away) are often less relevant than those the user is facing, and therefore would have switched the audio associated with those objects to stereo. Roginska ¶¶ 349, 171-183, 213-214, 349.

**3. Claim 6: switching from binaural to stereo when the virtual image vanishes**

This claim further recites switching the binaural sounds from the virtual image to stereo when the image vanishes from the 3D virtual environment.

The combination teaches this. As already discussed, Sauk teaches converting binaural sound to stereo to signify relevance. Sauk 11:25-41. A POSA would have understood that an object or character (i.e., a virtual image) is often less relevant when it leaves the environment. Roginska ¶¶ 350, 195-200, 210-216 (discussing, e.g., Ex.1015 2:32-59, 3:39-51, 4:20-24, 6:39-7:2, 7:38-63, 8:25-9:3, Fig. 2 and virtual games). Thus, a POSA would have switched the vanished character's audio to stereo. Roginska ¶¶ 350, 171-183, 215-216.

\* \* \*

Accordingly, the Clement combination renders obvious the challenged claims.

**V. Ground 2: All Claims Are Unpatentable Over Lyren and Reif**

Lyren (Ex.1008) is the great-great-grandparent of the '184 patent. '184 patent cover. Lyren is prior art because the '184 patent is not entitled a priority date any earlier than its actual filing date.

Lyren, like the '184 patent, lacks any teaching of alerting the user that the user is leaving the environment. Reif (Ex.1009), however, provides that teaching, and the combination renders obvious all of the '184 patent's claims.

**A. The '184 patent's effective filing date is its actual filing date: June 16, 2019**

**1. Background: shifting the burden of production**

Petitioners bear the ultimate burden of *persuasion* of demonstrating unpatentability. But once Petitioners provide invalidating art, the burden of *production* shifts to the Patentee to “show that the prior art does not actually invalidate the patent or that it is not prior art because the asserted claim is entitled to the benefit of an earlier filing date.” *Research Corp. Techs., Inc. v. Microsoft Corp.*, 627 F.3d 859, 871 (Fed. Cir. 2010); *Dynamic Drinkware, LLC v. Nat'l Graphics, Inc.*, 800 F.3d 1375, 1379-80 (Fed. Cir. 2015) (petitioner satisfied its initial burden “by arguing that [the art] anticipated the asserted claims,” shifting the burden of production to the patentee to show “either [the art] does not anticipate” or the art “is not prior art”); *Penumbra, Inc. v. RapidPulse, Inc.*, IPR2021-01466, Paper 34 at 18 (Mar. 10, 2023).

Here, Petitioners show that Lyren and Reif render obvious the '184 patent's claims, shifting the burden of production to Patentee to come forward with evidence showing either (i) Lyren and/or Reif are not *prior* art because the '184 patent's claims are entitled to the benefit of an earlier filing date, or (ii) the art does not actually invalidate the patent. Patentee can do neither, as demonstrated below.

**2. The '184 patent's claims are not supported by its parent, the '140 Application**

Each claim of the '184 patent is entitled to the benefit of an earlier-filed application only if the earlier application satisfies the written description requirement of 35 U.S.C. § 112. *See* 35 U.S.C. § 120; *Tronzo v. Biomet, Inc.*, 156 F.3d 1154, 1158 (Fed. Cir. 1998). There must also be a continuity of disclosure: “each application in the chain leading back to the earlier application must comply with the written description requirement of 35 U.S.C. § 112.” *Lockwood v. Am. Airlines, Inc.*, 107 F.3d 1565, 1571 (Fed. Cir. 1997). Further, “[e]ntitlement to a filing date does not extend to subject matter which is not disclosed, but would be obvious over what is expressly disclosed.” *Lockwood*, 107 F.3d at 1571-72.

Here, the priority chain is broken at the '184 patent's immediate parent, Application No. 16/106,140 (“'140 application,” Ex.1028 92-191). As a result, the '184 patent's claims are not entitled to the benefit of any date earlier than their actual filing date.

All of the '184 patent's claims directly (or indirectly via their independent claims) recite alerting or warning that user that the user is leaving the 3D environment by reducing the binaural sound's volume and also otherwise altering it. *See* Claim Elements 1[d], 7[d], 14[d]. But the '184 patent's immediate parent, the '140 application (including its as-filed claims) lacks any disclosure of these features. Ex.1028 92-191; Roginska ¶¶ 352-355, 217-229.

Certainly, the '140 application describes altering the sound provided to the user (e.g., changing from binaural to stereo or mono) upon detecting various *other* “events.” Ex.1028 106-115 (“a wide variety of different types of events”), 115-116 (“Figures 4-16 provide examples of events for changing [the] sound....”). But the described events do not include the user leaving the environment as recited in the independent claims. Roginska ¶¶ 225-229.

The closest exemplary triggering event in the '140 application might be determining “a location (such as a location of an electronic device or of a person listening to the sound).” (Ex.1028 107). But the '140 application does not give an example of using the user’s location to determine and warn the user that *the user is leaving the virtual environment*, as recited. Rather, the '140 application describes shifting from binaural sound to stereo or mono when a user is in a dangerous location in real life where binaural sound may be dangerous or distracting. That user is not in or leaving a virtual environment and receives no such alert. Indeed, the user is not even wearing a HMD or other WED displaying a virtual environment. Ex.1028 119-120 (in a hazardous area such as a construction zone or driving an automobile), 146-47 (on a mountain); Roginska ¶¶ 225-227.

The '140 application also describes triggering events such as other people or characters entering or leaving the environment. *E.g.*, Ex.1028 107 (“a person walking into a room”), 141 (“visually rendered character vanishing from an

augmented or virtual environment”), 144 (“any [sound localization point] SLP that travels ‘off stage’ by leaving the room”). But there is no description of altering the sound to alert the user that *the user* is leaving the environment. Roginska ¶ 228.

The ’140 application’s as-filed claims do not provide the requisite written description support, either. They instead recite devices other than the recited WED or HMD, and those devices detecting various events other than the user leaving a virtual environment. For example, as-filed claim 1 recites sensing with a handheld portable electronic device (HPED) that “an object interferes with the SLP” (Ex.1028 171), claim 4 recites determining with an HPED that two SLPs overlap (Ex.1028 172), claim 8 recites “sensing, by the computer system ... an object at the SLP” (Ex.1028 173), and so forth. Roginska ¶ 229.

In sum, nowhere does the ’140 application, including its as-filed claims, describe alerting or warning the user that the user is leaving the environment by reducing the volume and/or otherwise altering the sound as recited. Roginska ¶¶ 225-229. Accordingly, the ’184 patent claims are not entitled to an effective filing date any earlier than their actual filing date, and Patentee cannot meet its burden to show otherwise.

**B. Overview of the Prior Art**

**1. Lyren (Ex.1008)**

Lyren is the published version of the earliest application in the '184 patent's alleged priority chain. As just discussed, however, the '184 patent is entitled only to its actual filing date. Lyren is therefore prior art under § 102(a), and not within an exception of § 102(b), because it was published on June 29, 2017, over one year before the '184 patent's actual June 16, 2019, filing date.

Lyren teaches providing binaural sound to a user and, and when an “event occurs,” reducing the sound's volume, switching it to stereo or mono, or otherwise altering it. Lyren Abstract, [0025] (“chang[ing] binaural sound in response to an event”), [0063]-[0096] (including many examples), [0097] (“Figures 4-16 provide examples of events for changing sound from binaural sound to stereo sound, mono sound, or altered binaural sound” and “other types of actions”); [0103] (“In FIGS. 4-16, example actions include ... one or more of switch the sound from binaural sound to stereo sound, switch the sound from binaural sound to mono sound, ... maintain binaural sound but alter the binaural sound, stop binaural sound, *discontinue playing sound, mute the sound, lower a volume of the sound, ... ‘cancel-out’ or quiet a sound or part of a sound* by processing it with Active Noise Control (ANC), provide a sound or audio alert, provide a visual alert, ...”); Roginska ¶ 85.

For example, Lyren teaches triggering an alteration of the sound provided to the user that localizes from the image (e.g., reducing volume and/or shifting from binaural to stereo or mono) based on events such as other people or characters entering or leaving a room or the environment. Lyren [0065] (“a person walking into a room”), [0225] (“visually rendered character vanishing from an augmented or virtual environment”), [0232] (“any SLP that travels ‘off stage’ by leaving the room”). Lyren also teaches altering the sound based on determining “a location (such as the location of an electronic device or of a person listening to the sound).” Lyren [0065]; *see also* Lyren [0123] (shifting from binaural to stereo or mono in locations where “it is dangerous to localize sound” such as “near a construction zone”), [0240] (same, when the user is on a steep mountain); Roginska ¶¶ 84-89.

## **2. Reif (Ex.1009)**

Reif is a U.S. Patent Publication. It is § 102(a) prior art because it was filed on June 26, 2017 and published on December 27, 2018, both before the ’184 patent’s actual filing date.

Reif describes using a bounding box with a safe region to allow a user wearing a HMD to safely experience a virtual environment. Reif Abstract. “When it is determined that the user is located outside the safe region of the bounding box, the VR system can modify what is presented to the user via the HMD” and it “can warn the user” that the user is leaving the environment. Reif Abstract; Roginska ¶ 90.

**C. Overview of the Combination – Motivation to Combine**

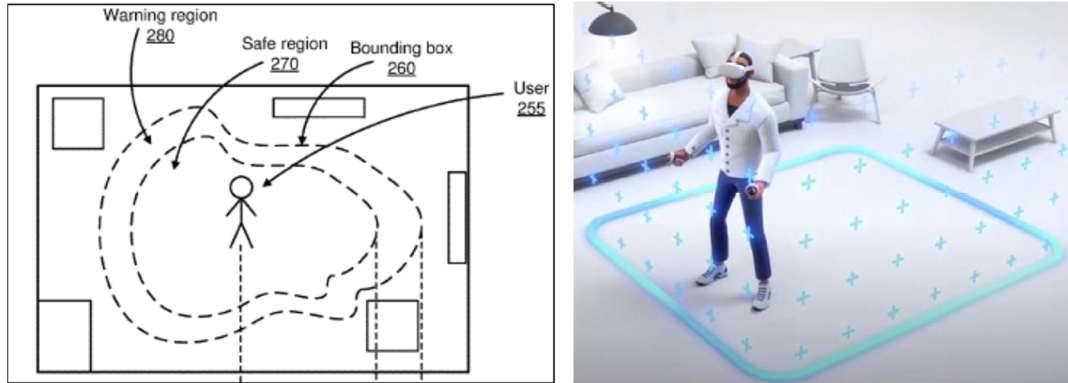
Lyren teaches nearly each and every claim element, but it does not disclose that its HMD/WED senses or determines when the user is leaving the 3D environment, and alerting or warning that user of that fact by altering the sound in the claimed manner(s).<sup>8</sup> Lyren, however, invites POSAs to apply its teachings to other events, stating that its techniques “are not limited to a specific type of an event or a specific time or duration of an event,” and that “events can be dynamic or static and selected by one or more of a user, a person, apparatus or machine, method, etc.” Lyren [0065]; Roginska ¶¶ 356, 88, 230-232.

Reif teaches detecting when the user is leaving the environment and alerting or warning the user of that fact. Reif also explains why a POSA implementing a HMD or other WED for viewing a virtual environment would have included such functionality. In particular, Reif explains that detecting such events was crucial for user safety—which Lyren expressly suggests is a valid concern. Lyren [0065]. Reif teaches identifying a “safe region,” like the one in Patentee’s infringement contentions, that excludes any real-life hazards to allows a user to move while

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<sup>8</sup> Also, to the extent that Patentee argues Lyren does not disclose any other claim elements, Patentee is admitting yet another reason the corresponding claim of the ’184 patent is not entitled to an earlier effective filing date.

engaged in the virtual environment and wearing an HMD that obscures the user's ability to see the real world:



Reif Fig. 2B; Ex.1084 9; *see also* Reif Abstract, Fig. 2A; [0003]-[0005] (safe region “enables a user wearing a head mounted display (HMD) to safely move around while still experiencing a virtual world or environment displayed via the HMD”), [0016]-[0023]; Roginska ¶¶ 356, 230-232, 251-257. To be sure, such regions were nothing new in this field. Ex.1080 4:49-5:24, 11:66-12:50, 13:34-45, 15:25-65, 16:10-32; Ex.1080 4; Ex.1083 [0060], Figs. 5-6, 9; Ex.1082 [0046], [0057]; Roginska ¶¶ 70, 155-161, 258; Ex.1095 210:20-211:12.

Reif also teaches warning the user when leaving the safe region. As Reif explains, “when it is determined that the user is located outside the safe region of the bounding box, the VR system can modify what is presented to the user via the HMD, can warn the user, and/or can suggest that the user move back to the safe region.” Reif Abstract, [0002]-[0005], [0016]-[0019]. A POSA would have implemented this feature to help protect the users from injury by bumping, hitting, tripping over, etc.,

real-world objects when moving around while viewing the virtual environment in the HMD (i.e., a type of head-mounted WED). Reif [0002], [0004], [0037]; Ex.1083 [0001], [0032], [0059]; Roginska ¶¶ 90, 251-254.

Reif teaches concurrently providing an audio indication to further alert or warn the user that the user is leaving the safe region and boundary box, and thus the virtual environment (which fades out when the user leaves the safe region). Reif [0039]; *see also* Element 14[d] below. Reif suggests a warning beep or voice message, but informs the POSA that “it should be appreciated that many variations are possible.” Reif [0039]; Roginska ¶¶ 255-256. Lyren discloses these many variations—including altering the binaural sound provided in the virtual environment by, *inter alia*, reducing its volume and/or switching it to stereo or mono. *See* Lyren Overview above; Roginska ¶¶ 248-250, 260-261.

It would have been obvious to use Lyren’s teaching of the claimed audible alerts/warnings, such as lowering the volume of the sound and/or switching to stereo or mono, in response to the event of the user leaving the virtual environment as discussed above. In particular, when the combination’s HMD detects that the “event” (in Lyren’s terms) of the user leaving the safe region (and thus the environment), it would have been obvious to lower the sound’s volume as taught by Lyren. *See, e.g.*, Lyren [0103]; Roginska ¶¶ 231-232, 261-263. A POSA would have known that Lyren’s techniques of lowering the volume or otherwise altering/degrading the

environment's binaural would have been particularly helpful in virtual games/environments—as was confirmed in a September 27, 2018 video posted on YouTube and cited in Patentee's infringement contentions. Ex.1085 13:00 to 14:40 (cited by Ex.1084 10);<sup>9</sup> Roginska ¶ 262.

As the Oculus engineers explained, they “needed some way to warn the player that [the player was] leaving the play space,” but a typical warning sound would be too loud during quiet scenes or too soft during louder scenes. Ex.1085 13:00 to 14:40. So instead of a using a warning sound, they “tried the absence of sound”—slowly reducing the environment's binaural sound's volume to zero. *Id.* (showing an example of the ramping down the binaural sound as leaving the space and fading out the virtual world, and ramping it back up when re-entering and fading back into the environment); Roginska ¶ 262 (summarizing this portion of the video, and also explaining why a POSA would have already known this).

For the same reasons, a POSA would have used Lyren's well-known technique of warning the user by altering the environment's binaural sound by reducing its volume and/or altering processing when determining or sensing that the user is leaving the environment (as taught by Reif). Roginska ¶¶ 262-263; *see also*

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<sup>9</sup> This video is prior art, but it is being used here as additional evidence of a POSA's knowledge at the relevant time supporting the motivation to combine.

Clement 9:20-31, 12:66-13:10 (similarly fading out audio); Sauk 11:40-41 (similarly reducing the “decibel level” of the sound).

**D. Independent Claim 14**

As with Ground 1, this Petition will address Claim 14 first.

**1. 14[pre]: a method executed by electronic devices**

To the extent the preamble is limiting, the combination teaches it. Lyren [0053], [0077], [0251]-[0253], [0258]-[0260], [0281]-[0282], Figs. 17, 18, 20; Reif Abstract, [0047]-[0048]; Roginska ¶¶ 357-358, 233-235.

**2. 14[b]: displaying a 3D virtual environment with a virtual image**

Lyren teaches this element. Lyren [0077] (placing a SLP in an empty space in real life that “include[s] images or video (e.g., images that are part of an augmented or virtual reality,” and displaying that image in, e.g., Alice’s “electronic glasses ... , [optical head-mounted display] OHMD, or a head-mounted display,” such that “the voice of Bob appears to emanate from the image of Bob”), [0085] (placing a SLP in an empty space in real life that is occupied in the virtual environment by a “virtual image” displayed in “3D images that appear through electronic glasses” or other “head-mounted display”), [0163]-[0164] (“Alice and Bob” chatting in a “visually rendered space” and “can see each other’s visual representation”), [0251]-[0252] (OHMD, smart glasses, or wearable electronic classes with a sound localization system (SLS) that performs any of the disclosed “functions or methods”), [0257]-

[0259] (SLS in the WEG or other HMD), [0281]-[0283], [0287]-[0288] (WEDs, WEGs), Figs. 17-18, 20; Roginska ¶¶ 357-358, 239-242.

Further, Reif also teaches displaying a 3D virtual environment in an HMD that includes virtual images in the environment. *E.g.*, Reif Abstract, [0002]-[0003] (HMD displaying a “virtual world or environment”), [0016]; Roginska ¶¶ 241-242 (explaining such virtual environment included virtual images in the environment as illustrated in Ex.1087, a video of an Oculus HMD in use at 1:02:18-1:03:8 (Oculus Quest); 26:33-28:07 (Oculus Rift)).

**3. 14[a]: storing HRTFs**

Lyren teaches this element. Lyren [0046] (“a SLS renders a source sound using an HRTF”), [0251]-[0252] (SLS in head-worn WED), [0256] (“Memory 1726 and/or dedicated memory in the SLS 1728 stores ... HRTFs”), [0283] (HRTFs stored in the electronic device), [0287] (WED stores HRTFs); Roginska ¶¶ 357-358, 236-238.

Accordingly, Lyren teaches storing the HRTFs in the head-worn WED’s memory, as required by the claim. Roginska ¶¶ 236-238.

**4. 14[c]: a DSP processing sound using HRTFs to generate binaural sound that externally localizes to the user at the virtual image**

Lyren teaches this element. First, Lyren teaches that its SLSs use HRTFs to generate binaural sound. Lyren [0046] (“a SLS renders a source sound using an

HRTF”), Lyren [0077] (placing a SLP at the position of a virtual image, i.e., in an environment that “include[s] images or video (e.g., images that are part of an augmented or virtual reality” such that, e.g., “the voice of Bob appears to emanate from the image of Bob”), [0085] (placing a SLP in an empty space in real life that is occupied by a “virtual image” displayed in “3D images that appear through electronic glasses” or other HMD), [0163]-[0164] (“Alice and Bob” chatting in a “visually rendered space” and “can see each other’s visual representation”); Roginska ¶¶ 357-358, 244.

Second, Lyren teaches that its WEDs worn on the user’s head include the just-described SLS, and that SLS uses one or more DSPs to process the sound as just discussed. Lyren [0043]-[0045], [0251]-[0252] (OHMD, smart glasses, or wearable electronic classes with a SLS that performs any of the disclosed “functions or methods”), [0256] (“Sound localization system 1728 includes ... a digital-to-audio converter (DAC), decompressor/decoder, digital signal processor (DSP), and includes hardware and/or software to process and localize sound to a SLP.”), [0257]-[0259] (SLS in the WEG or other HMD), [0270] (“audio rendering”), [0281]-[0283],

[0287]-[0288] (WEDs, WEGs), Figs. 11, 17, 18, 20; *see also id.* [0166]-[0177] (adjusting HRTFs); Roginska ¶ 245.<sup>10</sup>

In addition, it would also have been obvious to process the HRTFs using a DSP as recited in the claims. As discussed for Ground 1, Element 14[c], using DSPs for such HRTF processing was well-known, common, and routine. And POSAs would have understood the advantages of using a DSP for processing of spatial sound, including efficient processing of digital signals while using little power or space. Roginska ¶ 246, 138-153; Ex.1095 212:24-213:13.

**5. 14[d]: alerting the user that the user is leaving the virtual image in environment by altering processing and reducing the sound's volume**

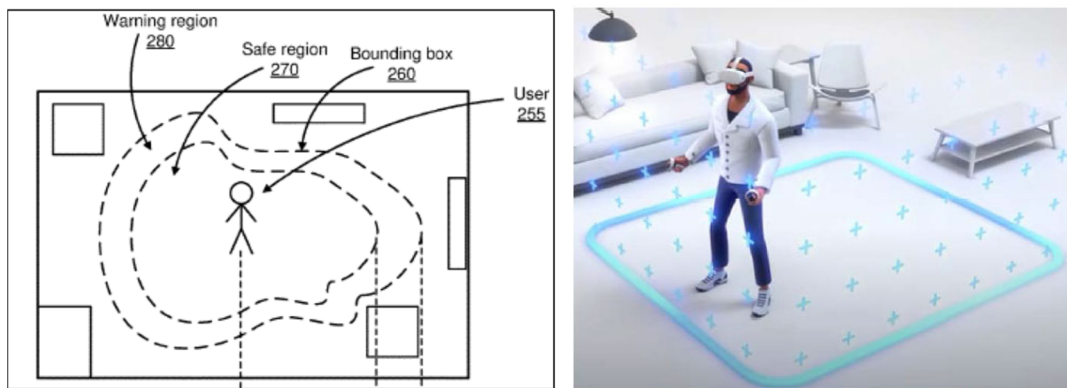
Lyren does not teach this element. It does, however, teach determining when “a wide variety of different types of [other] events” occur, and altering the binaural sound by, *inter alia*, reducing its volume and/or switching it to stereo or mono. Lyren [0025], [0063]-[0097], [0103]; *see also* Lyren Overview above. Lyren also invites POSAs to apply its teachings to other events. Lyren [0065]; *see also* Motivation to Combine section above.

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<sup>10</sup> These cites to Lyren include Patentee’s alleged structure and algorithms to perform this step, even if it is construed under § 112(f). Ex.1090 29, 45 (citing Lyren); Ex.1091 ¶¶ 15-16; Ex.1095 59:4-16.

Reif provides that teaching, and also explains that a POSA implementing a HMD or other WED for viewing a virtual environment (as in Lyren) would have included such functionality for safety reasons, i.e., to help protect users from injury by bumping or tripping over objects in the real world. *See* Motivation to Combine section above.

In particular, Reif teaches identifying a “safe region,” like the one in Patentee’s infringement contentions, that allows a user to move around safely while engaged in the virtual environment:



Reif Fig. 2B; Ex.1084 9; *see also* Motivation to Combine sections above. Reif also teaches warning the user as recited in the claims. “[W]hen it is determined that the user is located outside the safe region of the bounding box, the VR system can modify what is presented to the user via the HMD, can warn the user, and/or can suggest that the user move back to the safe region.” Reif Abstract, [0002]-[0005], [0016]-[0019]; Roginska ¶¶ 359-362, 252-254.

Reif further teaches that sensors on the user's HMD are used to determine the user's location in the real world, and thus the user's location relative to the "bounding box" shown above. Reif [0033]. This, too, was known in the art. Ex.1080 4:49-5:24; Ex.1083 [0056]; Roginska ¶¶ 45-48, 257-259; Ex.1095 250:2-9 (systems in the 1980s used tracking techniques); 229:25-230:10 (prior art sensors and tracking); *see also* Ground 1, Element 14[d] above.

Reif's HMD determines when the user is leaving the environment based on the user's location, and warns the user that the user is leaving the safe region and the 3D virtual environment displayed in the HMD by transitioning the user out of the environment. In particular, Reif gradually fades out the virtual embodiment as the user transitions from inside the safe region, through the warning zone, and to an area outside the bounding box, where the virtual environment is no longer visible. Reif [0016]-[0018], [0036]; *see also id.* [0002] (degrading the virtual environment as the user moves outside), [0004]-[0005] (transitioning from virtual environment to real world when moving from inside to outside the bounding box), [0019]-[0028] (similar examples), Figs. 2A-2D (graphical illustration of fade out); Roginska ¶ 254.

Reif also teaches audibly alerting or warning the user that the user is leaving the safe region and boundary box (and thus the virtual environment that fades out) with a beep, voice message, or any other of the "many variations" known to a POSA. Reif [0039]. Lyren discloses such variations—including altering the binaural sound

provided in the virtual environment by, *inter alia*, reducing its volume and/or switching it to stereo or mono. *See, e.g.*, Lyren [0103]; Lyren Overview above; Roginska ¶¶ 255-268.

A POSA would have used these audible alerts/warnings taught in Lyren to alert the user that the user is leaving the safe zone (and thus the virtual environment), as taught by Reif, to help keep users safe. *See* Motivation to Combine section above; Roginska ¶¶ 250-268.

\* \* \*

Accordingly Lyren and Reif render obvious claim 14.

#### **E. Dependent Claims 15-20**

These claims are unpatentable for the same reasons as claim 14 and as further explained below. Each will be addressed in turn.

##### **1. Claim 15: changing ITDs, ILDs, or HRTFs**

This claim recites that the altering of Element 14[d] is changing at least one of ITDs, ILDs, or HRTFs as the user leaves the environment. As discussed with respect to Element 14[d] above, Lyren teaches this. Lyren [0046] (changing binaural sound to “non-binaural audio” by adjusting spatial parameters such as “specific alterations per an ITD and/or interaural level difference (ILD)”); *see also* Lyren [0031], [0045], [0103]; Roginska ¶¶ 363-364, 264-268.

**2. Claim 16: stopping HRTF processing**

This claim recites alerting the user by stopping the DSP's HRTF processing of the binaural sound.

The combination teaches this for the reasons explained with respect to element 14[d] and as further explained here. The DSP (*see* Element 14[c]) alters its processing to provide stereo or mono audio, as discussed. One way that the DSP may do so is to stop the DSP's processing of the binaural sound with HRTFs. Lyren [0046] (changing binaural sound to “non-binaural audio” by “discontinu[ing] rendering or using the HRTF or ITD/ILD calculations”). Further, Lyren expressly discloses stopping HRTF processing in response to an event. Lyren [0103] (“stop binaural sound, discontinue playing sound, mute the sound ... cancel a SLP, ”), [0124] (“The earphones immediately stop localizing the voice of Bob”), [0246] (“the binaural music stops playing”), [0292] (“stopping transmission or emission of binaural sound, etc.”); Roginska ¶¶ 365-366.

**3. Claim 17: removing ITDs**

This claim recites alerting the user by removing ITDs.

The combination teaches this for the reasons explained with respect to element 14[d] and claim 15. *See also* Lyren [0045] (“us[ing] a DSP ... to ... eliminate sufficient audio cues to prevent a listener from experiencing external localization”), [0046] (changing binaural sound to “non-binaural audio” by “discontinu[ing]

rendering or using the HRTF or ITD/ILD calculations”), [103]. Roginska ¶¶ 367, 270.

**4. Claim 18: eliminating spatial cues**

This claim recites alerting the user by eliminating spatial cues in the binaural sound.

The combination teaches this for the reasons explained with respect to element 14[d] and claims 15-17. *See also* Lyren [0045] (“us[ing] a DSP ... to ... eliminate sufficient audio cues to prevent a listener from experiencing external localization”), [0046] (changing binaural sound to “non-binaural audio” by “discontinu[ing] rendering or using the HRTF or ITD/ILD calculations”); Roginska ¶¶ 368-369, 264-268.

**5. Claim 19: alerting by switching from binaural to stereo or mono**

This claim recites alerting the user by switching to stereo or mono sound. The combination teaches this for the same reasons explained with respect to element 14[d]. Roginska ¶¶ 370, 359-362.

**6. Claim 20: switching the binaural to stereo in response to detecting a voice with the WED’s microphone**

Lyren teaches this and also renders it obvious. Lyren teaches switching binaural sound in response to detecting a wide variety of events, such as “actions of a third person (such as a person walking into the room)” or when the WED “detects a presence of a sound or an image.” Lyren [0065], [0104]. Thus, if a person in a

user's environment physically walks up to the user and speaks, the user's microphone (on the user's WED) detects the person's voice—creating a triggering event. Lyren [0107]; Roginska ¶¶ 371, 273-275.

One of the actions that Lyren may take upon detecting such an event is switching the binaural sound to stereo. Lyren Abstract, [0023], [0025], [0066], [0105]. Lyren therefore teaches switching the binaural sound to stereo in response to detecting the person's voice, as recited in the claim. Roginska ¶ 276.

In addition, it would have been obvious to do so. Lyren explains that users are irritated, disquieted, and/or confused when sounds localize from the wrong position. *E.g.*, Lyren [0072] (If a sound localizes “from [the wrong] person” or “from a wall” when it should not, this “confuses or frustrates the [user].”), [0106] (Max's voice originating from the wrong place “confuses or disquiets” Alice.), [0217] (Alice is “confused” when she cannot distinguish between sounds in her environment vs. her earphones), [0225] (“a user is irritated by the positional blurring he perceives to SLPs that do not have a corresponding visual anchor, and the system switches accordingly.”); Roginska ¶ 277. And a POSA would have known that a user would likewise have been confused, frustrated, or irritated if this happens. Roginska ¶¶ 273-277. Accordingly, a POSA implementing the combination would switch to stereo to avoid that confusing/irritating situation, as taught by Lyren. Roginska ¶ 277.

**F. Independent Claim 7**

Independent claim 7 is generally similar to claim 14, except that it alerts the user by “altering processing of the sound by the DSP to degrade a spatial cue and to lower a volume of the sound playing to the user.”

**1. Elements 7[pre] to 7[c]**

These elements are taught by the combination for the same reasons discussed above for corresponding Elements 14[pre] to 14[c]. As discussed for Ground 1, the differences between Elements 7[pre] to 7[c] and 14[pre] to 14[c] do not affect the analysis. Roginska ¶¶ 357-358, 233-246.

**2. 7[d]: alerting the user by degrading a spatial cue and lowering the volume**

This element recites alerting the user that the user is leaving the environment, like Element 14[d], but does so but does so by “altering processing of the sound by the DSP to degrade a spatial cue and to lower a volume of the sound playing to the user.” “Spatial cues are ITDs and ILDs or head-related-transfer-functions (HRTFs).” Lyren [0031].

The combination teaches degrading spatial cues (e.g., modifying, removing, or otherwise degrading ITDs, ILDs, and HRTFs) for the same reasons discussed above for Element 14[d] and claims 15-17. Roginska ¶¶ 359-362, 247-263.

**G. Dependent Claims 8-13**

These claims are unpatentable for the same reasons as claim 7 and as further explained below.

**1. Claim 8: degrading ITDs**

This claim recites that the degraded spatial cue is an ITD. The combination teaches this for the same reasons explained with respect to Element 14[d] and claims 15-17 above. Roginska ¶¶ 378, 375-377.

**2. Claim 9: character voice in stereo**

This claim recites switching a game character's voice from binaural to stereo when the character is no longer displayed.

The combination teaches this. First, the combination contemplates performing the claimed methods while playing a computer game: Reif and Lyren both explain that their teachings apply to computer games. Reif [0040]-[0044]; Lyren [0282]; Roginska ¶ 284 (explaining that a POSA would understand the described virtual environments in both commonly occur in computer games). Further, Lyren teaches detecting the triggering event of “a visually rendered character vanishing from [the] virtual environment” (is no longer displayed) and in response, “switches the SLP [of the now-vanished character] to stereo or mono” to prevent confusing or irritating the user. Lyren [0225]; Roginska ¶¶ 379, 285.

**3. Claim 10: alerting the user by switching binaural to stereo**

This claim recites alerting the user by switching to stereo sound. This is taught for the reasons discussed for Element 7[d] above. Roginska ¶¶ 380, 286.

**4. Claim 11: stereo button on WED**

Lyren teaches this. Lyren [0236] (“switch or button”), [0238] (“switch that turns on and off binaural sound” to “stereo” or “mono”). Roginska ¶¶ 381, 287-288.

**5. Claim 12: reduce character’s volume when not facing character**

Lyren renders this obvious. The combination contemplates performing the claimed methods while playing a computer game. *See* Claim 9 above. Lyren teaches tracking the user’s head, and detecting which SLP/image the user is facing (e.g., which character the user is facing in a virtual game), and which ones she is not. Lyren [0242], [0172] (tracking user’s gaze with respect to speaking characters), [0225] (augmented reality). Lyren teaches reducing the volume of an SLP/image (e.g., the voice of the character) when an event, such as not facing the SLP/image (character), is detected. Lyren [0067] (“different volumes at SLPs”), [0103] (upon detecting event, “lower a volume of the sound” or “raise the volume of the sound”). A POSA would have thus lowered the volume of the speaking character’s voice when the user is not facing the character to help the user focus on what she is facing, and because users expect to better hear sounds in front of them. Roginska ¶¶ 382, 289-291.

**6. Claim 13: switch to stereo when physical object interferes**

Lyren teaches this. Lyren [0052] (“The third person 146 collides, interferes, or overlaps with the SLP 144” and because all other potential locations are occupied, “the system decides to switch the call to stereo.”), [0072] (voice appearing to originate from the wall or other people in the elevator is frustrating and confusing, so switch to stereo), [0105] (“Charlie walks up to Alice and interferes with the SLP” corresponding to Bob, so “the voice of Bob that Alice hears switches from binaural sound to stereo”), [0110]; Roginska ¶¶ 383, 292-293.

**H. Independent Claim 1**

Independent claim 1 is unpatentable for the same reasons as claim 14, and as further explained below.

**1. Elements 1[pre] to 1[c]**

These elements are taught by the combination for the reasons explained with respect to Elements 14[pre] to 14[c]. And as discussed for Ground 1, the differences between Elements 7[pre] to 7[c] and 14[pre] to 14[c] do not affect the analysis. Roginska ¶¶ 384-387.

**2. 1[d]: warning the user that the user is leaving the environment by altering a spectral cue and reducing the sound’s volume**

This element recites warning the user that the user is leaving the environment, like Element 14[d], but does so by filtering with the DPS the binaural sound to alter a spectral cue and lower a volume of the sound playing to the user. “Spectral cues

arise from an interaural level difference (ILD) due to shadowing of sound around the head.” Lyren [0031].

This (including altering spectral cues by altering ILDs) is taught by the combination for the reasons discussed above for Element 14[d] and claims 15-17. Roginska ¶¶ 388-390.

## **I. Dependent Claims 2-6**

These claims are unpatentable for the same reasons as claim 7 and as further explained below.

### **1. Claim 2: removing background sound**

This claim further recites removing background sound as part of the warning. As already discussed with respect to Element 14[d] (and thus Element 1[d]), the environment’s sounds may be reduced or muted. Lyren [0103] (“stop binaural sound, discontinue playing sound, mute the sound, lower a volume of the sound”), [0260]; Roginska ¶¶ 391, 298-299; *see also* Claim 9 above (explaining that combination teaches performing the claimed methods in a game).

Further, Lyren expressly discloses removing the background sound in particular. Lyren [0089] (triggering event, in our example is leaving the environment, causes removal of the environment’s background sounds, i.e., “first set of background sound”); Roginska ¶ 299.

**2. Claim 3: leaving virtual area**

This claim further recites that the warning occurs when the user leaves a virtual area where the image is located while remaining in the 3D virtual environment.

The combination teaches this claim element for the reasons explained above with respect to Element 1[d] (and thus 14[d]), and as further explained here. In particular, Lyren teaches that when a third person “travels ‘off stage’ by leaving the room can still be included in the conversation, but the sound can switch to mono or stereo.” Lyren [0232], [0053] (person walks out the door and out of the sight of the user), [0065] (“a person walking into a room” is a triggering event); [0067] (lowering the volume), [0103] (same).

It would have been obvious to implement the converse—when the user is the one who leaves the (virtual) area, alter the audio cues to prevent the user from experiencing external localization of the sounds (e.g., from the other people remaining in the room) and by lowering a volume of those sounds. The reasoning is the same whether, e.g., three people leave the area and the user remains behind, or if the user leaves the area and three people remain. In either case, the user is now in another area and would expect the volume to be reduced and to be unable to localize the persons’ locations because they are, e.g., on the other side of a wall. Roginska ¶¶ 300-302, 392.

In addition and in the alternative, Reif teaches first triggering the warning when the user crosses from the safe region (i.e., a virtual area) into the warning region (which is still in the environment), and gradually fading out the virtual environment as the user traverses the warning region. *E.g.*, Reif [0017]-[0018] (fading out the virtual environment until “the user’s location is determined to be outside the bounding box” which causes the “HMD 150 to cease displaying the virtual environment to the user.”). A POSA implementing the safe and warning zones of Reif would have likewise reduced the volume of the sounds and the audio cues gradually and while still inside the environment (i.e., still able to perceive it) to correspond to the visual fade out as the user travels through the warning region to provide a pleasing, coherent and seamless experience. Ex.1086 13:35-13:45 (“ramps nice and smooth ... because you want to keep everybody immersed”); Roginska ¶ 303; *see also* Element 14[d] above.

**3. Claim 4: switching to stereo when the user is faced away from a virtual image**

This claim further recites that the HMD tracks the position of the user’s head, and when the user faces away from the virtual image such that the virtual image is no longer visible, switching the sound from the image to stereo.

Lyren renders this obvious. Lyren teaches tracking the user’s head, and detecting which SLP/image she is facing, and which ones she is not. Lyren [0242]; *see also id.* [0172] (tracking user’s gaze with respect to speaking characters). Lyren

teaches switching the binaural sound of an SLP/image to stereo when an event, such as not facing the SLP/image, is detected because that indicates the user is not focused on that object, while providing binaural sound from the object that is the focus of the user's attention. Lyren [0067] (“The sound changes from being provided in binaural sound to being provided in stereo sound.”), [0103] (upon detecting event, “switch the sound from binaural sound to stereo sound”); [0233] (“Focus of the listener, for example, can be judged by a gaze”), [0242] (binaural sound only from the object of the user's gaze, i.e., “the SLP in her focus is perceived at the location of its corresponding image”). Thus, a POSA would have switched the out of focus audio (i.e., the audio from images the user is not facing) to stereo, as taught by Lyren. *See also* Sauk 11:26-41 (switching audio to stereo to signify relevance); Roginska ¶¶ 393, 304-305.

#### **4. Claim 5: stereo button on HMD**

Lyren teaches this. Lyren [0236] (“switch or button”), [0238] (“switch that turns on and off binaural sound” to “stereo” or “mono”). Roginska ¶¶ 394, 306.

#### **5. Claim 6: switching from binaural to stereo when the virtual image vanishes**

This claim further recites switching the binaural sounds from the virtual image to stereo when the image vanishes from the 3D virtual environment.

The combination teaches this. In particular, Lyren teaches detecting the triggering event of “a visually rendered character,” i.e., the claimed virtual image,

“vanishing from [the] virtual environment,” and in response, “switches the SLP [of the now-vanished image] to stereo or mono” to prevent confusing or irritating the user. Lyren [0225]; Roginska ¶¶ 395, 307-308.

\* \* \*

Accordingly, the combination renders obvious the challenged claims.

## **VI. Secondary Considerations**

There are no secondary considerations known to Petitioners that affect—let alone overcome—the strong cases of obviousness set out above. Should Patentee proffer any relevant evidence of secondary considerations in its preliminary response, Petitioners should be given leave to reply.

## **VII. The Board Should Reach the Merits of This Petition**

The Board should reach the merits of this petition and should not exercise its discretion to deny based on 35 U.S.C. § 314(a) or § 325(d). None of the prior art at issue in this petition was cited or relied upon during prosecution of the '184 patent. As for the district court case, the court is currently deciding a motion to transfer. *See Eight kHz, LLC v. Meta Platforms, Inc.*, No. 6:22-cv-00575-ADA-DTG, Dkt. Nos. 46, 48, 90 (W.D. Tex.).

Petitioners reserve the right to address any discretionary issues raised by Patentee based on the facts and law as they stand at that time.

## **VIII. Mandatory Notices under 37 C.F.R. § 42.8**

### **A. Real Parties-in-Interest**

Petitioners are the only real parties-in-interest.

### **B. Related Matters**

Patentee asserted the '184 patent in *Eight kHz, LLC v. Meta Platforms, Inc.*, No. 6:22-cv-00575-ADA-DTG (W.D. Tex. Jun. 3, 2022).

Petitioners are also petitioning for IPR of the related USP 10,368,179, and Application No. 16/401,242 is currently pending before the Office.

### **C. Grounds for Standing**

Petitioners certify that the '184 patent is available for IPR and that Petitioners are not barred from requesting this proceeding.

### **D. Lead and Backup Counsel and Service Information**

Pursuant to 37 C.F.R. §§ 42.8(b)(3), 42.8(b)(4), and 42.10(a), Petitioners designate the following lead counsel:

- Inge A. Osman (Reg. No. 74,480), inge.osman@lw.com, Latham & Watkins LLP; 555 Eleventh Street, NW, Ste. 1000; Washington, DC 20004-1304; 202.637.3308 (Tel.); 202.637.2201 (Fax).

Petitioners also designate the following backup counsel:

- Christopher W. Henry (Reg. No. 60,907), christopher.henry@lw.com, Latham & Watkins LLP; 200 Clarendon Street; Boston, MA 02116; 617.880.4550 (Tel.); 617.948.6001 (Fax).

Petition for *Inter Partes* Review of USP 10,448,184

- Jonathan M. Strang (Reg. No. 61,724), jonathan.strang@lw.com, Latham & Watkins LLP; 555 Eleventh Street, NW, Ste. 1000; Washington, DC 20004-1304; 202.637.2362 (Tel.); 202.637.2201 (Fax).
- Linfong Tzeng (Reg. No. 65,140), linfong.tzeng@lw.com, Latham & Watkins LLP; 140 Scott Drive, Menlo Park, CA 94025; 650.463.3092 (Tel.); 650.463.2600 (Fax).
- Kimberly Q. Li (Reg. No. 74,713), kimberly.li@lw.com, Latham & Watkins LLP; 200 Clarendon Street; Boston, MA 02116; 617.880.4529 (Tel.); 617.948.6001 (Fax), and
- Razi Safi (Reg. No. 75,594), razi.safi@lw.com, Latham & Watkins LLP; 555 Eleventh Street, NW, Ste. 1000; Washington, DC 20004-1304; 202.637.2120 (Tel.); 202.637.2201 (Fax).

Pursuant to 37 C.F.R. § 42.10(b), a Power of Attorney from Petitioners is attached. Petitioners consent to electronic service.

**E. Fee for *Inter Partes* Review**

The Director is authorized to charge the fee specified by 37 C.F.R. § 42.15(a) to Deposit Account No. 506269.

**IX. Conclusion**

IPR of the challenged claims of the '184 patent should be instituted, and each challenged claim should be found unpatentable.

Respectfully submitted,

Dated: June 8, 2023

By: / Inge A. Osman /

Inge A. Osman (Reg. No. 74,480)  
inge.osman@lw.com  
Latham & Watkins LLP  
555 Eleventh Street, NW, Ste. 1000  
Washington, DC 20004-1304  
Telephone: 202.637.2200  
Fax: 202.637.2201

*Counsel for Petitioners  
Meta Platforms, Inc., Meta Platforms  
Technologies, LLC, and Twisted Pixel  
Games, LLC*

**Claims Appendix**

The following listing of the challenged claims adds labels to the claim elements for clarity:

1[pre] A method comprising:

[a] storing head-related transfer functions (HRTFs);

[b] displaying, with a display of a head mounted display (HMD) worn on a head of a user, a three-dimensional (3D) virtual environment that includes a virtual image;

[c] processing, by a digital signal processor (DSP), sound with the HRTFs to generate binaural sound that plays to the user and that externally localizes in empty space at the virtual image in the 3D virtual environment; and

[d] warning the user that the user is leaving the 3D virtual environment by filtering, by the DSP, the binaural sound to alter a spectral cue and lower a volume of the sound playing to the user.

2. The method of claim 1 further comprising:

warning the user that the user is leaving the 3D virtual environment by removing, by the DSP, background sound that occurs in the 3D virtual environment as part of a game the user is playing.

3. The method of claim 1, wherein the warning occurs when the user is leaving a virtual area where the virtual image is located while remaining in the 3D virtual environment.

4. The method of claim 1 further comprising:

tracking, with head tracking in the HMD, head movements of the user; and

switching the sound from the binaural sound to stereo sound when a face of the user is directed away from the virtual image such that the virtual image is no longer visible to the user.

5. The method of claim 1 further comprising:

switching the sound from the binaural sound to stereo sound when the user activates a button located on the HMD.

6. The method of claim 1 further comprising:

switching the sound from the binaural sound to stereo sound when the virtual image vanishes from the 3D virtual environment.

7[pre] A method executed by one or more electronic devices, the method comprising:

[a] storing head-related transfer functions (HRTFs);

[b] displaying, by a display of a wearable electronic device (WED) worn on a head of a user, a virtual image in an environment;

[c] processing, by a digital signal processor (DSP), sound with the HRTFs to generate binaural sound that plays to the user and that externally localizes at the virtual image in the environment; and

[d] alerting the user that the user is leaving the environment by altering processing of the sound by the DSP to degrade a spatial cue and to lower a volume of the sound playing to the user.

8. The method of claim 7, wherein the spatial cue includes an interaural time difference (ITD).

9. The method of claim 7 further comprising:

displaying, by the WED, the virtual image while the user plays a game that includes a character as the virtual image; and

switching a voice of the character from the binaural sound to stereo sound when the WED no longer displays the virtual image during the game.

10. The method of claim 7 further comprising:

alerting the user that the user is leaving the environment by switching the binaural sound to stereo sound.

11. The method of claim 7 further comprising:

switching the binaural sound to stereo sound upon activation of a button on the WED.

12. The method of claim 7 further comprising:

wherein the WED includes electronic glasses, the environment is a physical room where the user is located, the virtual image is an augmented reality (AR) character that speaks to the user while the user plays a game, the WED includes head tracking, and a digital signal processor (DSP) in the WED reduces a volume of the binaural sound to alert the user when a face of the user is not directed to the virtual image in the environment.

13. The method of claim 7 further comprising:

sensing, with the WED, when a physical object interferes with a location of the virtual image in the environment; and

switching the binaural sound to stereo sound in response to sensing the physical object interferes with the location of the virtual image in the environment.

14. A method executed by one or more electronic devices, the method comprising:

[a] storing head-related transfer functions (HRTFs);

[b] displaying, with a wearable electronic device (WED) worn on a head of a user, a virtual image in an environment;

[c] processing, by a digital signal processor (DSP), sound with the HRTFs to generate binaural sound that externally localizes to the user at the virtual image in the environment; and

[d] alerting the user that the user is leaving the virtual image in the environment by altering processing of the binaural sound by the DSP and reducing a volume of the binaural sound that localizes to the user at the virtual image.

15. The method of claim 14, wherein the DSP alters processing of the binaural sound to alert the user by changing a spatial cue that includes at least one of an interaural time difference (ITD), an interaural level difference (ILD), and the HRTFs.

16. The method of claim 14 further comprising:

    alerting the user that the user is leaving the environment by stopping, by the DSP, the processing of the sound with the HRTFs.

17. The method of claim 14 further comprising:

    alerting the user that the user is leaving the environment by removing interaural time differences (ITDs) of the binaural sound being provided to the user.

18. The method of claim 14 further comprising:

    alerting the user that the user is leaving the environment by eliminating one or more spatial cues in the binaural sound being provided to the user.

19. The method of claim 14 further comprising:

    alerting the user that the user is leaving the environment by switching the binaural sound playing to the user to one of stereo sound and mono sound.

20. The method of claim 14 further comprising:

    detecting, with a microphone in the WED, a voice of a person in the environment of the user; and

    switching the binaural sound to stereo sound in response to detecting the voice.

**CERTIFICATE OF COMPLIANCE WITH 37 C.F.R. § 42.24**

I hereby certify that this Petition complies with the word count limitation of 37 C.F.R. § 42.24(a)(1)(i) because the Petition contains a total of 13,949 words, which is the sum of 13,931 words calculated by Microsoft Word's word-count feature and 18 words hand-counted in the figures. This total excludes the cover page, signature block, and the parts of the Petition exempted by 37 C.F.R. § 42.24(a)(1).

By: / Inge A. Osman /

Inge A. Osman (Reg. No. 74,480)  
inge.osman@lw.com  
Latham & Watkins LLP  
555 Eleventh Street, NW, Ste. 1000  
Washington, DC 20004-1304  
Telephone: 202.637.2200  
Fax: 202.637.2201

*Counsel for Petitioners*  
*Meta Platforms, Inc., Meta Platforms*  
*Technologies, LLC, and Twisted Pixel*  
*Games, LLC*

**CERTIFICATE OF SERVICE**

The undersigned certifies that a complete copy of this Petition for *Inter Partes* Review of U.S. Patent No. 10,448,184 and all Exhibits and other documents filed together with this Petition were served on the official correspondence address for the patent shown in Patent Center:

Philip S. Lyren  
Philip S. Lyren, PC  
289 Woodland Avenue  
Wadsworth, OH 44281

via FEDERAL EXPRESS next business day delivery, on June 8, 2023.

By: / Inge A. Osman /

Inge A. Osman (Reg. No. 74,480)  
inge.osman@lw.com  
Latham & Watkins LLP  
555 Eleventh Street, NW, Ste. 1000  
Washington, DC 20004-1304  
Telephone: 202.637.2200  
Fax: 202.637.2201

*Counsel for Petitioners*  
*Meta Platforms, Inc., Meta Platforms*  
*Technologies, LLC, and Twisted Pixel*  
*Games, LLC*