

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re *Inter Partes* Review of:)
U.S. Patent No. 11,172,316)
Issued: Nov. 9, 2021)
Application No.: 17/062,633)
Filing Date: Oct. 5, 2020)

For: **Wearable Electronic Device Displays A 3D Zone From Where Binaural
Sound Emanates**

**PETITION FOR *INTER PARTES* REVIEW
OF U.S. PATENT NO. 11,172,316**

TABLE OF CONTENTS

I.	Introduction.....	1
II.	Identification of Challenges.....	2
III.	Background.....	3
	A. The '316 Patent	3
	B. POSAs	5
	C. Claim Construction	5
IV.	Ground 1: Claims 1-20 Are Unpatentable Over Pedrotti in View of Jang, and Further in View of Begault.....	5
	A. Overview of Pedrotti	5
	B. Overview of Jang.....	7
	C. Overview of Begault	8
	D. Motivations to Combine.....	9
	E. Claim 1	11
	1. 1[pre]: A Method	11
	2. 1[a]: PED Dividing An Area Into Zone Including An SLP	11
	3. 1[b]: WED's Speakers Play Binaural Sound	18
	4. 1[c]: Tracking With WED When PED Is Moving Outside Zone.....	18
	5. 1[d]: Displaying VR Image Showing Zone	21
	F. Dependent Claims 2-8.....	22
	1. Claim 2.....	22
	a. 2[a]: Highlighting VR Image At SLP When PED Is Pointed At SLP	22

b.	2[b]: Playing With WED Binaural Sound In Response	26
2.	Claim 3: Displaying VR Image Showing Size And Shape Of Zone When PED Is Moving Outside Zone.....	27
3.	Claim 4	27
a.	4[a]: Storing Location, Size, And Shape of Zone, And Location Of SLPs In Memory Of WED	27
b.	4[b]: Retrieving Size And Shape In Response To WED Determining User Is In Location Of Zone	29
4.	Claim 5	30
a.	5[a]: Designating With PED Locations Of Multiple SLPs	30
b.	5[b]: Displaying VR Images At Locations Of Multiple SLPS	30
5.	Claim 6	31
a.	6[a]: Selecting SLP When PED Is Pointed At SLP	31
b.	6[b]: Displaying VR Image At SLP	32
6.	Claim 7: Cylindrical Or Rectangular Zone, Where User Is Centered	32
7.	Claim 8: Playing Audio Warning In Response to PED Moving Outside Zone	33
G.	Claim 9	34
1.	9[pre]: A Method	34
2.	9[a]: Dividing, With PED, An Area Into 3D Zone With SLPs	34
3.	9[b]: Determining With WED When User Is Leaving Zone.....	35

4.	9[c]: Warning User Is Leaving By Displaying 3D VR Image of Zone	36
H.	Dependent Claims 10-16	36
1.	Claim 10	37
a.	10[a]: Determining When PED Is Pointed at SLP	37
b.	10[b]: Playing With WED Binaural Sound In Response	37
2.	Claim 11: Highlighting Color Of VR Image At SLP	37
3.	Claim 12	38
a.	12[a]: Cylindrical 3D VR Image Of Zone, Where User Is Centered	38
b.	12[b]: WED Is HMD That Displays VR Images	38
c.	12[c]: WED Plays Binaural Sound While User Plays Game	38
4.	Claim 13	38
a.	13[a]: Rectangular 3D VR Image Of Zone, Where User Is Centered	38
b.	13[b]: WED Is HMD That Displays VR Images	39
c.	13[c]: WED Plays Binaural Sound While User Plays Game	39
5.	Claim 14: Playing Audio Warning Indicating User Should Move Back Into Zone	39
6.	Claim 15: Cylindrical 3D VR Image Of Zone Extends Around User	39
7.	Claim 16	40
a.	16[a]: Determining With WED When PED Is Leaving Zone	40

b.	16[b]: Warning User By Displaying 3D VR Image Of Zone	40
I.	Claim 17	40
1.	17[pre]: An Electronic System.....	40
2.	17[a]: PED That Divides An Area Into 3D Zone With SLPs	41
3.	17[b]: WED Worn On Head Of User	41
4.	17[c]: WED Wirelessly Communicates With PED.....	41
5.	17[d]: Speakers That Play Binaural Sound.....	42
6.	17[e]: Sensors That Sense PED Is Leaving Zone.....	42
7.	17[f]: Display Displays VR Image Of Zone.....	42
8.	17[g]: Display Displays VR Image of Zone To Warn That User Is Leaving.....	42
J.	Dependent Claims 18-20.....	43
1.	Claim 18: Display Highlights Color Of VR Image At SLP	43
2.	Claim 19: Automatically Displays VR Image	43
3.	Claim 20.....	44
a.	20[a]: Speakers In WED Play Binaural Sound In Response To PED Pointing At SLP	44
b.	20[b]: Cylindrical Zone, Where User Is Centered	44
V.	Ground 2: Claims 1-20 Are Unpatentable Over McCulloch In View Of Pedrotti, And Further In View Of Flaks.....	44
A.	Overview of McCulloch.....	45
B.	Overview of Flaks	46
C.	Motivations to Combine.....	46

D.	Claim 1	48
1.	1[pre]: A Method	48
2.	1[a]: PED Dividing An Area Into Zone Including An SLP	48
3.	1[b]: Speakers in WED Play Binaural Sound	53
4.	1[c]: Tracking With WED When PED Is Moving Outside Zone.....	53
5.	1[d]: Displaying VR Image Showing Zone	54
E.	Dependent Claims 2-8	55
1.	Claim 2	55
a.	2[a]: Highlighting VR Image At SLP When PED Is Pointed At SLP	55
b.	2[b]: Playing With WED Binaural Sound In Response	57
2.	Claim 3: Displaying VR Image Showing Size And Shape Of Zone When PED Is Moving Outside Zone.....	58
3.	Claim 4	58
a.	4[a]: Storing Location, Size, And Shape of Zone, And Location Of SLPs In Memory Of WED	58
b.	4[b]: Retrieving Size And Shape In Response To WED Determining User Is In Location Of Zone	59
4.	Claim 5	60
a.	5[a]: Designating With PED Locations Of Multiple SLPs	60
b.	5[b]: Displaying VR Images At Locations Of Multiple SLPS	61
5.	Claim 6	62

a.	6[a]: Selecting SLP When PED Is Pointed At SLP.....	62
b.	6[b]: Displaying VR Image At SLP	62
6.	Claim 7: Cylindrical Or Rectangular Zone, Where User Is Centered	62
7.	Claim 8: Playing Audio Warning In Response to PED Moving Outside Zone	63
F.	Claim 9	63
1.	9[pre]: A Method	63
2.	9[a]: Dividing, With PED, An Area Into 3D Zone With SLPs	63
3.	9[b]: Determining With WED When User Is Leaving Zone.....	63
4.	9[c]: Warning User Is Leaving By Display 3D VR Image of Zone	64
G.	Dependent Claims 10-16.....	64
1.	Claim 10.....	64
a.	10[a]: Determining When PED Is Pointed at SLP	64
b.	10[b]: Playing With WED Binaural Sound In Response	64
2.	Claim 11: Highlighting Color Of VR Image At SLP	64
3.	Claim 12.....	65
a.	12[a]: Cylindrical 3D VR Image Of Zone, Where User Is Centered	65
b.	12[b]: WED Is HMD That Displays VR Images	65
c.	12[c]: WED Plays Binaural Sound While User Plays Game	65

4.	Claim 13	66
a.	13[a]: Rectangular 3D VR Image Of Zone, Where User Is Centered	66
b.	13[b]: WED Is HMD That Displays VR Images	66
c.	13[c]: WED Plays Binaural Sound While User Plays Game	66
5.	Claim 14: Playing Audio Warning Indicating User Should Move Back Into Zone	66
6.	Claim 15: Cylindrical 3D VR Image Of Zone Extends Around User	66
7.	Claim 16	67
a.	16[a]: Determining With WED When PED Is Leaving Zone	67
b.	16[b]: Warning User By Displaying 3D VR Image Of Zone	67
H.	Claim 17	67
1.	17[pre]: An Electronic System	67
2.	17[a]: PED That Divides An Area Into 3D Zone With SLPs	67
3.	17[b]: WED Worn On Head Of User	67
4.	17[c]: WED Wirelessly Communicates With PED	68
5.	17[d]: Speakers That Play Binaural Sound	68
6.	17[e]: Sensors That Sense PED Is Leaving Zone	68
7.	17[f]: Display Displays VR Image Of Zone	68
8.	17[g]: Display Displays VR Image of Zone To Warn That User Is Leaving	68

I.	Dependent Claims 18-20	69
1.	Claim 18: Display Highlights Color Of VR Image At SLP	69
2.	Claim 19: Automatically Displays VR Image	69
3.	Claim 20	70
a.	20[a]: Speakers In WED Play Binaural Sound In Response To PED Pointing At SLP	70
b.	20[b]: Cylindrical Zone, Where User Is Centered	70
VI.	Secondary Considerations	70
VII.	The Board Should Reach the Merits of This Petition	70
VIII.	Mandatory Notices Under 37 C.F.R. § 42.8(B)	71
A.	Real Parties-In-Interest.....	71
B.	Related Matters.....	71
C.	Grounds for Standing	71
D.	Counsel and Service Information.....	71
E.	IPR Fee	73
IX.	Conclusion	73

TABLE OF ABBREVIATIONS

Term	Abbreviation
wearable electronic device	WED
head mounted display	HMD
portable electronic device	PED
handheld portable electronic device	HPED
three-dimensional	3D
sound localization point	SLP
head-related transfer function	HRTF
virtual reality	VR

Exhibit List

Ex.	Description
1001	U.S. Patent No. 11,172,316 (“’316 patent”)
1002	U.S. Patent No. 11,172,316 File History (“’316 FH”)
1003	Declaration of Dr. Gregory Welch in Support of Petition for <i>Inter Partes</i> Review of the ’316 Patent (“Welch”)
1004	Curriculum Vitae of Dr. Gregory Welch
1005	U.S. Patent No. 9,851,786 (“Pedrotti”)
1006	U.S. Patent No. 8,520,872 (“Jang”)
1007	Durand R. Begault, <i>3-D Sound for Virtual Reality and Multimedia</i> , NASA/TM-2000-209606 (Aug. 2000) (“Begault”)
1008	U.S. Patent No. 9,041,622 (“McCulloch”)
1009	U.S. Patent No. 8,767,968 (“Flaks”)
1010	Declaration of Ingrid Hsieh-Yee in Support of Petition for <i>Inter Partes</i> Review of the ’316 Patent (“Hsieh-Yee”)
1011	<i>Curriculum Vitae</i> of Ingrid Hsieh-Yee
1012	International Patent Publication No. WO 2016/064435 (“Fei”)
1013	U.S. Patent No. 8,884,984 (“Flaks 984”)
1014	U.S. Patent No. 5,900,849 (“Gallery”)
1015	U.S. Patent Application Publication No. 2007/0173265 (“Gum”)
1016	U.S. Patent No. 2,955,156 (“Heilig”)
1017	U.S. Patent No. 9,544,706 (“Hirst”)
1018	RESERVED
1019	U.S. Patent No. 7,330,197 (“Kobayashi”)
1020	U.S. Patent No. 9,884,248 (“Koseki”)
1021	U.S. Patent Application Publication No. 2015/0119130 (“Lovitt”)
1022	U.S. Provisional Patent Application No. 62/289085 (“Mangiat”)
1023	RESERVED
1024	RESERVED

Ex.	Description
1025	RESERVED
1026	U.S. Patent No. 10,509,466 (“Miller 466”)
1027	U.S. Patent Application No. 13/288350 (“Mount 350”)
1028	RESERVED
1029	U.S. Patent No. 9,703,369 (“Mullen”)
1030	U.S. Patent No. 9,767,618 (“Najaf-Zadeh”)
1031	U.S. Patent No. 9,037,468 (“Osman”)
1032	U.S. Patent No. 10,162,177 (“Pedrotti 177”)
1033	U.S. Patent No. 9,674,507 (“Pirchheim”)
1034	U.S. Patent No. 9,367,811 (“Ramachandran”)
1035	U.S. Patent No. 10,070,239 (“Romigh”)
1036	U.S. Patent Application Publication No. 2016/0124502 (“Sawyer”)
1037	U.S. Patent No. 9,301,069 (“Seligmann”)
1038	U.S. Patent No. 9,787,846 (“Srinivasan”)
1039	RESERVED
1040	U.S. Patent No. 10,114,465 (“Wan”)
1041	U.S. Patent No. 8,419,545 (“Yen”)
1042	U.S. Patent Application Publication No. 2012/0183161 (“Agevik”)
1043	U.S. Patent Application Publication No. 2017/0115488 (“Ambrus”)
1044	U.S. Patent No. 7,710,654 (“Ashkenazi”)
1045	RESERVED
1046	V.R. Algazi et al., <i>The CIPIC HRTF Database</i> , IEEE Workshop on Applications of Signal Processing to Audio and Acoustics 99-102 (2001) (“Algazi”)
1047	ASME International, <i>The Link Flight Trainer, A Historic Mechanical Engineering Landmark</i> , (June 2000)
1048	Mark Billingham et al., <i>A Wearable Spatial Conferencing Space</i> , IEEE (1998) (“Billingham 1998”)

Ex.	Description
1049	Mark Billinghurst et al., <i>A Survey of Augmented Reality</i> , 8 Foundations and Trends in Human-Computer Interactions 73-272 (2015) (“Billinghurst 2015”)
1050	Douglas S. Brungart, <i>Near-Field Virtual Audio Displays</i> , IMAGE 2000 Conf., Scottsdale, Ariz., July 10-14, 2000 (“Brungart”)
1051	Anil Çamci et al., <i>Interactive Virtual Soundscapes: A Research Report</i> , ICMC 2015, Sept. 25-Oct. 1, 2015 (“Çamci”)
1052	Michael Cohen, <i>Integrating Graphic and Audio Windows</i> , 1 Presence 468-81 (Fall 1992) (“Cohen 1992”)
1053	Michael Cohen, <i>Throwing, Pitching and Catching Sound: Audio Windowing Models and Modes</i> , 39 Int. J. Man – Machine Studies 269-304 (1993) (“Cohen 1993”)
1054	John David N. Dionisio et al., <i>3D Virtual Worlds and the Metaverse: Current Status and Future Possibilities</i> , 45 ACM Computing Surveys, 34 (June 2013)
1055	Steve DiPaola & David Collins, <i>A 3D Virtual Environment for Social Telepresence</i> , W. Comput. Graphics Symp., Mar. 24-27, 2002
1056	Kai-Uwe Doerr et al., <i>Evaluation of a Low-Cost 3D Sound System for Immersive Virtual Reality Training Systems</i> , 13 IEEE Transactions on Visualization & Comput. Graphics 204-12 (2007)
1057	Thomas Erickson et al., <i>Synchronous Interaction Among Hundreds: An Evaluation of a Conference in an Avatar-based Virtual Environment</i> , CHI 2011 Session: Meetings & Interaction Spaces, May 7-12, 2011 (“Erickson”)
1058	Oli Welsch, <i>Oculus Touch Is the Gold Standard in VR Control</i> , (June 24, 2015), https://www.eurogamer.net/oculus-touch-is-the-gold-standard-in-vr-control
1059	Foster, Cornell Univ. (SP2012), Lecture 25 <i>Memory and Locality</i> , https://www.cs.cornell.edu/courses/cs3110/2012sp/lectures/lec25-locality/lec25.html (“Foster”)
1060	Nathan Martz, <i>Spatial Audio Comes to the Cardboard SDK</i> , Google Developers Blog (Jan. 13, 2016), https://developers.googleblog.com/2016/01/spatial-audio-comes-to-

Ex.	Description
	cardboard-sdk.html
1061	John L. Hennessy & David A. Patterson, <i>Computer Architecture, A Quantitative Approach</i> (5 th ed. 2012) (“Hennessy”) (excerpts)
1062	M.P. Hollier et al., <i>Spatial Audio Technology for Telepresence</i> , 15 BT Tech. J. 33-41 (Oct. 1997)
1063	Jason Jerald, <i>The VR Book: Perception and Interaction Design for Virtual Reality</i> (2015) (“VR Book”)
1064	Jiménez, TAMU Lecture 7: Caches, https://people.engr.tamu.edu/djimenez/taco/utsa-www/cs5513-fall07/lecture7.html (last visited Apr. 18, 2023)
1065	RESERVED
1066	Dean F. Kocian, <i>A Visually-Coupled Airborne Systems Simulator (VCASS) – An Approach to Visual Simulation</i> , Report No. AMRL-TR-77-31 (1977)
1067	Julian Löhr, <i>OpenAL-MOB With OpenFrameworks on Android</i> (Dec. 18, 2014), https://www.julianloehr.de/tag/ndk
1068	Bruce D. Lucas & Takeo Kanade, <i>An Iterative Image Registration Technique with an Application to Stereo Vision</i> , Proc 7 th Intl Joint Conf on Artificial Intelligence (IJCAI) 674-79 (Aug. 24-28, 1981)
1069	David McGrath, <i>Huron – A Digital Audio Convolution Workstation</i> , 5 th Australian Regional Convention 1-7 (Apr. 26-28, 1995) (“McGrath”)
1070	Timoni West, <i>UX Pointers for VR Design</i> (Nov. 10, 2015), https://medium.com/@timoni/ux-pointers-for-vr-design-dd52b718e19
1071	Todd Holmdahl, <i>BUILD 2015: A Closer Look at the Microsoft HoloLens Hardware</i> , Microsoft Blog (Apr. 30, 2015), https://blogs.windows.com/devices/2015/04/30/build-2015-a-closer-look-at-the-microsoft-hololens-hardware/ (“Microsoft, BUILD 2015”)
1072	Microsoft, Overview, Spatial Audio (Dec. 1, 2015)
1073	NSA, <i>Virtual Reality</i> , DOCID: 3929132 (1992)
1074	Xueni Pan et al., <i>Virtual Character Personality Influences Participant Attitudes and Behavior – An Interview with a Virtual Human Character about Her Social Anxiety</i> , 2 Frontiers in Robots & AI

Ex.	Description
	Article 1 (Feb. 2015)
1075	Tony Parisi, <i>Learning Virtual Reality: Developing Immersive Experiences and Applications for Desktop, Web, and Mobile</i> , (2016) (“Parisi”)
1076	Randy Pausch et al., <i>Disney’s Aladdin: First Steps Toward Storytelling in Virtual Reality</i> , ACM 193-205 (1996) (“Pausch”)
1077	Tabitha C. Peck et al., <i>An Evaluation of Navigational Ability Comparing Redirected Free Exploration with Distractors to Walking-in-Place and Joystick Locomotion Interfaces</i> , Proc IEEE Virtual Real Conf. 55-62 (Mar. 19, 2011) (“Peck”)
1078	Glenn Chapman, <i>Google Glass Available in US as of April 15</i> , Phys.Org (Apr. 10, 2014), https://phys.org/news/2014-04-google-glass-april.html
1079	RESERVED
1080	Spanner Spencer, <i>Sixense Picks Up CES Awards for Virtual Reality Controller</i> (Jan. 13, 2015), http://www.pocketgamer.biz/news/60642/sixense-picks-up-ces-awards-for-virtual-reality-controller
1081	Francisco Cheng, <i>What’s So Special About the Digital Signal Processor?</i> , Qualcomm OnQ Blog (Dec. 5, 2013)
1082	Qualcomm, <i>Mobile Processors 101: Why Smartphones are Smarter with an All-In-One Processor</i> , Qualcomm OnQ Blog (June 12, 2013)
1083	RAF Museum, <i>Flight Simulation and Synthetic Trainers</i> , https://www.rafmuseum.org.uk/research/online-exhibitions/taking-flight/historical-periods/flight-simulation-and-synthetic-trainers/ (last visited Apr. 4, 2023)
1084	VisiSonics Corp., Manual for VisiSonics’ RealSpace3D Audio Unity Plugin (Nov. 17, 2015)
1085	Paul James, <i>Watch Halo Played on Microsoft HoloLens in Augmented Reality</i> , RoadtoVR (Dec. 7, 2015), https://www.roadtovr.com/watch-halo-played-on-microsoft-hololens-in-augmented-reality/
1086	Paul James, <i>Samsung Gear VR Gets Positional Tracking Via Sixense STEM, Announced at SFVR (Video)</i> , RoadtoVR (Nov. 8, 2014),

Ex.	Description
	https://www.roadtovr.com/samsunng-gear-vr-gets-positional-tracking-via-stem-demod-sfvr-video/
1087	Warren Robinett & Richard Holloway, <i>The Visual Display Transformation for Virtual Reality</i> , 4 Presence 1-23 (1995)
1088	Eric E. Sabelman & Roger Lam, <i>The Real-Life Dangers of Augmented Reality</i> , North American, Spectrum.ieee.org (July 2015) (“Sabelman”)
1089	<i>Using the Oculus Rift with Second Life</i> , Linden Labs Blog (May 21, 2014), http://community.secondlife.com/blogs/entry/1275-using-the-oculus-rift-with-second-life/
1090	Jianbo Shi and Carlo Tomasi, <i>Good Features to Track</i> , IEEE Conf. on Comput. Vision & Pattern Recognition (CVPR94) (June 1994) (“Shi”)
1091	M. Slater et al., <i>Acting in Virtual Reality</i> , ACM 103-10 (2000) (“Slater”)
1092	<i>Characteristics of Flight Simulator Visual Systems</i> , NASA Technical Memorandum 81278 (Irving C. Statler ed., Apr. 1981)
1093	Ivan E. Sutherland, <i>A Head-Mounted Three Dimensional Display</i> , Fall Joint Comput. Conf. 757-64 (1968) (“Sutherland 1968”)
1094	Frederic Lardinois, <i>HoloLens Hands-On: How We Built An App For Microsoft’s Augmented Reality Headset</i> , TechCrunch (May 2015)
1095	Stuart Dredge, <i>Virtual World Second life to Be Reincarnated, with Oculus Rift</i> , The Guardian (June 24, 2014), https://www.theguardian.com/technology/2014/jun/24/second-life-oculus-rift-virtual-world
1096	Unity Manual: Audio Spatializer SDK (2020), https://docs.unity.cn/530/Documentation/Manual/AudioSpatializerSDK.html
1097	Ian Hamilton, <i>In a Cartoon World, Holojam Shows Participants a Slice of Space-Time</i> , Upload VR (Aug. 4, 2015) https://www.uploadvr.com/holojam-shows-participants-slice-space-time/
1098	Joe Durbin, <i>Google Cardboard Now Offers Spatial Audio</i> , UploadVR

Ex.	Description
	(Jan. 15, 2016)
1099	Dean Takahashi, <i>Second Life Creator Linden Lab Starts Testing Its Virtual-Reality World: Project Sansar</i> , Venture Beat (Aug. 18, 2015), https://venturebeat.com/games/linden-lab-starts-testing-its-virtual-reality-world-projet-sansar/
1100	Dean Takahashi, <i>Unreal Engine’s Latest Innovation Is About Building Games While Inside Virtual Reality</i> , Venture Beat (Feb. 4, 2016), https://venturebeat.com/games/epic-games-lets-you-design-your-game-inside-vr-with-new-edition-of-unreal-engine-editor
1101	Dean Takahashi, <i>Final Approach Is an HTC Vive VR Game that Turns You into a Kid Playing with Toy Airplanes</i> , Venture Beat (Jan. 29, 2016), https://venturebeat.com/games/final-approach-is-an-htc-vive-vr-game-that-turns-you-into-a-kid-playing-with-toys
1102	Dean Takahashi, <i>Valve’s Virtual Reality Apps with the HTC Vive Headset Won’t Make You Seasick</i> , Venture Beat (May 2, 2015), https://venturebeat.com/games/valves-virtual-reality-apps-with-the-htc-vive-headset-wont-make-you-seasick/
1103	Greg Welch et al., <i>High Performance Wide-Area Optical Tracking: The HiBall Tracking System</i> , 10 Presence: Teleoperators and Virtual Environments 1-22 (Feb. 2001) (“Welch 2001”)
1104	Elizabeth M. Wenzel et al., <i>A Virtual Display System for Conveying Three-Dimensional Acoustic Information</i> , Proc. Hum. Factors Soc’y – 32 nd Annual Meeting (1988) (“Wenzel 1988a”)
1105	Elizabeth M. Wenzel et al., <i>Development of a Three-Dimensional Auditory Display System</i> , 20 SIGCHI Bull. 52-57 (Oct. 1988) (“Wenzel 1988b”)
1106	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) (1991) (“Wenzel 1991”)
1107	Zhiying Zhou, <i>An Experimental Study on the Role of Software Synthesized 3D Sound in Augmented Reality Environments</i> , 16 Interacting with Computers 989-1016 (2004) (“Zhou”)
1108	RESERVED
1109	Cardboard Unity (2015), https://github.com/jkammerl/cardboard-

Ex.	Description
	unity/blob/master/Cardboard/Editor/CardboardAudioSourceEditor.cs
1110	Aurale R. DeRuyck & Jack Kuipers, <i>An Electromagnetic Position Sensor</i> , Report No. AFAL-TR-73-281 (Nov. 30, 1973)
1111	Dmitry N. Zotkin et al., <i>Rendering Localized Spatial Audio in a Virtual Auditory Space</i> , 6 IEEE Transactions on Multimedia 553-64 (Aug. 2004) (“Zotkin”)
1112	Ronald T. Azuma, <i>A Survey of Augmented Reality</i> , 6 Presence 355-85 (1997)
1113	Gary Bishop & Henry Fuchs, <i>The Self-Tracker: A Smart Optical Sensor on Silicon</i> , 1984 Conf. on Advanced Rsch. in VLSI 65-73 (Jan. 23, 1984) (“Bishop”)
1114	Mark R. Mine, <i>Working in a Virtual World: Interaction Techniques Used in the Chapel Hill Immersive Modeling Program</i> , TR96-029, Univ. N.C. (Aug. 1, 1996) (“Mine 1996”)
1115	Mark R. Mine, <i>ISAAC: A Meta-CAD System for Virtual Environments</i> , 29 Computer-Aided Design 547-53 (1997) (“Mine ISAAC 1997”)
1116	Mark Raymond Mine, <i>Exploiting Proprioception in Virtual-Environment Interaction</i> (1997) (Ph.D. dissertation, Univ. N.C. (“Mine Exploiting Proprioception 1997”))
1117	Adrienne Vincent-Phoenix, <i>Step into the DISH – A Visit to Imagineering’s Digital Immersive Showroom</i> , MousePlanet (June 5, 2012), https://mouseplanet.com/9994/Step_into_the_DISH_a_visit_to_Imagineering’s_Digital_Immersive_Showroom
1118	Ian Hamilton, <i>How They Did It: Cars Land’s Virtual Reality</i> , Orange Cty. Reg., June 25, 2012, https://www.ocregister.com/2012/06/25/how-they-did-it-cars-lands-virtual-reality/
1119	Gregory F. Welch, <i>Hybrid Self-Tracker: An Inertial/Optical Hybrid Three-Dimensional Tracking System</i> (1995) (dissertation proposal, Univ. N.C.) (“Welch 1995”)
1120	Steven M. Kaplan, <i>Wiley Electrical and Electronics Engineering Dictionary</i> 71, 335 (2004)

Ex.	Description
1121	Plaintiff’s Infringement Contentions, Exhibit 16, <i>Eight Khz, LLC v. Meta Platforms, Inc.</i> , No. 6:22-cv-00575 (W.D. Tex. Mar. 3, 2023)
1122	Amended Complaint for Patent Infringement and Demand for Jury Trial, <i>Eight Khz, LLC v. Meta Platforms, Inc.</i> , No. 6:22-cv-00575-ADA (W.D. Tex. Oct. 10, 2022)
1123	Mark Billinghurst et al., <i>The MagicBook – Moving Seamlessly Between Reality and Virtuality</i> , IEEE Computer Graphics and Applications, 6-8 (2001) (“Billinghurst 2001”)
1124	Jaka Sodnik & Sašo Tomažič, <i>Spatial Auditory Human-Computer Interfaces</i> , Springer Briefs Comput. Sci. (2015) (“Sodnik”)
1125	U.S. Patent No. 9,392,212 (“Ross”)
1126	Defendant’s 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
1127	Plaintiff’s Claim Construction Reply Brief, <i>Eight kHz, LLC v. Meta Platforms, Inc.</i> , No. 6:22-cv-00575, (W.D. Tex. May 3, 2023), ECF No. 92
1128	Declaration of Durand R. Begault, Ph.D. in Support of Plaintiff’s Claim Construction Reply 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
1129	Plaintiff’s Infringement Contentions, Exhibit 15, <i>Eight Khz, LLC v. Meta Platforms, Inc.</i> , No. 6:22-cv-00575 (W.D. Tex. Mar. 3, 2023)
1130	Plaintiff’s Infringement Contentions, Exhibit 17, <i>Eight Khz, LLC v. Meta Platforms, Inc.</i> , No. 6:22-cv-00575 (W.D. Tex. Mar. 3, 2023)
1131	U.S. Patent No. 5,173,944 (“Begault 944”)
1132	U.S. Patent No. 5,438, 623 (“Begault 623”)
1133	RESERVED
1134	Mark Mine, <i>Towards Virtual Reality for the Masses: 10 Years of Research at Disney’s VR Studio</i> , Eurographics Ass’n (2003) (“Mine 2003”)
1135	Greg Welch & Eric Foxlin, <i>Motion Tracking: No Silver Bullet, but a Respectable Arsenal</i> , IEEE Computer Graphics and Applications 24-

Ex.	Description
	28 (2002) (“Welch, “ <i>No Silver Bullet</i> ”)
1136	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.”)
1137	Dave Smith, <i>Three-Dimensional Audio Makes Virtual Reality So Much Better It’s Crazy</i> , BUSINESS INSIDER (Apr. 3, 2015, 1:06PM), https://www.businessinsider.com/virtual-reality-the-importance-of-3d-positional-audio-2015-4
1138	Mona Lalwani, <i>Surrounded by Sound: How 3D Audio Hacks Your Brain</i> , THE VERGE (Feb. 12, 2015, 10:30AM), https://www.theverge.com/2015/2/12/8021733/3d-audio-3dio-binaural-immersive-vr-sound-times-square-new-york
1139	Ben Kuchera, <i>Google Cardboard Adds ‘Inexpensive’ Spatial Audio to Its SDK</i> , POLYGON (Jan. 13 2016, 12:00PM EST)
1140	Ivan Edward Sutherland, <i>Sketchpad, A Man-Machine Graphical Communication System</i> (Jan. 7, 1963) (Ph.D. dissertation, Mass. Inst. Tech) (“Sutherland 1963”)

I. Introduction

Meta Platforms, Inc., Meta Platforms Technologies, LLC, and Twisted Pixel Games, LLC (“Petitioners”) request IPR of claims 1-20 of U.S. Patent No. 11,172,316 (Ex.1001).

The ’316 patent relates generally to systems and methods for generating three-dimensional (3D) sound, i.e., binaural sound, in virtual and augmented reality environments. ’316 patent, 1:7-23, 2:20-29. The ’316 patent acknowledges that 3D sound localization was known, providing that “[p]eople are able to localize binaural sound by sensing audio cues” and that such spatialized sound also “can be artificially created using,” for example, “Head Related Transfer Functions (HRTFs).” *Id.* 1:7-14. Thus, the patent focuses on potential applications of 3D sound, and, in particular, generating sound in virtual zones at one or more sound localization points (SLPs)—locations where a listener localizes sound (*id.* 12:59-61). The challenged claims, specifically, are directed to (i) using a handheld portable electronic device (PED) to divide an area around a user into a zone that includes SLPs, (ii) using speakers in a head-worn wearable electronic device (WED) to play binaural sound, and (iii) determining and displaying an image of a zone when the PED leaves it. *Id.* 40:46-42:66.

The challenged claims run straight into the prior art. As the Pedrotti reference discussed in both grounds shows, it was known before the ’316 patent’s earliest

possible priority date (February 2016) that systems with tracked handheld controllers and head mounted displays could divide and display zones around users, for example, to “assist[] a user in remaining in a selected area” in “a virtual world,” e.g., a “safe area” (zone) bound by “a virtual fence” that appears to “provid[e] a warning that the user is about to move out of the selected area.” Pedrotti, Title, 4:32-44. Likewise, it was known that binaural sound should be used in virtual environments to give users a better sense of reality and immersivity, including with sound sources at particular locations (SLPs) and sound generated through speakers. This is shown by the Jang and Begault references addressed with Pedrotti in Ground 1, and the McCulloch and Flaks references discussed with Pedrotti in Ground 2. Any alleged differences between this art and the challenged claims amount to obvious and trivial variations of common features in virtual environments.

Petitioners ask the Board to institute review and find the challenged claims unpatentable.

II. Identification of Challenges

Ground 1: Claims 1-20 are obvious over Pedrotti (Ex.1005) in view of Jang (Ex.1006), and further in view of Begault (Ex.1007).

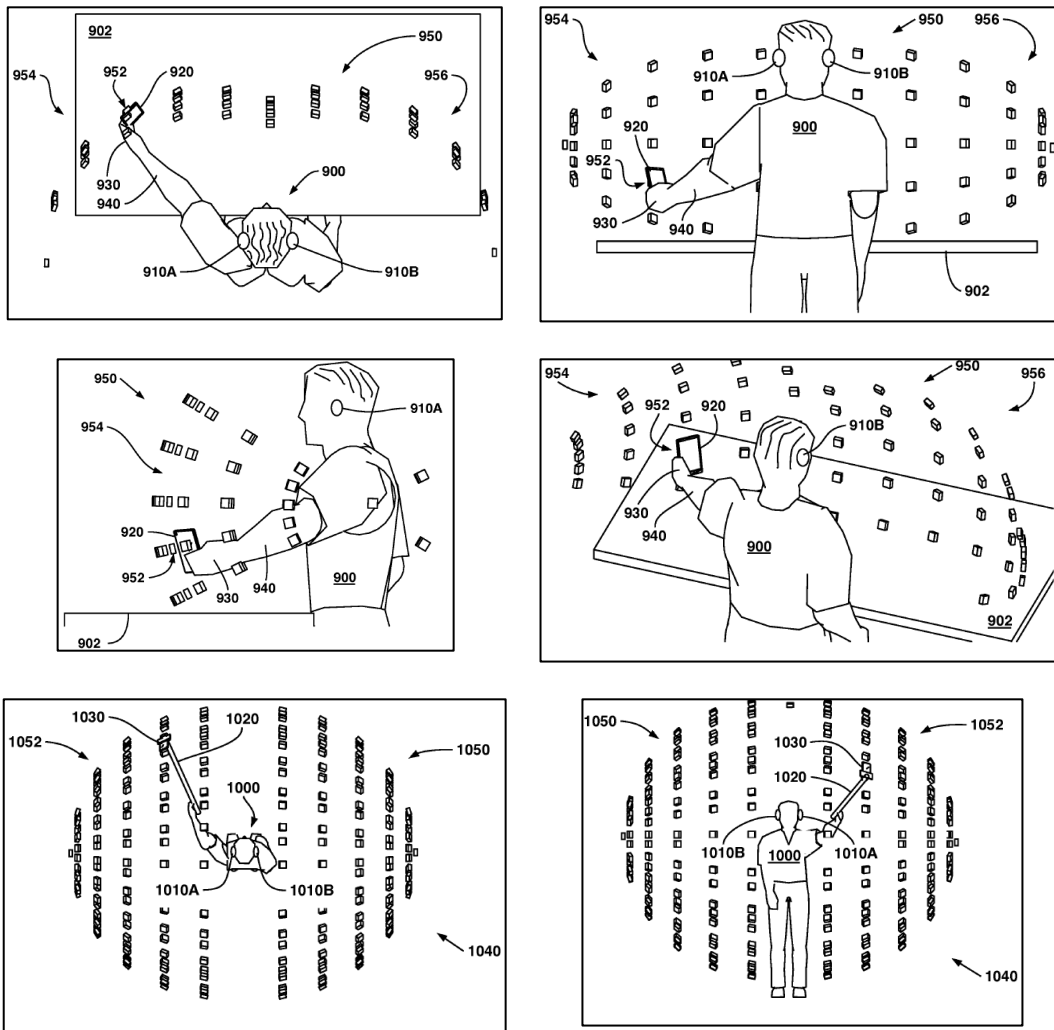
Ground 2: Claims 1-20 are obvious over McCulloch (Ex.1008) in view of Pedrotti, and further in view of Flaks (Ex.1009).

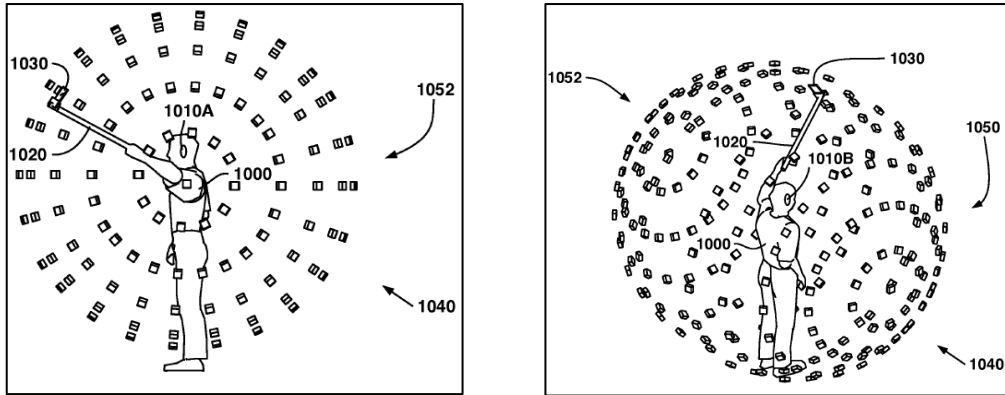
III. Background

A. The '316 Patent

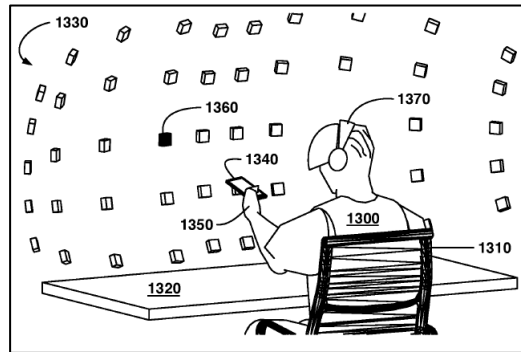
The '316 patent discloses the designation of “one or more SLPs to a zone or area around a head of a person.” '316 patent, 18:24-38.

Figures 9A to 10D depict a person with a PED (in hand or on a pole) generating SLPs at different locations surrounding the person:





Id. Figs. 9A-10D, 25:64-66, 26:7-10, 26:26-63. The user can use these SLPs to organize sound, for example, by “select[ing an] SLP for sound localization for a source he designates”:



Id. Fig. 13 (selected SLP 1360), 28:19-32. The user can divide areas containing SLPs into “a plurality of zones” and receive “visual indication[s]” of zones and SLPs.

Id. 18:27-57, 18:46-47, 18:55-57, 20:37-57, 21:64-22:7; Welch ¶¶27-31, 565.

B. POSAs

A person of ordinary skill in the art (“POSA”) as of the ’316 patent’s earliest alleged priority date (February 20, 2016)¹ would have had a Bachelor’s degree in computer science/engineering, or a related field, and at least two years of industry experience or academic research experience in virtual/augmented reality, including visual and audio modeling and rendering. Additional education can compensate for less experience, and vice-versa. Welch¶¶32-37.

C. Claim Construction

The challenged claims are unpatentable under any reasonable construction, including their plain meaning.²

IV. Ground 1: Claims 1-20 Are Unpatentable Over Pedrotti in View of Jang, and Further in View of Begault

Challenged claims 1-20 are obvious over Pedrotti in view of Jang, and further in view of Begault, for the reasons discussed below.

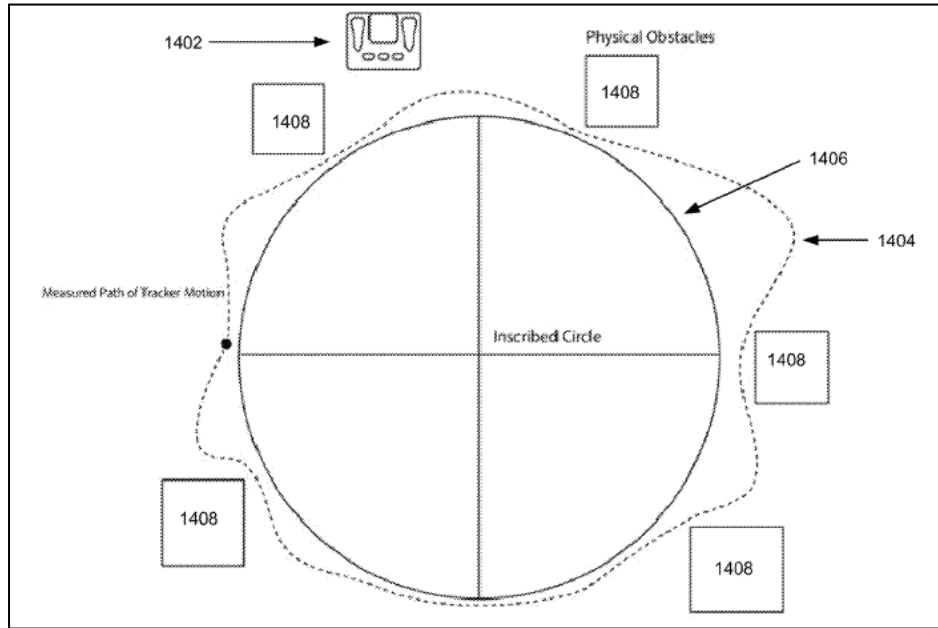
A. Overview of Pedrotti

Pedrotti, filed in July 2015 and issued in December 2017, is § 102(a) prior art and was not considered during prosecution.

¹ Petitioners reserve the right to challenge this priority date in other proceedings.

² Petitioners reserve the right to argue alternative constructions in other proceedings, including that claims are indefinite where such a defense is available.

Pedrotti taught ways to “assist[] a user in remaining in a selected area” in virtual environments. Pedrotti, Title. It disclosed methods for defining an area’s boundaries, including boundaries that “can be defined, for example, by having the user walk around a perimeter chosen by the user with” a “tracker[]”:



Id. Fig. 14, 14:6-15:3, Figs. 12-13.

In Pedrotti’s virtual environments, a processor, which may be “in the HMD,” tracks the positions and orientations of a “HMD tracker” and “trackers in the physical controllers,” so it “knows where the user’s head and hands are located.” *Id.* 4:37-44, 12:31-39, 15:4-39, 16:22-26, Fig. 15. The “processor causes the HMD to display a warning, such as a virtual fence, to alert the user if the user approaches to within a preselected distance of the boundary,” e.g., to “avoid[s] collisions.” *Id.* Abstract, Fig. 11, 2:7-12, 11:43-12:15-13:33. Pedrotti’s teachings apply to “HMDs

that block the user's view of all or only part of the physical world.” *Id.* 16:14-19; Welch ¶¶146-157.

B. Overview of Jang

Jang, issued in August 2013, is § 102(a) prior art and was not considered during prosecution.

Jang taught that VR systems can provide “a high degree of realism” through “manufactured sensory inputs.” Jang, 1:28-33. For example, in a VR game, “life-like images and sounds may be generated,” with images “three-dimensionally realized” with an “HMD” and sound produced through “a localization technique capable of expressing the virtual location,” e.g., sound processed to “express directionality” using HRTFs. *Id.* 1:35-56.

Jang disclosed that, in VR, movement need not “precisely mimic the real world,” and users can “shift between virtual spaces without having to portray the passage of distance or time.” Jang, 1:57-67. Such shifts “may occur in various ways,” e.g., through “key input of [a] user,” or when a “scene change” is otherwise detected “due to space shift.” *Id.* 9:11-17; Welch ¶620 (discussing known VR navigation methods). Jang taught techniques providing “a higher sense of realism” during these shifts. Jang, 2:1-11.

Specifically, Jang disclosed processing sound in “sound areas” divisible into “focus” areas, e.g., a user's visual perspective, and “un-focus” areas. *Id.* 1:18-23,

2:35-47, 3:39-48, 8:25-36, Fig. 2. These areas are modifiable based on “characteristics and/or topography of the virtual area at which [a] character is located,” “contain any number of virtual objects represented by” “audio and visual data,” and can be sub-divided “according to a predetermined priority.” *Id.* 8:36-49, 4:25-39, 9:47-65, cls. 4, 10.

Jang taught that when a space shift occurs, e.g., from a virtual basketball court to a conference room, “sensory output” for “the focus area of the second virtual space” can be generated before “sensory output” for “the non-focus area.” *Id.* 4:6-9, Fig. 5; Welch ¶¶158-171.

C. Overview of Begault

Begault, published in 2000, is § 102(a) prior art and was not considered during prosecution. Hsieh-Yee ¶¶9-64; Begault Dep. (Ex.1136) 222:21-223:17.

Begault described processes for producing “3-D sound,” “spatialized sound,” and “binaural audio,” explaining these terms refer to techniques that use digital filters to position sounds in “virtual space.” Begault, x. Begault taught that sound should have an “interactive, spatial character” because one can “work more effectively within a VR environment if actions [a]re accompanied by appropriate sounds that seemingly emit from their proper locations.” *Id.* 12-13.

Begault described in detail HRTF processing for binaural sound (*id.* ch. 2) and taught that such sound can be “controlled by the user,” including through interfaces

“for arranging [] various sound inputs in virtual auditory space.” *Id.* 172-74, Fig. 5.12; Welch¶¶172-184.

D. Motivations to Combine

POSAs would have known and been motivated to combine Pedrotti’s systems and methods with Jang’s and Begault’s sound processing techniques. Welch¶¶209-224.

Pedrotti, Jang, and Begault are analogous art—all relate to improving virtual environments comprising virtual objects with which users interact. Pedrotti, 1:8-10; Jang, 1:18-30; Begault, 10; Welch¶¶210, 218. Pedrotti discloses “sight and sound” as the “most commonly used” senses in virtual environments (Pedrotti, 1:14-20) but does not address sound processing. POSAs reading Pedrotti thus would have been motivated to look to references, like Jang and Begault, which disclose advantageous sound processing techniques providing “a higher sense of realism” and enabling “a rich auditory environment.” Jang, 1:42-56, 2:9-11, 2:26-28; Begault, 10-11, 13. Adding Jang and Begault’s sound processing techniques would have amounted to no more than applying known techniques (e.g., binaural sound processing) to a known device (Pedrotti’s HMD) ready for improvement to yield predictable results (spatialization of sound for an immersive VR experience). Welch¶¶211-212, 219.

POSAs would have implemented Pedrotti’s HMD with Jang and Begault’s sound processing techniques for several reasons. POSAs would have understood

that providing binaural sound would enhance the sense of “presence” for users, making the VR experience more immersive. A virtual environment and its images seem more realistic when they have realistic and compelling sound. Conversely, when sound does not match imagery, the optical illusion begins to break down, creating disbelief and detracting from users’ sense of presence or immersion. Ex.1138; Ex.1137. Further, binaural sound was known to enhance perception of space, distance, and size within virtual environments. “An accurate spatial reproduction of sound can significantly enhance 3D perception,” enabling users to better identify and localize objects. Ex.1124, 54; Welch¶¶211-213. Also, binaural sound, as disclosed by Jang and Begault, was a computationally efficient way of achieving these goals. Begault, 11 (spatial audio is “easier to accomplish”); Ex.1139 (spatial audio “inexpensive”); Welch¶¶220-223.

Additionally, Pedrotti and Jang are Sixense and Samsung patents, respectively. POSAs would have known that both companies were working on VR systems, including in concert and on complementary technologies. Welch¶¶214-216; Ex.1086 (Samsung gets VR tracking from Sixense); Ex.1080 (Sixense “demos on Samsung Gear VR”).

Furthermore, POSAs would have reasonably expected to succeed in combining the teachings of these references, which disclose well-known hardware, such as HMDs and controllers, and methods of using that hardware, e.g., to spatialize

binaural sound, that were commonly known. §§IV.A-IV.C. McCulloch, 21:21-38 (describing an HMD with a binaural sound engine). To POSAs, implementing the audio processing described in Jang and Begault in Pedrotti’s HMD would have been well within a POSA’s skill and common sense and obvious to try. Welch¶¶220-223.

E. Claim 1

1. 1[pre]: A Method³

Claim 1’s preamble recites: “A method comprising.” Pedrotti disclosed a “method of assisting a user... in remaining in a selected area.” Pedrotti, 2:27-59. Jang disclosed a “method to perform sound processing.” Jang, 2:15-20. Welch¶¶567-569.

2. 1[a]: PED Dividing An Area Into Zone Including An SLP

Limitation 1[a] recites: “dividing, with a portable electronic device (PED) held in a hand of a user, an area around the user into a zone that extends around the user and that includes a sound localization point (SLP) from where binaural sound in empty space originates to the user.”

A user of Pedrotti’s system “wear[s] a head-mounted display (HMD)” and “hold[s] a handheld controller” (PED) comprising a “tracker,” which “provides information regarding a position of the handheld controller.” *Id.* 2:44-57, 15:7-12,

³ The “Claims Appendix” attached to this Petition reproduces challenged claims with bracketed cross-referencing identifiers.

4:49-5:24 (“trackers” “known to those of skill in the art”). A processor tracks the controller’s movement (*id.* 12:31-39), including to determine “a boundary of a selected area,” so a user “may move freely” without hitting “obstacles.” Pedrotti 2:49-51, 4:32-36. That boundary can be defined “by having the user walk around a perimeter chosen by the user with one of the trackers,” e.g., a controller tracker, “to define the outer boundary of [the] selected area.” *Id.* 14:56-65, 15:13-22.

After Pedrotti’s boundary is defined, e.g., by the “measured path of tracker motion” (*id.* Fig. 14), and a user is in “the virtual world,” when “the processor determines from the position of the handheld controller that the handheld controller is within a preselected distance of the boundary,” it instructs the HMD to display “a visual warning to the user,” e.g., “grid lines” or “a virtual fence.” *Id.* 11:43-55, 15:30-37, Figs. 11, 14-15. Thus, Pedrotti’s handheld controller (PED) divides an area around a user into a zone—Pedrotti’s “selected” or “safe” area, bound by Pedrotti’s boundary and virtual fence. Welch¶¶570-576. This zone extends (or at a minimum obviously extends) around the user. Pedrotti, Fig. 11 (“virtual fence 1114”), Fig. 14 (“boundary 1404” extending around user); Welch¶577.

Notably, Pedrotti’s controller-divided zone is nearly identical to features Patentee contends in the parallel district court action satisfy claim language reciting the same elements as limitation 1[a]:



Ex.1130, 3 (addressing limitation 9[a]); Welch¶¶578-579.

Further, Patentee asserts in district court that these elements are satisfied by a zone for game play that “***will include*** sound localization points for presentation of binaural sound to the user,” contending that any area for gameplay that ***subsequently*** includes binaural sound is enough. Ex.1130, 4. Under such an interpretation, Pedrotti, alone or in view of Jang, renders limitation 1[a] obvious.

Pedrotti’s controller-divided zone will (or at a minimum will obviously) include SLPs from which binaural sound will originate, for example, when a user plays a VR game. Welch¶¶579-580. Pedrotti disclosed its application to VR games. Pedrotti, 1:42-45 (“play a video game, while in a virtual world”), 1:66-2:12, 9:26-40 (describing “virtual weapon” for virtual game), 11:43-12:15, Fig. 8 (virtual sword 802). And POSAs would have known that virtual objects (e.g., Pedrotti’s sword or

another “virtual weapon”) could and would have associated binaural sounds that move with them to multiple locations (multiple SLPs). Associating and moving sounds with virtual images were “extremely important” features of VR well before February 2016. Welch¶¶580, 625-628 (collecting references); Pedrotti, 1:19-20 (“sight and sound” are “the senses most commonly used today to create virtual reality”); Ross (Ex.1125), 17:22-18:35 (describing “moving objects and/or characters” in VR).

Jang confirms the obviousness of using, in zones around users, an SLP “from where binaural sound in empty space originates to the user,” e.g., during VR game play. Jang’s sound processing system “check[s] sound source information” on “characters and other objects” and provides localized audio (i.e., binaural sound) for “sound sources” “according to the[ir] relative locations” (SLPs), including in “sound areas” around a user. Jang, 7:24-59; *id.* 1:28-2:11, 5:35-37, 8:18-49, 8:65-9:3, Fig. 2 (illustrating “sound areas of a virtual reality space”); Welch¶¶581-582; *id.*¶¶101-129 (additional references showing POSAs would have known to use binaural sound in VR, including because “[a]uditory cues play a crucial role in... VR”). POSAs also would have understood that SLPs in Jang’s sound areas (in Pedrotti’s zone) could and would be in “empty space,” i.e., space not occupied by a physical object. ’316 patent, 6:1-5; Welch¶592; Jang, 4:19, 4:45-55.

Additionally and alternatively, if limitation 1[a] requires a zone that “includes” an SLP for binaural sound when divided by a PED, limitation 1[a] would have been obvious over Pedrotti and Jang, or over Pedrotti, Jang, and Begault.

Jang disclosed processing and producing sound in “sound areas” comprising “focus” and “un-focus” areas. Jang, 2:32-47, 2:60-3:4. These areas may be subdivided according to a “predetermined priority” or “scheme” and contain multiple “audio sources.” *Id.* 4:19-39, 6:51-59, 8:46-58, 9:47-10:5. This allows Jang’s system to “output sensory elements of the focus area differently than sensory elements of the non-focus areas” and better manage VR space shifts. *Id.* 6:47-59, 11:1-16, 11:47-63. “For example, if a user’s character moves from a basketball court to a conference room, visual, audio, or tactile elements of the basketball court may decrease in magnitude, and visual, audio, or tactile elements of the conference room may begin to be transferred to a virtual reality device,” with sensory data for focus areas processed first. *Id.* 11:64-12:16. And, Jang taught using “a localization technique capable of expressing the virtual location” of “a sound-generating object” and HRTFs “to give the sense of reality to the sound.” *Id.*, 1:42-51, 1:52-56, 7:38-63, 8:54-9:3.

POSAs reading Jang would have known and been motivated to set, author, and control the predetermined priorities for sound areas by assigning locations from where sound sources will produce sound (i.e., SLPs for binaural sound).

Welch¶¶583-586. For example, in Jang’s basketball court, a virtual team’s bench and stands could be set as a “focus area,” with priority characters and sound-generating objects (e.g., an announcer or a pep band) assigned to locations therein (SLPs) while lower priority characters (e.g., an airhorn in the stands) can be outside the “focus area.” Similarly, in Jang’s conference room, one side of the room could be set as a “focus area,” with priority sound-generating objects (e.g., certain attendees and a monitor) assigned to locations therein (SLPs). *Id.*¶586.

Such divisions of sensory elements in, and authoring of, VR environments were well known. *Id.*¶¶111-129, 587; VR Book, 254-55 (“Center of Action” setups “split[] the world around the user into different zones”); Ross, 14:53-15:28, 15:29-55, 20:22-21:51 (VR content displayed based on “a position of the user within the virtual space,” e.g., when a user moves “across a boundary”), 22:17-29 (“user may virtually reach out and grab and/or move... objects”), 22:55-56. As Begault taught, “virtual spatial hearing with a 3-D sound system involves the positioning of each of a number of sources individually.” Begault, 4. And as Dr. Durand Begault—the author of the Begault reference and Patentee’s expert in the parallel district court litigation—testified, this means that “if you use a 3D sound system, oftentimes a number of sound sources are positioned to different locations.” Begault Dep., 225:15-226:13; *see also id.* 135:6-25 (admitting his own pre-2014 patents disclosed “processing sound to move virtual sound images to different locations”); Welch¶110.

Moreover, Begault disclosed methods for assigning positions for binaural sound (SLPs) that POSAs would have recognized as useful for managing Jang’s sound areas. For example, Begault taught that “[a]ll types of sonic input c[an] be directionalized to a specific location” and “controlled by [a] user” through “audio spatial mapping,” which, as in Jang, “correspond[s] to a prioritization scheme.” Begault, 172. And Begault disclosed interfaces for “arranging [] various sound inputs in virtual auditory space” to provide “commands” to an associated “multiinput, 3-D sound spatialization subsystem,” i.e., a system for producing binaural sound (*id.* 172-73, Fig. 5.12), which POSAs would have known could be used in a Pedrotti-Jang system to arrange and assign locations for the sound-producing virtual objects that Jang disclosed are in its virtual spaces. Welch ¶¶588-591. Moreover, POSAs would have readily known how to implement such interfaces, as they were frequently used in VR environments. *Id.* ¶¶111-129; Ross, 21:52-23:45 (disclosing GUIs for the “creation, customization, and/or adjustment of” VR content).

Further, POSAs would have known and recognized that a user’s use of a virtual environment designed as described above—with Jang’s or Jang and Begault’s binaural sound sources at multiple locations (SLPs)—could and would benefit from Pedrotti’s “safe area” zone. As discussed, such a zone could and would prevent user injury, e.g., if moving between Jang’s virtual basketball court and its virtual conference room would, in reality, cause a user to trip over a sofa or crash into a

wall. Welch¶¶ 130-133, 213, 591. And a Pedrotti zone drawn for such a virtual environment, with 3D sound sources assigned to different locations per Jang’s or Jang and Begault’s teachings, would (or at a minimum obviously would) include SLPs for binaural sound. *Id.*¶591; Ross, 6:5-27, 22:23-23:21 (users may sense and configure boundaries, e.g., with a “[c]ontent creation preview” that allows them to “continue to make changes” to boundaries).

3. 1[b]: WED’s Speakers Play Binaural Sound

Limitation 1[b], which recites, “playing, with speakers in a wearable electronic device (WED) worn on a head of the user, the binaural sound that originates from the SLP in empty space,” would have been obvious for the same reasons as limitation 1[a]. §IV.E.2. Additionally, playing binaural sound with a WED’s speakers would have been obvious over Pedrotti because Pedrotti’s HMD plays sound, Pedrotti, 2:27-43, 15:56-58 (“audio warning”), and speakers were routinely used in HMDs before February 2016, as Jang shows. Jang, 1:44-45 (VR system sound “generated by speakers”), 7:5-6 (“sensory output unit” includes “speakers”); Welch¶¶593-599.

4. 1[c]: Tracking With WED When PED Is Moving Outside Zone

Limitation 1[c] recites: “tracking, with one or more sensors in the WED worn on the head of the user, the PED to determine when the PED held in the hand of the user is moving outside the zone that extends around the user.”

Pedrotti disclosed, or at a minimum rendered obvious, “tracking” “the PED” “with one or more sensors in [a] WED worn on the head.” Pedrotti taught handheld controllers (PEDs) tracked by an HMD (WED). §IV.E.2. Pedrotti’s processor, which may be “in the HMD” (WED) (*id.* 16:20-24), tracks the HMD and handheld controllers using sensors so it “knows where the user’s head and hands are located.” Pedrotti, 2:49-57, 2:60-3:12, 4:32-44, 12:31-41, 15:7-12. Further, Pedrotti taught that trackers in controllers, e.g., “light-emitting trackers,” “provide position and orientation information to” sensors, e.g., “a camera mounted on [a] base station or elsewhere.” *Id.* 5:8-24. Thus, POSAs would have known and been motivated to use Pedrotti’s HMD with sensors, e.g., cameras, to track Pedrotti’s controllers, e.g., light-emitting controller trackers. Welch¶¶600-602. This technique was well known and widely used due to accuracy advantages. *Id.*¶¶ 88-98, 603-604; VR Book, 315 (“Hand-held tracked devices typically use inertial, electromagnetic, ultrasonic, or optical (camera) technologies.”).

Pedrotti also disclosed, or at a minimum rendered obvious, “determin[ing] when the PED held in the hand of the user is moving outside” the claimed zone. As noted, Pedrotti’s system helps a user stay in a zone during gameplay and displays a virtual fence “when the user’s head or hands are approaching the [zone’s] boundary as determined by the trackers on the user’s head or hands”—e.g., when Pedrotti’s HMD, with its processor, determines controller trackers are approaching the

boundary. Pedrotti, 13:34-62; *id.* 2:60-3:12, 5:8-24, 12:35-13:11 (“since the hand of the user 1002 is within the preselected distance of the boundary of the selected area, the processor generates instructions to the HMD to generate the visual warning”), 16:20-24. Pedrotti further taught that “the preselected distance” triggering its warning “may vary by application” and users’ expected body movements (*id.* 13:46-62), and that if the “user’s head or hand,” with a controller, “goes beyond the boundary”—i.e., moves outside a zone—“the processor can cause the HMD to fade to black, and present, for example, only a warning message and/or a beacon or arrows directing the user to move in the direction of the boundary and the selected area.” *Id.* 13:67-14:5; Welch¶¶606-609.

Accordingly, Pedrotti disclosed or at a minimum rendered obvious tracking a PED (a controller) with one or more sensors in a WED worn on a user’s head (e.g., a camera on Pedrotti’s HMD) to determine when the PED moves outside the zone (outside Pedrotti’s “safe area” boundary). Welch¶¶610-612.⁴ Furthermore,

⁴ In district court, Patentee draws no distinction between (i) determining a user “is leaving” a zone and (ii) determining or sensing a PED “moves outside” or “is moving outside” a zone. *E.g.*, Ex.1130, 6. Regardless, both actions are, at a minimum, obvious over Pedrotti. Welch¶605.

chaperone systems that alerted users they were moving outside virtual zones were well known. Welch ¶¶130-142; Begault Dep., 210:20-211:12.

5. 1[d]: Displaying VR Image Showing Zone

Limitation 1[d] recites: “displaying, with the WED worn on the head of the user, a virtual reality (VR) image that shows the zone in response to the WED determining that the PED is moving outside the zone.”

Pedrotti disclosed, or at a minimum rendered obvious, a WED worn on the user’s head (HMD) that determines that a PED (controller) is moving outside a zone, and taught that, based on this determination, its HMD displays a VR image that shows the zone (Pedrotti’s “grid or virtual fence”). §§IV.E.2, IV.E.4; Pedrotti, 4:32-44, 11:48-52, 12:51-13:11 (“visual warning [] in the form of a grid of lines or a ‘virtual fence’ located at the boundary”), 13:17-27, 13:63-67 (“If the user’s head or hand go beyond the boundary..., the processor can provide...an additional visual warning”), 15:4-7, 15:35-55, Fig. 11; Welch ¶¶613-615, 617.

Notably, Pedrotti’s fence is nearly identical to features Patentee contends in district court satisfy the limitation “displaying ... a 3D virtual reality (VR) image of the zone”:



Ex.1130, 6; Welch¶616; Pedrotti, Fig. 11.

F. Dependent Claims 2-8

Claims 2-8 are unpatentable for the same reasons as claim 1 and as further explained below.

1. Claim 2

a. 2[a]: Highlighting VR Image At SLP When PED Is Pointed At SLP

Limitation 2[a] recites: “highlighting, while the user is located inside the zone and with a display of the WED, a VR image at the SLP in the zone when the PED held in the hand of the user is pointed at the SLP in the zone.”

Pedrotti and Jang, or Pedrotti, Jang, and Begault, render obvious limitation 2[a]’s (i) user in a zone with a WED that displays VR images at an SLP and (ii) highlighting a VR image at an SLP in the zone when a handheld PED is pointed at it.

Pedrotti’s system is used by a user in a zone (Pedrotti’s PED-divided “safe

area” for gameplay with boundary and virtual fence), and Pedrotti’s HMD displays VR images inside that zone. §§IV.E.2, IV.E.4, IV.E.5; §IV.A; Pedrotti, Abstract (HMD “display[s] a virtual world”); Fig. 8 (virtual sword 802); Welch¶¶620-622.

Limitation 2[a]’s “pointed” PED would have been obvious over Pedrotti. Pedrotti’s controllers (PEDs) manipulate and control virtual objects in VR. Pedrotti, 4:9-10 (controllers control actions in virtual world), 5:25-46, 8:14-35 (“grasping a virtual object”). Welch¶¶623-624. And “[t]he Pointing Pattern is one of the most fundamental and often-used patterns for selection” in VR. VR Book, 327; Welch¶¶74-76, 624. Indeed, Dr. Begault confirmed that, before 2014, “it was known that people in virtual reality environments could point their controllers at virtual objects to select and move them, and then a virtual object’s sound would move with it.” Begault Dep., 195:12-196:10; *id.* 135:6-19.

Limitation 1[c]’s “highlighting” also would have been obvious over Pedrotti. Pedrotti explained that a VR image, e.g., its fence, “can be glowing or colored if desired to be more visible.” Pedrotti, 12:66-13:11. POSAs thus would have understood that Pedrotti’s system could and would use “highlighting”—i.e., “visually outlining or changing the color of an object”—which was frequently used to facilitate user selection. VR Book, 305 (“Highlighting” is used “to convey that

an object” may “be selected or grabbed”), 281, 361; Welch ¶¶625-627.⁵

Accordingly, POSAs would have known that Pedrotti’s controllers could and would be pointed at virtual objects, e.g., to select or move them, and that such objects could and would be highlighted, e.g., to facilitate selection. These were well-known techniques. Welch ¶¶628-629; VR Book, 327 (“Pointing Pattern extends a ray into the distance” for selecting objects), Fig. 26.5 (“bottle is highlighted to show” it “can be grabbed”), 285 (“Shoot a ray,” “push the grab button, move... to a new location, release the grab button”); Mine ISAAC 1997, 548 (“[t]o select,” “user points the laser beam at a desired object and clicks”).

Likewise, Pedrotti’s system could and would highlight an SLP’s “VR image” “when the PED... is pointed at” the SLP because the processor in Pedrotti’s HMD tracks “the position and orientation of one or more trackers in the physical controllers,” and it was common for controllers to convey target locations in VR, e.g., for interacting with virtual objects. Pedrotti, 4:37-44, 5:8-36; Welch ¶¶84-100, 629. Also, POSAs would have known that binaural sound of a virtual object is (or at a minimum is obviously) associated, and presented in concert with, a virtual

⁵ The ’316 patent describes “visually distinguish[ing]” selected SLPs—i.e., images representing SLPs—in this same, well-known manner. ’316 patent, 28:19-38; Welch ¶626.

object's image, at the virtual object's location for display and sound (an SLP). This was an "extremely important" feature of VR before February 2016. Welch¶632. For example, when Pedrotti's virtual sword slices through another virtual object, it would have been obvious for a slicing sound to emanate from SLPs associated with the virtual sword, at the locations for the sword's moving VR image. Pedrotti, 9:29-52, 16:33-42, Fig. 8.

After all, a sound source in virtual space (i.e., at an SLP) is just one type of virtual object that could and would be controlled and arranged in VR, for example, by pointing at, highlighting, selecting, and moving it with its associated visual element (its VR image). Welch¶¶630-633; Brungart, 9 (listeners "grab virtual sound sources and move them around the head"). POSAs practiced this type of sound control—e.g., "arranging [] various sound inputs in virtual auditory space"—years before February 2016. §IV.E.2; Welch¶¶114-121; Begault Dep., 135:6-19.

Consequently, with a Pedrotti-Jang or Pedrotti-Jang-Begault system, POSAs would have known to use Pedrotti's controller to point to select a sound source—e.g., the image of a pep band in Jang's virtual basketball court associated with the pep band's sound, or a conference attendee in Jang's virtual conference room—and that highlighting could be used to indicate this selection. Then, the selected and highlighted sound source could be moved between locations (SLPs). Welch¶634. POSAs further would have understood that sound sources could and would be so

arranged directly in the virtual environment (e.g., with immersive authoring), or through an interface like Begault’s Figure 5.12. *Id.* ¶635; Ross, 7:51-62 (“user may create, customize, and/or adjust the virtual reality content, the fields of view, view boundaries”). In either case, it would have been obvious to highlight an SLP’s VR image when a user points a controller at it, e.g., to select. Welch ¶¶636-637.

b. 2[b]: Playing With WED Binaural Sound In Response

Limitation 2[b] recites: “playing, with the WED worn on the head of the user, the binaural sound that emanates from the SLP in response to the PED pointing at the SLP.”

Pedrotti’s HMD obviously plays binaural sound emanating from an SLP, and POSAs would have known that it could and would determine when a controller is pointed at an SLP. §§IV.E.3, IV.F.1.a; Welch ¶¶638-639. Playing binaural sound in response to such pointing would have been obvious because that technique was routine before February 2016—e.g., Jang’s binaural sounds could and would, like highlighting, facilitate user selections. Welch ¶640; VR Book, 281 (“objects can make a sound” “when ... they have been selected”), 356 (“use audio and highlighting to signify touching of objects”). POSAs thus would have known that a Pedrotti-Jang or Pedrotti-Jang-Begault system could and would “play[] binaural sound” from an SLP “in response to” Pedrotti’s controller pointing at an SLP.

Welch¶640; Begault, 159-60 (sounds “spatialized using 3-D audio techniques”—i.e., binaural sounds—used for “selecting items,” e.g., “click” and “latch” sounds).

2. Claim 3: Displaying VR Image Showing Size And Shape Of Zone When PED Is Moving Outside Zone

Claim 3 recites: “displaying, with the WED worn on the head of the user, the VR image that shows a size and a shape of the zone in response to the WED determining that the PED is moving outside the zone.”

Pedrotti disclosed or at a minimum rendered obvious a WED (HMD) determining that a PED (controller) moves outside a zone, and taught that, based on this determination, its HMD displays a VR image (e.g., “a grid or virtual fence”). §§IV.E.2, IV.E.4-IV.E.5, IV.F.1.a; Welch¶641. Pedrotti’s “grid or virtual fence” shows, or at a minimum obviously shows, the size and a shape of Pedrotti’s zone by displaying the boundary of the area in which the user can move. Pedrotti, 12:10-15, 12:51-13:11, 15:4-7, 15:35-39, 15:53-55, Figs. 10-11; *see also id.* 13:63-67 (“processor can provide...an additional visual warning” if “user’s head or hand go beyond the boundary”); Welch¶¶642-644.

3. Claim 4

a. 4[a]: Storing Location, Size, And Shape of Zone, And Location Of SLPs In Memory Of WED

Limitation 4[a] recites: “storing, in memory of the WED, a location of the zone, a size and a shape of the zone, and a location of the SLP in the zone from where the binaural sound originates to the user.”

POSAs would have understood that, to implement its methods, which display virtual zone boundaries, Pedrotti's system stores, or at a minimum obviously stores, the location, size, and shape of Pedrotti's zone. Welch¶¶645-646; Pedrotti, 14:56-62 (creation of user-defined zone), Fig. 14. Pedrotti's system could and would obviously store such information to facilitate determinations of when to display the virtual fence. Welch¶¶647-648; §§IV.A, IV.E.4-IV.E.5. POSAs also would have known that the zone's information (location, size, shape) could advantageously be stored in memory in Pedrotti's HMD since the processor is in the HMD, thus eliminating the need for the HMD to communicate with external storage. Welch¶649. Such HMD storage was known, as Jang shows. Jang, Fig. 1A ("storage unit" 102 in VR apparatus); Welch¶¶650-651; Ross, Figs. 1-2 ("storage 30" in HMD).

Additionally, storing SLPs in memory would have been equally straightforward and obvious, including over Pedrotti and Jang, or over Pedrotti, Jang, and Begault. Jang taught that its system, with HMD storage, generates binaural sound from audio elements arranged at different locations (SLPs) in sound areas around a user according to "predetermined" priorities, on which Jang's binaural sound processing depends. §§IV.E.2, IV.F.1.b; §IV.B. Jang further taught that its "storage unit 102" stores "sound[] and/or other sensory data to output to the user to represent the virtual environment." Jang, 6:39-42, 7:24-32, 11:64-12:16 ("sensory

output data” is output after being “[t]ransferred ... from a storage unit within the virtual reality device to a control unit.”), Fig. 1A (“storage unit” 102). Thus, POSAs would have known that the locations for the sound sources from which Jang’s binaural sound originates (SLPs)—including the audio elements arranged in virtual space as described for limitation 1[a]—are (or obviously could and would be) stored in HMD memory, per Jang’s teachings. Welch¶¶652-654.

b. 4[b]: Retrieving Size And Shape In Response To WED Determining User Is In Location Of Zone

Limitation 4[b] recites: “retrieving, from the memory of the WED, the size and the shape of the zone in response to the WED determining that the user is in the location of the zone.”

Limitation 4[b] would have been obvious for the same reasons as limitation 4[a]. §IV.F.3.a. Pedrotti’s system could and would retrieve the size and shape of its zone from HMD memory in response to the HMD determining that the user is in the location of the zone because, for Pedrotti’s system to determine “when the user’s head and/or hand approaches the boundary,” the HMD’s processor must be “provided with information about the boundary of the selected area.” Pedrotti, 12:35-39; Welch¶655. Further, Jang taught accessing HMD storage for “audio, sound, and/or other sensory data to output to the user to represent the virtual environment,” which, in a Pedrotti-Jang system, is what would occur before

Pedrotti's HMD displays the VR image of its zone with a virtual fence. Jang, 6:39-44; Welch¶¶656.

4. Claim 5

a. 5[a]: Designating With PED Locations Of Multiple SLPs

Limitation 5[a], which recites, “designating, with the PED held in the hand of the user, locations of multiple SLPs in empty space in the zone from where the binaural sound originates to the user,” would have been obvious for the same reasons as limitations 1[a] and 2[a]. §§IV.E.2, IV.F.1.a. As explained above, Pedrotti and Jang, or Pedrotti, Jang, and Begault, render obvious using Pedrotti's handheld controller, including through routine pointing and selecting actions, to assign (i.e., designate) locations in Jang's sound areas from where binaural sounds originate (multiple SLPs)—e.g., locations for spatialized sounds from the virtual objects in Jang's basketball court or conference room. *Id.*; Welch¶¶657-658.

b. 5[b]: Displaying VR Images At Locations Of Multiple SLPS

Limitation 5[b] recites: “displaying, with the WED, VR images at the locations of the multiple SLPs in empty space in the zone.”

Pedrotti's HMD displays VR images. §§IV.A, IV.E.2; Welch¶¶659-660. And Jang disclosed that, before outputting “audio, sound, and/or other sensory data” “to the user to represent the virtual environment,” its sound system can “check sound source information on other characters and other objects existing in the virtual reality

spaces” to “provide[] the virtual reality apparatus 110 with sound sources occurring in real time according to the[ir] relative locations.” Jang, 6:17-20, 6:36-42, 7:24-32. Thus, POSAs would have known that when Pedrotti’s handheld controller is used to assign (i.e., designate) and control SLP locations in Pedrotti’s zone, as discussed for limitations 1[a] and 5[a], a Pedrotti-Jang or Pedrotti-Jang-Begault system would (or at a minimum obviously would) display VR images at those designated SLPs. Welch¶¶661-662. For example, if a user designated a location for an announcer in Jang’s virtual basketball court, a VR image of the announcer could and would be displayed at that location. Similarly, POSAs would have understood that if a user used an interface like Begault’s to arrange sound sources—e.g., through icons representing sound sources, which are “VR images” themselves—then corresponding VR images of the arranged sound sources (e.g., a computer monitor) could and would be displayed in the virtual environment at their designated locations. Begault, 172-73, Fig. 5:12; Welch¶¶663-664.

5. Claim 6

a. 6[a]: Selecting SLP When PED Is Pointed At SLP

Limitation 6[a], which recites “selecting one of multiple SLPs in the zone when the PED held in the hand of the user is pointed at the one of the multiple SLPs in the zone,” would have been obvious for the same reasons as limitations 1[a], 2[a], and 5[a]. §§IV.E.2, IV.F.1.a, IV.F.4.a. Because pointing to select in VR (and

highlighting to indicate selections) was well known, selecting an SLP when a PED (e.g., Pedrotti's controller) is pointed at it would have been obvious over Pedrotti and Jang, or over Pedrotti, Jang, and Begault. Welch¶¶665-668.

b. 6[b]: Displaying VR Image At SLP

Limitation 6[b], which recites “displaying, with the WED worn on the head of the user, a VR image at the one of the multiple SLPs in response to the one of the multiple SLPs being pointed at by the PED held in the hand of the user,” would have been obvious for the same reasons as limitations 1[a], 5[a], 5[b] and 6[a]. §§IV.E.2, IV.F.4.a, IV.F.4.b, IV.F.5.a; Welch¶669. For example, a Pedrotti-Jang or Pedrotti-Jang-Begault system could and would display with Pedrotti's HMD a VR image associated with one of multiple SLPs in response to a user pointing Pedrotti's controller at the SLP and its image, e.g., when a user points at and selects an announcer or pep band virtual object in a virtual basketball court to facilitate moving the virtual object from one location to another. Welch¶670.

6. Claim 7: Cylindrical Or Rectangular Zone, Where User Is Centered

Claim 7 recites: “wherein the zone has one of a three-dimensional (3D) shape of a cylinder and a 3D shape of a rectangle, and the user is centered in the zone.”

Pedrotti taught, or at a minimum rendered obvious, claim 7 because a user of Pedrotti's system can define Pedrotti's zone boundary by “walk[ing] around a perimeter chosen by the user.” Pedrotti, 14:56-62, Fig. 14; Welch¶¶671-672.

POSAs would have known that if a user defined a circular or rectangular boundary for Pedrotti's zone—for example, if either of those was a suitable or advantageous shape for the user's VR gameplay area, including based on surrounding obstacles—then the zone, with its “virtual fence,” would have the 3D shape of a cylinder or rectangle, respectively, extending up from the floor. Welch¶¶673. A rectangular shape would have been obvious because it mirrors physical spaces (e.g., rooms). *E.g.*, Jang, Fig. 6 (rectangular virtual spaces). Further, Pedrotti depicted circular boundaries and disclosed a “cylindrical projection” of its “virtual fence.” Pedrotti, 13:12-33, 15:13-22, Figs. 12-13; Welch¶¶674-675. In addition, POSAs would have known that a user could and would be centered in a cylindrical or rectangular Pedrotti zone—the user can walk around in the zone, including to its center. Welch¶¶676-677; §IV.A.

7. Claim 8: Playing Audio Warning In Response to PED Moving Outside Zone

Claim 8 recites: “playing, with the speakers in the WED worn on the head of the user, an audio warning in response to the WED determining that the PED is moving outside the zone.”

Pedrotti taught, or at a minimum rendered obvious, claim 8 because Pedrotti disclosed “generat[ing] an audio warning” to “provid[e] a warning that the user is about to move out of the selected area.” Pedrotti, 2:44-59, 4:37-44, 11:66-12:15, 12:31-50, 13:44-14:5, 16:53-60; §§IV.E.3-IV.E.4. Moreover, Pedrotti's warnings

can be presented if a user “goes beyond the boundary,” to “direct[] the user to move in the direction of the boundary and the selected area.” Pedrotti, 13:67-14:5, 2:8-12, 3:65-67, 15:66-16:9, 16:43-45. Further, POSAs would have known that audio warnings were commonly used in chaperone systems. For example, Begault disclosed VR systems that provided “a ‘crashing’ sound through headphones when a person walks into a virtual boundary.” Begault, 12, 171 (“crashing sound” indicates “boundary has been violated”); Welch¶¶678-682.

G. Claim 9

1. 9[pre]: A Method

Claim 9’s preamble, which recites “[a] method comprising,” would have been obvious for the same reasons as claim 1’s preamble. §IV.E.1; Welch¶¶683.

2. 9[a]: Dividing, With PED, An Area Into 3D Zone With SLPs

Limitation 9[a], which recites, “dividing, with a portable electronic device (PED) held in a hand of a user, an area around the user into a three-dimensional (3D) zone that extends around the user and that includes sound localization points (SLPs) from where binaural sound originates to the user,” would have been obvious for the same reasons as limitation 1[a]. §IV.E.2. Additionally, Pedrotti’s “safe” area is a “three-dimensional” zone because it is the zone in a 3D virtual environment bound by Pedrotti’s boundary and virtual fence extending (or at a minimum obviously extending) around the user. Pedrotti, Figs. 11 (“virtual fence 1114”), 14 (“boundary 1404”); Welch¶¶684.

Again, Pedrotti’s controller-defined zone is nearly identical to what Patentee contends in district court satisfy limitation 9[a]’s requirement of a “three-dimensional (3D) zone that extends around the user”:



Ex.1130, 3; Pedrotti, Fig. 11; Welch¶685.

3. 9[b]: Determining With WED When User Is Leaving Zone

Limitation 9[b] recites: “determining, with a wearable electronic device (WED) worn on a head of the user, when the user is leaving the zone.”

Limitation 9[b] would have been obvious for the same reasons as limitations 1[c]-1[d]. §§IV.E.4-IV.E.5. Also, POSAs would have considered equally obvious over Pedrotti determining that a tracked object—e.g., a user’s head (via HMD) or hands (via controllers)—is (i) “moving outside the zone” (1d]) and (ii) “leaving the zone” (9[b]). Welch¶686; Pedrotti, 4:37-44, 5:8-36 (discussing known tracking methods), 12:31-41 (processor “determine[s] when the user’s head

and/or hands approaches the boundary”), 13:57-62 (“auditory warning” provided if user goes “beyond the boundary”), 16:22-24; Welch¶¶687-689.

4. 9[c]: Warning User Is Leaving By Displaying 3D VR Image of Zone

Limitation 9[c], which recites, “warning the user that the user is leaving the zone by displaying, with the WED worn on the head of the user, a 3D virtual reality (VR) image of the zone in response to the WED determining that the user is leaving the zone,” would have been obvious for the same reasons as limitations 1[c], 1[d], and 9[b] and claim 3. §§IV.E.4-IV.E.5, IV.F.2, IV.G.3. Additionally, Pedrotti’s “grid or virtual fence” is, or at a minimum is obviously, a “3D” VR image—it is a virtual image presented in a 3D VR environment. Pedrotti, 12:51-13:11; Welch¶¶690-691. Pedrotti also taught that “shapes other than a grid-shaped virtual fence can be displayed to the user,” for example, “some other design to provide contrast with, or maintain thematic correctness with, the particular virtual world being displayed.” Pedrotti, 12:60-13:11. And virtual chaperone systems displaying “3D” VR boundary images were known. Welch¶¶138-140.

H. Dependent Claims 10-16

Claims 10-16 are unpatentable for the same reasons as claim 9 and as further explained below.

1. Claim 10

a. 10[a]: Determining When PED Is Pointed at SLP

Limitation 10[a], which recites, “determining, with the WED, when the PED is pointed at one of the SLPs while the user is located in the zone,” would have been obvious for the same reasons as limitations 1[c], 2[a], and 5[a]. §§IV.E.4, IV.F.1.a, IV.F.4.a; Welch¶¶694-697.

b. 10[b]: Playing With WED Binaural Sound In Response

Limitation 10[b], which recites, “playing the binaural sound that originates from the one of the SLPs in the zone in response to the WED determining that the PED is pointed at the one of the SLPs,” would have been obvious for the same reasons as limitation 2[b]. §IV.F.1.b; Welch¶¶698-699.

2. Claim 11: Highlighting Color Of VR Image At SLP

Claim 11, which recites “highlighting, while the user is located in the zone and with a display of the WED, color of a VR image at one of the SLPs in the zone when the PED held in the hand of the user points at the one of the SLPs in the zone,” would have been obvious for the same reasons as limitation 2[a]. §IV.F.1.a; VR Book, 305 (“Highlighting is visually outlining or changing the color of an object.”); Welch¶700.

3. Claim 12

a. 12[a]: Cylindrical 3D VR Image Of Zone, Where User Is Centered

Limitation 12[a], which recites “wherein the 3D VR image of the zone is shaped as a cylinder with the user being centered in the cylinder,” would have been obvious for the same reasons as claim 7 and limitation 9[b]. §§IV.F.7, IV.G.4; Welch¶701.

b. 12[b]: WED Is HMD That Displays VR Images

Limitation 12[b], which recites “the WED is a head mounted display that display VR images,” would have been obvious for the same reasons as limitations 1[a] and 1[d]. §§IV.E.2, IV.E.5; §IV.A; Welch¶702.

c. 12[c]: WED Plays Binaural Sound While User Plays Game

Limitation 12[c], which requires that the WED “plays the binaural sound while the user plays a game,” would have been obvious for the same reasons as limitation 1[b] and because Pedrotti’s system applies to VR games. §IV.E.3; Pedrotti, 1:40-44, 9:24-40; Welch¶¶703-704.

4. Claim 13

a. 13[a]: Rectangular 3D VR Image Of Zone, Where User Is Centered

Limitation 13[a], which recites “wherein the 3D VR image of the zone is shaped as a rectangle with the user being centered in the rectangle,” would have been

obvious for the same reasons as claim 7 and limitation 9[b]. §§IV.F.7, IV.G.4; Welch¶705.

b. 13[b]: WED Is HMD That Displays VR Images

Limitation 13[b], which recites “the WED is a head mounted display that displays VR images,” would have been obvious for the same reasons as limitations 1[a] and 1[d]. §§IV.E.2, IV.E.5; §IV.A; Welch¶706.

c. 13[c]: WED Plays Binaural Sound While User Plays Game

Limitation 13[c], which requires that the WED “plays the binaural sound while the user plays a game,” would have been obvious for the same reasons as limitations 1[b] and 12[c] and because Pedrotti applies to VR games. §§IV.E.3, IV.H.3.c; Pedrotti, 1:40-45, 9:24-40; Welch¶707.

5. Claim 14: Playing Audio Warning Indicating User Should Move Back Into Zone

Claim 14, which recites “playing, with the WED worn on the head of the user, an audio warning indicating the user should move back into the zone in response to the WED determining that the user is leaving the zone,” would have been obvious for the same reasons as claim 8. §IV.F.7; Welch¶708.

6. Claim 15: Cylindrical 3D VR Image Of Zone Extends Around User

Claim 15, which recites “wherein the 3D VR image of the zone is shaped as a cylinder that extends around the user,” would have been obvious for the same

reasons as claim 7 and limitation 12[a]. §§IV.F.6, IV.H.3.a. Also, Pedrotti's zone extends around the user, so the 3D VR image of Pedrotti's zone also would (or at a minimum obviously would). §IV.E.2; Welch¶709.

7. Claim 16

a. 16[a]: Determining With WED When PED Is Leaving Zone

Limitation 16[a], which recites “determining, with the WED worn on the head of the user, when the PED is leaving the zone,” would have been obvious for the same reasons as limitations 1[c]-1[d]. §§IV.E.4-IV.E.5. POSAs would have considered equally obvious over Pedrotti determining that a PED is (i) “moving outside the zone” (1[c]) and (ii) “leaving the zone” (16[a]). Welch¶710.

b. 16[b]: Warning User By Displaying 3D VR Image Of Zone

Limitation 16[b], which recites “warning the user that the PED is leaving the zone by displaying, with the WED worn on the head of the user, the 3D VR image of the zone in response to the WED determining that the PED is leaving the zone,” would have been obvious for the same reasons as limitations 1[d], 9[c], and 16[a]. §§IV.E.5, IV.G.4, IV.H.7.a; Welch¶711.

I. Claim 17

1. 17[pre]: An Electronic System

Pedrotti taught claim 17's preamble, which recites “An electronic system comprising.” *E.g.*, Pedrotti, 2:44-59; §IV.A; Welch¶712.

2. 17[a]: PED That Divides An Area Into 3D Zone With SLPs

Limitation 17[a], which recites “a portable electronic device (PED) held in a hand of a user that divides an area around the user into a three-dimensional (3D) zone that extends around the user and includes sound localization points (SLPs) in empty space from where binaural sound originates to the user while the user is located inside the zone,” would have been obvious for the same reasons as limitations 1[a] and 9[a]. §§IV.E.2, IV.G.2; Welch¶713.

3. 17[b]: WED Worn On Head Of User

Limitation 17[b], which recites “a wearable electronic device (WED) that is worn on a head of the user,” would have been obvious for the same reasons as limitation 1[a]. §IV.E.2; §IV.A; Welch¶714.

4. 17[c]: WED Wirelessly Communicates With PED

Limitation 17[c] requires that the WED “wirelessly communicates with the PED.” Pedrotti taught, or at a minimum rendered obvious, an HMD (WED) communicating wirelessly with controllers (PEDs) because Pedrotti disclosed multiple tracking methods that POSAs would have understood are or could be implemented wirelessly, including “magnetic, optical, electrical, sonar, radar, [and] ultrasonic” tracking. Pedrotti, 4:49-5:26; §IV.E.4 (discussing Pedrotti’s HMD-tracked controllers); Welch¶¶715-716.

5. 17[d]: Speakers That Play Binaural Sound

Limitation 17[d], which requires that the WED “includes speakers that play to the user the binaural sound that emanates from the SLPs in empty space inside the zone,” would have been obvious for the same reasons as limitation 1[b]. §IV.E.3; Welch¶717.

6. 17[e]: Sensors That Sense PED Is Leaving Zone

Limitation 17[e], which requires that the WED “includes one or more sensors that sense when the PED is leaving the zone,” would have been obvious for the same reasons as limitations 1[c] and 16[a]. §§IV.E.4, IV.H.7.a; Welch¶718.

7. 17[f]: Display Displays VR Image Of Zone

Limitation 17[f], which requires that the WED “includes a display that displays a virtual reality (VR) image of the zone in response to sensing that the PED is leaving the zone,” would have been obvious for the same reasons as limitations 1[d] and 17[e]. §§IV.E.5, IV.I.6; Welch¶719.

8. 17[g]: Display Displays VR Image of Zone To Warn That User Is Leaving

Limitation 17[g], which recites “wherein the display displays the VR image of the zone to warn the user that the user is leaving the zone,” would have been obvious for the same reasons as limitations 1[d] and 9[c]. §§IV.E.5, IV.G.4; Welch¶720.

J. Dependent Claims 18-20

Claims 18-20 are unpatentable for the same reasons as claim 17 and as further explained below.

1. Claim 18: Display Highlights Color Of VR Image At SLP

Claim 18, which recites “wherein the display of the WED highlights a color of a VR image at one of the SLPs in response to the WED determining that the PED is pointing to the VR image at the one of the SLPs,” would have been obvious for the same reasons as limitation 2[a] and claim 11. §§IV.F.1.a, IV.H.2; Welch¶723.

2. Claim 19: Automatically Displays VR Image

Claim 19 recites “wherein the WED tracks a location of the user with respect to the SLPs, and automatically displays a VR image at a location of one of the SLPs in response to determining that the user is proximate to the location of the one of the SLPs.”

Claim 19 would have been obvious for the same reasons as limitations 1[c], 1[d], 4[a], 5[b], 6[b], and claim 3. §§IV.E.4, IV.E.5, IV.F.2, IV.F.3.a, IV.F.4.b, IV.F.5.b. Additionally, it would have been obvious to apply the logic that causes Pedrotti’s HMD to automatically display a virtual image of a fence when a user is proximate to a zone boundary to the display of a virtual image at an SLP. Pedrotti, 4:37-44, 7:1-19; Welch¶724-726. Automatically displaying virtual images at their sound source locations (SLPs) when users approach was a well-known VR effect, e.g., to present content of interest while pausing or not presenting other content.

Welch¶727; Ross, 2:32-67 (primary VR content “may resume (e.g., automatically) when the user returns his view (e.g., and/or moves within the virtual space) to the primary... field of view”), 4:21-39, 6:41-67, 15:29-36; §IV.B (discussing Jang’s sound processing for virtual space shifts).

3. Claim 20

a. 20[a]: Speakers In WED Play Binaural Sound In Response To PED Pointing At SLP

Limitation 20[a], which recites “wherein the speakers in the WED play the binaural sound that emanates from one of the SLPs in empty space in response to the WED determining that the PED is pointed to the one of the SLPs in empty space,” would have been obvious for the same reasons as limitation 1[b] and claim 2. §§IV.E.3, IV.F.1; Welch¶728.

b. 20[b]: Cylindrical Zone, Where User Is Centered

Limitation 20[b], which recites “the zone is shaped as a 3D cylinder with the user being centered in the 3D cylinder,” would have been obvious for the same reasons as claim 7. §IV.F.6; Welch¶729.

V. Ground 2: Claims 1-20 Are Unpatentable Over McCulloch In View Of Pedrotti, And Further In View Of Flaks

Challenged claims 1-20 are obvious over McCulloch in view of Pedrotti, and further in view of Flaks, for the reasons discussed below.

A. Overview of McCulloch

McCulloch, issued in May 2015, is § 102(a) prior art and was not considered during prosecution.

McCulloch disclosed a system for controlling virtual objects displayed by an “augmented reality display” comprising an HMD, control circuitry, and “controller device[s].” McCulloch, 1:46-48, 4:25-55, 6:55-7:22, 8:1-39, Figs. 1B, 2A, 5. McCulloch’s HMD receives user input “requesting an action to be performed by the virtual object” through controllers, “appl[ies] the user input,” and then “display[s] the action.” *Id.* 1:59-66, 11:42-46.

The HMD tracks its position and orientation, “virtual objects” in the field of view, and the handheld controllers for controlling those objects. *Id.* 4:14-31, 7:24-67, 8:17-9:16, 11:56-12:17, 12:41-48, 15:30-47, 29:4-43, Figs. 4A, 8B, 8D. McCulloch further taught that users “identify[] boundaries for a playspace in which virtual objects can be positioned.” *Id.* 20:11-13.

McCulloch’s HMD has an image and audio processing engine that renders virtual scenes, stores virtual object data, and generates 3D audio. *Id.* 13:56-14:67, 21:21-38, 22:66-23:4, Fig. 4A, cl. 8. McCulloch taught that each object is associated with audio projected from its “3D space position” generated through HRTF processing (*id.* 26:7-19)—i.e., binaural sound from SLPs—including as described in U.S. Patent Application No. 12/903,610, which McCulloch incorporated by

reference. *Id.* 21:21-38. That application issued as U.S. Patent No. 8,767,968, the Flaks reference. Flaks (Ex.1009), Cover; Welch¶¶185-197.

B. Overview of Flaks

Flaks, issued in July 2014, is § 102(a) prior art and was not considered during prosecution. Flaks disclosed techniques “for providing 3D audio,” including applying HRTFs to generate “3D audio signal[s],” i.e., binaural sound. Flaks, Abstract, 9:4-10:4, 11:44-13:16, 13:55-14:4, Figs. 5A, 7, 8, 10; Welch¶¶198-206.

C. Motivations to Combine

McCulloch incorporates, and thus includes as part of its own disclosures, Flaks’s “3D audio engine.” McCulloch, 21:21-38. Further, POSAs would have known to combine McCulloch’s system with Flaks’ 3D audio engine because McCulloch says to do so, and to enhance the VR immersive experience using 3D audio. *Id.*; §V.A; Welch¶¶418-419.

Additionally, POSAs would have been motivated to combine McCulloch’s system (including Flaks’s 3D audio engine) with Pedrotti’s method for assisting a user in remaining within a selected area. McCulloch taught “identifying boundaries for a playspace” (McCulloch, 20:11-13), and POSAs would have recognized that Pedrotti describes an advantageous method for defining boundaries for virtual environments, including to protect users. §IV.A.

In AR and VR environments, immersivity is key, and users risk personal injury and property damage due to collisions and tripping hazards. For example, a user may be following a virtual helicopter flying overhead, as McCulloch describes, and accidentally trip over a sofa. Or if a user is attacking a virtual monster standing in front of (and occluding) a bookshelf, the user may hit the bookshelf. Pedrotti encourages POSAs to use its system given these known risks, including with systems that obscure only “portion of the user’s field of vision of the physical world,” like McCulloch’s. Pedrotti, 16:14-19. Pedrotti’s methods help users stay within boundaries and avoid such collisions, without disrupting immersive experiences. Welch¶¶409-415; §IV.A; Pedrotti, 11:66-12:3; McCulloch, 26:35-48, 20:28-29, 23:39-51.

McCulloch (including with Flaks) and Pedrotti also are analogous art. Both are directed to systems and methods for providing immersive, interactive virtual experiences and use motion-tracked HMDs and controllers. §§IV.A, V.A; Welch¶¶407-408.

Furthermore, POSAs combining the teachings of McCulloch (including with Flaks) with Pedrotti’s methods would have had a reasonable expectation of success. These references disclosed hardware that was well known before June 2016, such as HMDs, controllers, and processors, and common methods of using such hardware, e.g., to set boundaries and process sound with HRTFs. §§IV.A, V.A-V.B.

McCulloch’s HMD already had the capability to capture and store playspace boundaries. McCulloch, 20:11-13. It also had a computing platform for running AR applications and displaying virtual objects, and could thus display a virtual fence as taught by Pedrotti. To POSAs, combining the teachings of McCulloch, Flaks, and Pedrotti to implement Pedrotti’s “safe area” system would have been obvious to try and well within common sense, and would have been routine, requiring no more than combining known elements with known functions, to improve similar devices in known ways. Welch¶¶416-417.

D. Claim 1

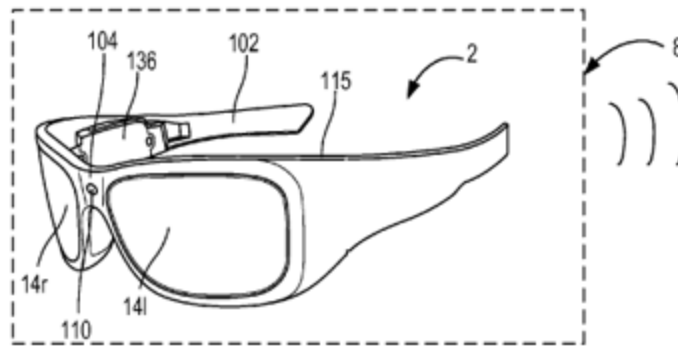
1. 1[pre]: A Method⁶

McCulloch taught claim 1’s preamble with methods executed by electronic devices, including an HMD and controllers. McCulloch, 4:49-55, 6:55-61, Figs. 1A-1B; Welch¶¶732-733. So did Pedrotti. §IV.E.1; Welch¶734.

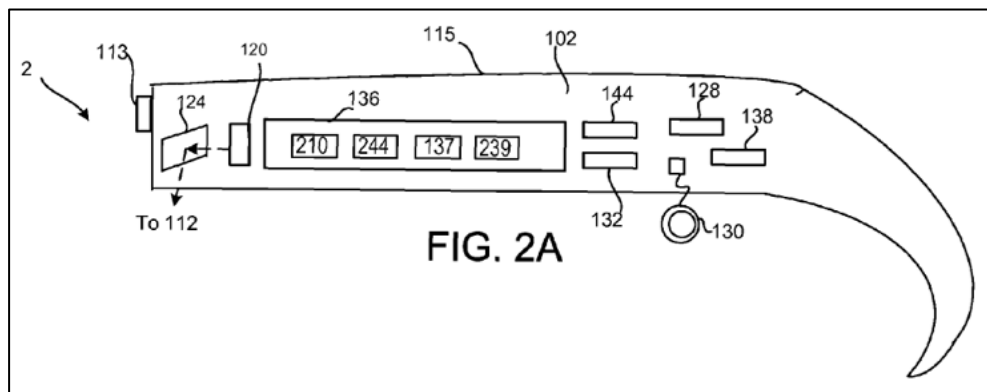
2. 1[a]: PED Dividing An Area Into Zone Including An SLP

McCulloch and Pedrotti render limitation 1[a] obvious. McCulloch disclosed a “display device system 8” comprising a “head mounted display device 2” (WED) worn on a user’s head:

⁶ The attached Claims Appendix and Ground 1 present claim recitations in full.



McCulloch, Fig. 1B (excerpted), 4:49-55, 8:1-46; *see also* '316 patent, 7:34-39 (“electronic glasses” and HMDs listed as WEDs). The HMD has “[c]ontrol circuitry 136” comprising a “processing unit 210” including “one or more processors”:



McCulloch, Fig. 2A, 8:1-16. The HMD’s “computing environment” comprises an “image and audio processing engine 191” that receives inertial and positional data from “handheld IMU controller[s]”—i.e., McCulloch’s HMD tracks the controllers. *Id.* 4:25-31, 13:52-18:7 (describing “computing environment 54”), 28:63-66, 29:4-63 (“Inertial motion sensors ... in the handheld real controller device 19 identify parameters like speed, acceleration and direction of motion... which is sent as data to the display device system 8.”), 24:28-35, Figs. 4A, 8B, 8D. The HMD tracks the

controllers relative to the HMD and the surrounding environment using image and depth data. McCulloch, 7:34-59, 8:17-30, 12:18-21, 22:4-8, 28:5-11; Welch¶¶737-749.

Consequently, POSAs would have known that McCulloch’s system—which McCulloch taught can “identify[] boundaries for a playspace in which virtual objects can be positioned” (McCulloch, 20:7-13, 15:48-16:41)—could and would be used to implement Pedrotti’s method of assisting a user in remaining in a selected area. Welch¶¶745, 750-753; §V.C. And a McCulloch system (with its HMD and controllers) implementing Pedrotti’s method would render limitation 1[a]’s PED-divided zone obvious in view of the Pedrotti disclosures addressed for this limitation in Ground 1. §IV.E.2; Welch¶750.

Furthermore, as noted, Patentee contends in district court that any area defined for game play that *subsequently* includes binaural sound satisfies the elements of limitation 1[a]. §IV.E.2; Ex.1130, 4. Under such an interpretation, limitation 1[a] would have been obvious over McCulloch (alone or with Flaks) and Pedrotti. Welch¶¶735-736.

First, POSAs would have known that the zone into which Pedrotti’s method divides an area around the user could and would subsequently include SLPs for binaural sound. §IV.E.2 (Pedrotti’s system and methods facilitate VR gameplay,

which would obviously include locations for VR images and associated binaural sounds (SLPs)); Welch¶¶754.

Second, McCulloch confirms the obviousness of SLPs for binaural sound existing in a zone. McCulloch teaches that a virtual “playspace” is an area “in which virtual objects can be positioned,” and POSAs would have known that virtual objects could and would include binaural sound-producing virtual objects. McCulloch, 20:11-23; Welch¶¶753-755. Indeed, McCulloch taught localized sound (i.e., binaural sound) emanating from virtual objects, as its 3D audio engine produces audio “projected from a 3D space position of the virtual object” (an SLP). *E.g.*, McCulloch, 26:7-9. McCulloch also incorporated Flaks for implementation details, including that the 3D audio engine’s sound is generated using HRTFs, which POSAs would have known are used for binaural sound. McCulloch, 14:59-64, 21:21-38, 29:43-57; Flaks, 2:6-20, 4:10-15, 13:36-41; Welch¶¶756-758 (Flaks discloses HRTFs and “binaural cues” (Flaks, 1:9-11) for producing binaural sound at SLPs).

Additionally and alternatively, if limitation 1[a] is interpreted to require a PED-divided zone that “includes” SLPs for binaural sound when divided by a PED, limitation 1[a] would have been obvious over McCulloch (alone or with Flaks) and Pedrotti. Welch¶761.

McCulloch disclosed virtual environments in which “virtual objects can be positioned.” McCulloch, 20:7-13 (describing “applications” that “store adaptive

virtual environment rules” and a “gaming application” that “receive[]s user input identifying boundaries”). And as noted, McCulloch taught that its “3D audio engine 304 plays audio data for [a] virtual object projected from a 3D space position,” i.e., an SLP. *Id.* 26:7-9; *id.*, 21:25-29. Thus, POSAs would have known that McCulloch’s virtual playspace could and would include “virtual objects” “positioned” at “3D space positions” for “3D audio”—i.e., SLPs from where binaural sound originates. Welch¶762. POSAs also would have known that Pedrotti’s method, which divides an area around a user into a zone as claimed, could and would (i) be used and useful with McCulloch’s virtual environment and (ii) include that environment’s binaural sound-producing virtual objects and their locations (SLPs). *Id.*¶¶762-763; §V.C.

Moreover, POSAs would have known that McCulloch’s virtual objects and their SLPs (in McCulloch’s playspace in Pedrotti’s zone) could and would be in “empty space,” i.e., space not occupied by a physical object. ’316 patent, 6:1-5. For example, McCulloch discloses a virtual basketball in “empty space.” *See* McCulloch, Fig. 8B, 29:4-17 (actions applied to “basketball virtual object 30₂” after “real basketball 30 has been erased”). Similarly, McCulloch discloses a virtual helicopter that POSAs would have known could and would be positioned, with its binaural sound, in “empty space”—e.g., as it flies through the “playspace.” McCulloch, 25:8-11, 26:12-19; Welch¶759.

3. 1[b]: Speakers in WED Play Binaural Sound

Limitation 1[b] would have been obvious for the same reasons as limitation 1[a]. §V.D.2. Additionally, playing binaural sound with speakers in a WED would have been obvious over McCulloch and Pedrotti, or over McCulloch, Flaks, and Pedrotti because McCulloch's HMD plays binaural sound for SLPs in empty space through earphones, which obviously comprise speakers. McCulloch, 21:21-38 ("positional 3D audio engine" "receives input audio data and outputs audio data for the earphones 130"), Fig. 2A (item 130), 8:17-22 ("Inside, or mounted to temple 102, are an earphone o[r] a set of earphones 130"); Welch¶¶764-766.

4. 1[c]: Tracking With WED When PED Is Moving Outside Zone

McCulloch and Pedrotti render limitation 1[c] obvious. McCulloch's HMD (WED) tracks handheld controllers (PEDs). §V.D.2; Welch¶¶767-768. McCulloch also taught using devices such as cameras and infrared transceivers (i.e., sensors) in its HMD to detect and track infrared light, including from controllers. McCulloch, 7:34-40 (capture devices), 8:3-39 (transceivers), 5:19-36 (companion processing module in HMD communicates via infrared with controllers). And using sensors on HMDs to track controllers—including light-emitting controllers, which were widely used due to accuracy advantages—was well known. Welch¶¶88, 604, 769; VR Book, 315 ("Hand-held tracked devices typically use inertial, electromagnetic, ultrasonic, or optical (camera) technologies.").

Further, McCulloch's system (with HMD-tracked controllers) implementing Pedrotti's method would render obvious limitation 1[c]'s "determin[ing] when the PED held in the hand of the user is moving outside the zone that extends around the user" in view of the Pedrotti disclosures discussed for this limitation in Ground 1. §IV.E.4. Indeed, it would have been straightforward for POSAs, including in view of McCulloch's teaching regarding a scene mapping engine, to compare locations of McCulloch's tracked controllers against boundaries of a Pedrotti-type zone, which could and would be stored in McCulloch's HMD's memory, to determine when a controller moves outside or leaves that zone. McCulloch, 15:30-16:62 ("scene mapping engine 306 identifies the position and tracks the movement of real and virtual objects"), 8:1-11 ("memory 244" in HMD 2), Fig. 2A; Welch¶¶770-773.

5. 1[d]: Displaying VR Image Showing Zone

McCulloch and Pedrotti disclosed HMDs that display virtual images. McCulloch, Fig. 8B, 8:40-46, 16:49-65, 13:52-14:5, Fig. 4A; Pedrotti, Abstract. And McCulloch's system implementing Pedrotti's method would have rendered obvious limitation 1[d] in view of the Pedrotti disclosures discussed for this limitation in Ground 1. §IV.E.5; Welch¶¶774-775. POSAs also would have known that McCulloch's system could and would generate, store, and display Pedrotti's boundaries and virtual fence because McCulloch taught an HMD with a virtual data

engine that displays virtual images. §V.A; McCulloch, 17:14-31, 17:47-48, 23:25-38; Welch¶¶776-779.

E. Dependent Claims 2-8

Claims 2-8 are unpatentable for the same reasons as claim 1 and as further explained below.

1. Claim 2

a. 2[a]: Highlighting VR Image At SLP When PED Is Pointed At SLP

McCulloch (including with Flaks) and Pedrotti render obvious limitation 2[a]’s (i) user in a zone with a WED that displays VR images and (ii) highlighting a VR image at the SLP in the zone when a PED is pointed at it.

A user using McCulloch’s system implementing Pedrotti’s method would use McCulloch’s HMD while in a Pedrotti-type safe zone. §IV.A (Pedrotti overview); Welch¶¶780-781. McCulloch’s HMD displays VR images inside that zone. §§V.D.5, V.A; McCulloch, Figs. 8A-8D (depicting virtual images displayed by McCulloch’s HMD, which could and would be inside Pedrotti’s zone), 8:40-46, 16:49-65, 13:52-14:5, Fig. 4A; Welch¶¶782.

Additionally, limitation 2[a]’s “pointed” PED would have been obvious over McCulloch. McCulloch, like Pedrotti, taught that its controllers manipulate virtual objects. McCulloch’s title is “Controlling a Virtual Object with a Real Controller Device,” and it disclosed multiple examples of “real controller device[s]” for

controlling virtual objects, including “a joystick,” “a pointing device,” and the “handheld inertial motion unit (IMU)” discussed above, which obviously could be pointed. McCulloch, Title, 4:25-33, cl. 12; *id.* 6:55-66 (examples of “real controller device[s]”), 25:25-28 (“real controller device” used to identify and control a “selected object”); Welch¶¶783-786; §IV.F.1.a.

Limitation 1[c]’s “highlighting” also would have been obvious over McCulloch. McCulloch’s system uses a “visual effects library” comprising “routines for animations, **highlighting**, and other... visual enhancements” “associated with particular actions.” McCulloch, 23:4-7. And “[h]ighlighting” was a well-known tool used for selection. VR Book, 281 (“objects can” “become highlighted” “when ... selected”), 305; Welch¶¶626, 787-789; §IV.F.1.a.

Further, POSAs would have known and understood that McCulloch’s controllers could and would point at virtual objects (e.g., a VR image of a basketball or helicopter) to select them, e.g., to move them, and that selected virtual objects could and would be highlighted to facilitate selection. These were well-known techniques. McCulloch, 12:51-52, 29:45; Welch¶¶627-633, 790-791. Also, McCulloch’s system could and would highlight an SLP’s VR image “when the PED ... is pointed at” the SLP because McCulloch’s HMD tracks its own position and uses image and depth data to track objects, including controllers. McCulloch, 7:34-59, 8:17-30, 12:18-21, 22:4-8, 28:5-11; §V.D.2; Welch¶792.

Moreover, as discussed in Ground 1, a sound source in virtual space (at an SLP) is just one type of virtual object that could and would be controlled and arranged in a virtual environment, for example, by pointing at, highlighting, selecting, and moving it with its associated VR image. §IV.E.2. Such sound control would have been obvious. *Id.*; Welch¶¶627-635.

Thus, based on McCulloch (including with Flaks) and Pedrotti, POSAs would have known that McCulloch's controller could and would control virtual objects in McCulloch's playspace (inside Pedrotti's zone), including by pointing at and selecting binaural sound-producing virtual objects—e.g., a virtual helicopter—and that highlighting could obviously indicate selections. Then, a selected and highlighted sound source could be moved from one location (SLP) to another location (a different SLP). Welch¶¶790-791; McCulloch, Fig. 8D, 29:36-63 (virtual basketball controlled so it smashes television).

b. 2[b]: Playing With WED Binaural Sound In Response

Limitation 2[b] would have been obvious over McCulloch (including with Flaks) and Pedrotti. McCulloch's HMD plays binaural sounds emanating from SLPs. §V.D.3. And POSAs would have known that McCulloch's HMD could and would determine when a controller is pointed at an SLP. §V.E.1.a. Further, as noted in Ground 1, playing binaural sound from an SLP in response to pointing would have been obvious because that technique was common before February 2016, e.g., to

facilitate user selections. Welch¶¶793-794; VR Book, 281 (“objects can make a sound” “when... selected”), 356. Consequently, POSAs would have understood that a McCulloch-Pedrotti or McCulloch-Flaks-Pedrotti system could and would “play[] binaural sound” from an SLP “in response to” McCulloch’s controller pointing at an SLP. Welch¶¶793-794.

2. Claim 3: Displaying VR Image Showing Size And Shape Of Zone When PED Is Moving Outside Zone

Claim 3 would have been obvious for the same reasons as limitations 1[c]-1[d], and in view of the Pedrotti disclosures discussed for this limitation in Ground 1. §§V.D.4-V.D.5, IV.F.2; Welch¶¶795-796.

3. Claim 4

a. 4[a]: Storing Location, Size, And Shape of Zone, And Location Of SLPs In Memory Of WED

Limitation 4[a] would have been obvious in view of the Pedrotti disclosures discussed for this limitation in Ground 1. §IV.F.3.a. Also, POSAs would have known that McCulloch’s system implementing Pedrotti’s method would (or at a minimum would obviously) store the zone’s location, size, and shape. *Id.* And POSAs would have known that such information could advantageously be stored in an HMD’s memory, consistent with McCulloch’s teachings. *Id.*; Welch¶¶797-801; McCulloch, 8:1-11 (“memory 244”), Fig. 2A (depicting same), 20:22-27.

Additionally, storing SLP locations would have been equally obvious. McCulloch taught that its system, which has HMD storage, stores virtual objects’

locations and generates binaural sound for those virtual objects. McCulloch, 8:1-11 (“memory 244”), 15:48-54 (storing maps in memory), 19:8-27 (storage of virtual object properties), 19:51-62 (using stored properties to “update a 3D space position or position volume for an object”), 21:21-39; §V.D.3; Welch¶¶798, 801. Thus, POSAs would have known that McCulloch’s virtual objects’ locations, from which binaural sound originates, are (or obviously could and would be) stored in McCulloch’s HMD memory. Welch¶802.

b. 4[b]: Retrieving Size And Shape In Response To WED Determining User Is In Location Of Zone

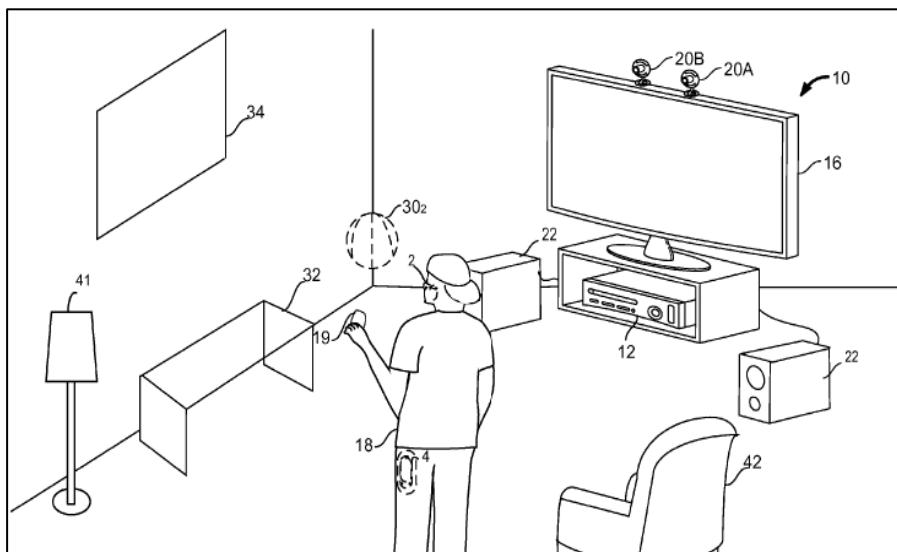
Limitation 4[b] would have been obvious for the same reasons as limitation 4[a], and in view of the Pedrotti disclosures discussed for this limitation in Ground 1. §§IV.F.3.b, V.E.3.a. Additionally, McCulloch disclosed generating and storing 3D environment maps, so it would have been obvious to POSAs reading McCulloch to store the size and shape of a Pedrotti-type zone applicable to such an environment, and to retrieve and display that zone when a user “enter[s] or re-enter[s] the environment”—i.e., in response to determining that the user is located in the zone—to give the user a sense of the zone’s boundaries. McCulloch, 15:48-54, 15:63-67; Welch¶¶803-805.

4. Claim 5

a. 5[a]: Designating With PED Locations Of Multiple SLPs

Limitation 5[a] recites: “designating, with the PED held in the hand of the user, locations of multiple SLPs in empty space in the zone from where the binaural sound originates to the user.” Patentee has argued in district court that claim limitations reciting and requiring designations of SLPs by PEDs are satisfied by “a game character” being “moved by direction of” the PED. *See* Ex.1121, 4. Under such an interpretation, limitation 5[a] would have been obvious. Welch¶¶806-810.

McCulloch disclosed examples of a controller moving virtual objects, including virtual images that are, or obviously could and would be, associated with binaural sounds. McCulloch, 12:49-13:51, 25:6-50, 29:4-17, Figs. 3A-3E, 8A-8D. For example, in Figure 8B, McCulloch depicted moving “real controller device 19” upward, which “translate[s] into an up action” for “the basketball virtual object 30₂”:



Id. Fig. 8B, 29:12-16. And McCulloch disclosed that virtual objects’ sounds—e.g., basketballs smashing televisions or crashing helicopters—should be produced “as if coming from the direction of the virtual object” (i.e., from their VR images). *Id.* 21:21-38, 14:53-67, 24:67-26:34 (“play[ing] audio for the virtual object projected from a 3D space position of the virtual object”), 26:7-19 (helicopter), 29:4-30:3 (basketball), Figs. 5, 8A-8D; §V.D.3 (McCulloch, including with Flaks, taught binaural sound for PED-controlled virtual objects); Welch¶¶811-815.

b. 5[b]: Displaying VR Images At Locations Of Multiple SLPs

Limitation 5[b] recites: “displaying, with the WED, VR images at the locations of the multiple SLPs in empty space in the zone.” McCulloch and Pedrotti both disclosed HMDs that display VR images. McCulloch, Fig. 8B, 8:40-46, 16:49-65, 13:52-14:5, Fig. 4A; Pedrotti, Abstract; Welch¶¶816-817. And McCulloch disclosed, or at a minimum rendered obvious, displaying VR images, e.g., a basketball or a helicopter (or other virtual objects), at the locations for the VR images’ binaural sounds (SLPs), e.g., where the virtual basketball smashes a virtual television or where the virtual helicopter crashes into the wall, including in empty space in a zone. §§V.D.3, V.E.4.a; Flaks, 4:10-20 (“virtual sound source 29a c[an] be an object being displayed on [a] display”); Welch¶¶818-821; §IV.F.4.a.

5. Claim 6

a. 6[a]: Selecting SLP When PED Is Pointed At SLP

Limitation 6[a] would have been obvious for the same reasons as limitations 1[a], 2[a], and 5[a]. §§V.D.2, V.E.1.a, V.E.4.a; Welch¶822. As discussed in Ground 1, pointing to select (and highlighting to indicate selections) was well known before February 2016, and thus selecting an SLP when a PED (e.g., McCulloch's controller) is pointed at it, would have been obvious over McCulloch (including with Flaks) and Pedrotti. §IV.F.5.a; Welch¶¶823-825.

b. 6[b]: Displaying VR Image At SLP

Limitation 6[b] would have been obvious for the same reasons as limitations 1[a], 5[a], 5[b] and 6[a]. §§V.D.2, V.E.4.a-V.E.4.b, V.E.5.a; Welch¶826. Also, POSAs would have known that McCulloch's HMD could and would display a VR image associated with an SLP in response to a user pointing McCulloch's controller at the SLP and its VR image, e.g., when a user points and selects a VR helicopter's image to move it. Welch¶827.

6. Claim 7: Cylindrical Or Rectangular Zone, Where User Is Centered

Claim 7 would have been obvious in view of the Pedrotti disclosures discussed for this claim in Ground 1. §IV.F.6; Welch¶¶828-829.

7. Claim 8: Playing Audio Warning In Response to PED Moving Outside Zone

Claim 8 would have been obvious in view of the Pedrotti disclosures discussed for this claim in Ground 1. §IV.F.7; Welch¶830. Further, POSAs would have known that the audio warning Pedrotti teaches could and would be played through the earphones of McCulloch's HMD, which obviously include speakers. §V.D.3; McCulloch, 21:21-29, Fig. 2A (item 130), 8:17-22; Welch¶¶831-832.

F. Claim 9

1. 9[pre]: A Method

Claim 9's preamble would have been obvious for the same reasons as claim 1's preamble. §V.D.1; Welch¶833.

2. 9[a]: Dividing, With PED, An Area Into 3D Zone With SLPs

Limitation 9[a] would have been obvious for the same reasons as limitation 1[a], and in view of the Pedrotti disclosures discussed for this limitation in Ground 1. §V.D.2; §IV.G.2; Welch¶¶834-835.

3. 9[b]: Determining With WED When User Is Leaving Zone

Limitation 9[b] would have been obvious for the same reasons as limitations 1[c]-1[d], and in view of the Pedrotti disclosures discussed for this limitation in Ground 1. §§V.D.4-V.D.5, IV.G.3; Welch¶¶836-840.

4. 9[c]: Warning User Is Leaving By Display 3D VR Image of Zone

Limitation 9[c] would have been obvious for the same reasons as limitation 1[d], and in view of the Pedrotti disclosures discussed for this limitation in Ground 1. §§V.D.5, IV.G.4; Welch¶841.

G. Dependent Claims 10-16

Claims 10-16 are unpatentable for the same reasons as claim 9 and as further explained below.

1. Claim 10

a. 10[a]: Determining When PED Is Pointed at SLP

Limitation 10[a] would have been obvious for the same reasons as limitations 1[c], 2[a], and 5[a]. §§V.D.4, V.E.1.a, V.E.4.a; Welch¶844.

b. 10[b]: Playing With WED Binaural Sound In Response

Limitation 10[b] would have been obvious for the same reasons as limitation 2[b]. §V.E.1.b; Welch¶¶845-846.

2. Claim 11: Highlighting Color Of VR Image At SLP

Claim 11 would have been obvious for the same reasons as limitation 2[a], and in view of the Pedrotti disclosures discussed for this claim in Ground 1. §§V.E.1.a, IV.H.2; Welch¶847. In addition to teaching “highlighting,” which encompasses highlighting a color, McCulloch taught “other types of visual

enhancements,” which POSAs likewise would have known could and would include emphasizing and changing color. §§V.E.1.a; McCulloch, 23:4-7; Welch¶848.

3. Claim 12

a. 12[a]: Cylindrical 3D VR Image Of Zone, Where User Is Centered

Limitation 12[a] would have been obvious for the same reasons as claim 7 and limitation 9[b], and in view of the Pedrotti disclosures discussed for this limitation in Ground 1. §§V.E.6, V.F.3, IV.H.3.a; Welch¶¶849-850.

b. 12[b]: WED Is HMD That Displays VR Images

McCulloch’s system uses an HMD that displays VR images. §§V.D.2 (1[a]), V.D.5 (1[d]), V.E.1.a (2[a]), V.E.4 (claim 5); Welch¶851.

c. 12[c]: WED Plays Binaural Sound While User Plays Game

Limitation 12[c] would have been obvious for the same reasons as limitations 1[a]-[b]. §§V.D.2-V.D.3. Additionally, McCulloch and Pedrotti disclosed using their systems for game play, including in VR. McCulloch, 6:29-33 (discussing “game applications” executed on display device system 8), 24:1-4 (describing video-see mode); Pedrotti, 1:40-45, 9:24-40; Welch¶¶852-853.

4. Claim 13

a. 13[a]: Rectangular 3D VR Image Of Zone, Where User Is Centered

Limitation 13[a] would have been obvious for the same reasons as claim 7 and limitation 9[b], and in view of the Pedrotti disclosures discussed for this limitation in Ground 1. §§V.E.6, V.F.3, IV.H.4.a; Welch¶¶854-856.

b. 13[b]: WED Is HMD That Displays VR Images

McCulloch's system uses an HMD that displays VR images. §§V.D.2 (1[a]), V.D.5 (1[d]), V.E.1.a (2[a]), V.E.4 (claim 5); Welch¶857.

c. 13[c]: WED Plays Binaural Sound While User Plays Game

Limitation 13[c] would have been obvious for the same reasons as limitations 1[a]-[b] and 12[c]. §§V.D.2-V.D.3, V.G.3.c; Welch¶¶858-859.

5. Claim 14: Playing Audio Warning Indicating User Should Move Back Into Zone

Claim 14 would have been obvious for the same reasons as claim 8, and in view of the Pedrotti disclosures discussed in the context of this claim for Ground 1. §§V.E.7, IV.H.5; Welch¶860.

6. Claim 15: Cylindrical 3D VR Image Of Zone Extends Around User

Claim 15 would have been obvious for the same reasons as claim 7 and limitation 12[a], and in view of the Pedrotti disclosures discussed for this claim in Ground 1. §§V.E.6, V.G.3.a, IV.H.6; Welch¶861.

7. Claim 16

a. 16[a]: Determining With WED When PED Is Leaving Zone

Limitation 16[a] would have been obvious for the same reasons as limitations 1[c]-1[d], and in view of the Pedrotti disclosures discussed for this limitation in Ground 1. §§V.D.4-V.D.5, V.G.7.a; Welch¶862.

b. 16[b]: Warning User By Displaying 3D VR Image Of Zone

Limitation 16[b] would have been obvious for the same reasons as limitations 1[d], 9[c], and 16[a], and in view of the Pedrotti disclosures discussed for this limitation in Ground 1. §§V.D.5, V.F.4, V.G.7.a, IV.H.7.b; Welch¶863.

H. Claim 17

1. 17[pre]: An Electronic System

McCulloch taught claim 17's preamble with its "display device system." McCulloch, 4:43-49; §V.A; Welch¶864; §IV.I.1 (Pedrotti taught 17[pre]).

2. 17[a]: PED That Divides An Area Into 3D Zone With SLPs

Limitation 17[a] would have been obvious for the same reasons as limitations 1[a] and 9[a], and in view of the Pedrotti disclosures discussed for this limitation in Ground 1. §§V.D.2, V.F.2, IV.I.4; Welch¶865.

3. 17[b]: WED Worn On Head Of User

McCulloch's system uses an HMD. §§V.D.2 (1[a]), V.D.5 (1[d]), V.E.1.a (2[a]), V.E.4 (claim 5); Welch¶866.

4. 17[c]: WED Wirelessly Communicates With PED

McCulloch disclosed that its HMD is able to communicate “wirelessly,” e.g., via infrared, with controllers. McCulloch, 5:19-36; Welch¶867. Pedrotti disclosed this as well. §IV.I.4.

5. 17[d]: Speakers That Play Binaural Sound

Limitation 17[d] would have been obvious for the same reasons as limitation 1[b]. §V.D.3; Welch¶868.

6. 17[e]: Sensors That Sense PED Is Leaving Zone

Limitation 17[e] would have been obvious for the same reasons as limitation 1[c], and in view of the Pedrotti disclosures discussed for this limitation in Ground 1. §§V.D.4, IV.I.6; Welch¶869.

7. 17[f]: Display Displays VR Image Of Zone

Limitation 17[f] would have been obvious for the same reasons as limitation 1[d], and in view of the Pedrotti disclosures discussed for this limitation in Ground 1. §§V.D.5, IV.I.7; Welch¶870.

8. 17[g]: Display Displays VR Image of Zone To Warn That User Is Leaving

Limitation 17[g] would have been obvious for the same reasons as limitation 1[d] and 9[c], and in view of the Pedrotti disclosures discussed for this limitation in Ground 1. §§V.D.5, V.F.4, IV.I.8; Welch¶¶871-872.

I. Dependent Claims 18-20

Claims 18-20 are unpatentable for the same reasons as claim 17 and as further explained below.

1. Claim 18: Display Highlights Color Of VR Image At SLP

Claim 18 would have been obvious for the same reasons as limitations 2[a] and claim 11. §§V.E.1.a, V.G.2; Welch¶875.

2. Claim 19: Automatically Displays VR Image

Claim 19 would have been obvious for the same reasons as limitations 1[c], 1[d], 4[a], 5[b], 6[b], and claim 3. §§V.D.4, V.D.5, V.E.2, V.E.3.a, V.E.4.b, V.E.5.b. Additionally, McCulloch disclosed storing locations of virtual objects, which are associated with SLPs. McCulloch, 19:8-21, 19:51-62. And, as discussed in Ground 1, it would have been obvious to apply Pedrotti’s logic for automatically displaying a fence’s virtual image to automatically displaying other VR images at SLPs. §IV.J.2. Automatically displaying images when users get close was a well-known virtual environment effect (*id.*), e.g., to present content of interest while pausing or not presenting other content. Welch¶¶876-878; Ross, 2:32-67. McCulloch’s HMD supports this functionality as its scene mapping engine “identifies the position and tracks the movement of real and virtual objects,” and thus could and would compare a user’s location with locations of virtual objects and their SLPs. McCulloch, 16:49-65, 21:1-4; Welch¶879.

3. Claim 20

a. 20[a]: Speakers In WED Play Binaural Sound In Response To PED Pointing At SLP

Limitation 20[a] would have been obvious for the same reasons as limitation 1[b] and claim 2. §§V.D.3, V.E.1; Welch¶880.

b. 20[b]: Cylindrical Zone, Where User Is Centered

Limitation 20[b] would have been obvious for the same reasons as claim 7, and in view of the Pedrotti disclosures discussed for this limitation in Ground 1. §§V.E.6, IV.J.3.b Welch¶881.

VI. Secondary Considerations

Petitioners are unaware of any secondary considerations that affect—let alone overcome—the obviousness cases set out above. Should Patentee proffer any secondary considerations evidence in its preliminary response, Petitioners should be permitted to reply.

VII. The Board Should Reach the Merits of This Petition

The Board should reach this petition’s merits and should not exercise its discretion to deny based on 35 U.S.C. § 314(a) or § 325(d). The prior art at issue here was not cited or relied upon during prosecution of the ’316 patent. As for the district court case, the court is currently deciding a motion to transfer. *Eight kHz v. Meta Platforms*, No. 6:22-cv-00575, Dkt. 46 (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(B)

A. Real Parties-In-Interest

Petitioners are the only real parties-in-interest.

B. Related Matters

Patent Center indicates that U.S. Patent Application Nos. 15/049,071, 15/424,901, 15/944,796, 16/162,416, 16/445,268, 16/558,078, 16/938,936, and 17/520,584, currently pending, are related to the '316 patent, which issued from Application No. 17/062,633.

The '316 patent is at issue in *Eight KHZ LLC v. Meta Platforms, Inc.*, No. 6:22-cv-00575 (W.D. Tex.).

C. Grounds for Standing

Petitioners certify that the '316 patent is available for IPR and Petitioners are not barred from requesting same.

D. 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).
- 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. IPR Fee

The Director is authorized to charge the requisite fee to Deposit Account No. 506269.

IX. Conclusion

IPR of challenged claims 1-20 should be instituted, and each claim should be found unpatentable.

Respectfully submitted,

Dated: June 9, 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

This “Claims Appendix” reproduces the challenged claims, with bracketed identifiers added for cross-referencing.

Claim 1:

[pre] A method comprising:

[a] dividing, with a portable electronic device (PED) held in a hand of a user, an area around the user into a zone that extends around the user and that includes a sound localization point (SLP) from where binaural sound in empty space originates to the user;

[b] playing, with speakers in a wearable electronic device (WED) worn on a head of the user, the binaural sound that originates from the SLP in empty space;

[c] tracking, with one or more sensors in the WED worn on the head of the user, the PED to determine when the PED held in the hand of the user is moving outside the zone that extends around the user; and

[d] displaying, with the WED worn on the head of the user a virtual reality (VR) image that shows the zone in response to the WED determining that the PED is moving outside the zone.

Claim 2:

[a] The method of claim 1 further comprising: highlighting, while the user is located inside the zone and with a display of the WED, a VR image at the SLP in the zone when the PED held in the hand of the user is pointed at the SLP in the zone; and

[b] playing, with the WED worn on the head of the user, the binaural sound that emanates from the SLP in response to the PED pointing at the SLP.

Claim 3:

The method of claim 1 further comprising: displaying, with the WED worn on the head of the user, the VR image that shows a size and a shape of the zone in response to the WED determining that the PED is moving outside the zone.

Claim 4:

[a] The method of claim 1 further comprising: storing, in memory of the WED, a location of the zone, a size and a shape of the zone, and a location of the SLP in the zone from where the binaural sound originates to the user; and

[b] retrieving, from the memory of the WED, the size and the shape of the zone in response to the WED determining that the user is in the location of the zone.

Claim 5:

[a] The method of claim 1 further comprising: designating, with the PED held in the hand of the user, locations of multiple SLPs in empty space in the zone from where the binaural sound originates to the user; and

[b] displaying, with the WED, VR images at the locations of the multiple SLPs in empty space in the zone.

Claim 6:

[a] The method of claim 1 further comprising: selecting one of multiple SLPs in the zone when the PED held in the hand of the user is pointed at the one of the multiple SLPs in the zone; and

[b] displaying, with the WED worn on the head of the user, a VR image at the one of the multiple SLPs in response to the one of the multiple SLPs being pointed at by the PED held in the hand of the user.

Claim 7:

The method of claim 1, wherein the zone has one of a three-dimensional (3D) shape of a cylinder and a 3D shape of a rectangle, and the user is centered in the zone.

Claim 8:

The method of claim 1 further comprising: playing, with the speakers in the WED worn on the head of the user, an audio warning in response to the WED determining that the PED is moving outside the zone.

Claim 9:

[pre] A method comprising:

[a] dividing, with a portable electronic device (PED) held in a hand of a user, an area around the user into a three-dimensional (3D) zone that extends around the user and that includes sound localization points (SLPs) from where binaural sound originates to the user;

[b] determining, with a wearable electronic device (WED) worn on a head of the user, when the user is leaving the zone; and

[c] warning the user that the user is leaving the zone by displaying, with the WED worn on the head of the user, a 3D virtual reality (VR) image of the zone in response to the WED determining that the user is leaving the zone.

Claim 10:

[a] The method of claim 9 further comprising: determining, with the WED, when the PED is pointed at one of the SLPs while the user is located in the zone; and

[b] playing the binaural sound that originates from the one of the SLPs in the zone in response to the WED determining that the PED is pointed at the one of the SLPs.

Claim 11:

The method of claim 9 further comprising: highlighting, while the user is located in the zone and with a display of the WED, color of a VR image at one of the SLPs in the zone when the PED held in the hand of the user points at the one of the SLPs in the zone.

Claim 12:

[a] A method of claim 9, wherein the 3D VR image of the zone is shaped as a cylinder with the user being centered in the cylinder, and

[b] the WED is a head mounted display that display VR images and

[c] plays the binaural sound while the user plays a game.

Claim 13:

[a] A method of claim 9, wherein the 3D VR image of the zone is shaped as a rectangle with the user being centered in the rectangle, and

[b] the WED is a head mounted display that displays VR images and

[c] plays the binaural sound while the user plays a game.

Claim 14:

The method of claim 9 further comprising: playing, with the WED worn on the head of the user, an audio warning indicating the user should move back into the zone in response to the WED determining that the user is leaving the zone.

Claim 15:

The method of claim 9, wherein the 3D VR image of the zone is shaped as a cylinder that extends around the user.

Claim 16:

- [a] The method of claim 9 further comprising: determining, with the WED worn on the head of the user, when the PED is leaving the zone; and
- [b] warning the user that the PED is leaving the zone by displaying, with the WED worn on the head of the user, the 3D VR image of the zone in response to the WED determining that the PED is leaving the zone.

Claim 17:

- [pre] An electronic system comprising:
 - [a] a portable electronic device (PED) held in a hand of a user that divides an area around the user into a three-dimensional (3D) zone that extends around the user and includes sound localization points (SLPs) in empty space from where binaural sound originates to the user while the user is located inside the zone; and
 - [b] a wearable electronic device (WED) that is worn on a head of the user,
 - [c] wirelessly communicates with the PED,
 - [d] includes speakers that play to the user the binaural and that emanates from the SLPs in empty space in the zone,
 - [e] includes one or more sensors that sense when the PED is leaving the zone,
 - [f] and includes a display that displays a virtual reality (VR) image of the zone in response to sensing that the PED is leaving the zone,
 - [g] wherein the display displays the VR image of the zone to warn the user that the user is leaving the zone.

Claim 18:

The electronic system of claim 17, wherein the display of the WED highlights a color of a VR image at one of the SLPs in response to the WED determining that the PED is pointing to the VR image at the one of the SLPs.

Claim 19:

The electronic system of claim 17, wherein the WED tracks a location of the user with respect to the SLPs, and automatically displays a VR image at a location of one of the SLPs in response to determining that the user is proximate to the location of the one of the SLPs.

Claim 20:

[a] The electronic system of claim 17, wherein the speakers in the WED play the binaural sound that emanates from one of the SLPs in empty space in response to the WED determining that the PED is pointed to the one of the SLPs in empty space, and

[b] the zone is shaped as a 3D cylinder with the user being centered in the 3D cylinder.

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 13,989 words, which is the sum of 13,975 words calculated by Microsoft Word's word-count feature and 14 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 Meta Platforms, Inc.

CERTIFICATE OF SERVICE

The undersigned certifies that a complete copy of this Petition for *Inter Partes* Review of U.S. Patent No. 11,172,316 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 overnight delivery, on June 9, 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