



# Meta Platforms, Inc. v. Eight kHz, LLC

IPR2023-01003  
(U.S. Patent No. 9,226,090)

Petitioner's Demonstratives  
October 29, 2024



## Issues

- **Claim Construction**

- whether independent claims require HRTFs and 6DOF
- “capturing ... binaural sound” (claim 1 only)

- **Disputes**

- Under Petitioner’s Construction
- Under PO’s Construction

- **Motions to Exclude and Strike**

- Exhibits 2029-30 to be excluded
- Arguments to be stricken from the record

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

# Challenged Patent

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

# '090 Patent: Localization by Adjusting Sound

|                                                                                                                            |  |                                                                                                                                                                                                                                                                                         |
|----------------------------------------------------------------------------------------------------------------------------|--|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| (12) <b>United States Patent</b>                                                                                           |  | (10) <b>Patent No.:</b> <b>US 9,226,090 B1</b>                                                                                                                                                                                                                                          |
| <b>Norris et al.</b>                                                                                                       |  | (45) <b>Date of Patent:</b> <b>Dec. 29, 2015</b>                                                                                                                                                                                                                                        |
| (54) <b>SOUND LOCALIZATION FOR AN ELECTRONIC CALL</b>                                                                      |  | USPC ..... 381/303<br>See application file for complete search history.                                                                                                                                                                                                                 |
| (71) Applicants: <b>Glen A. Norris, Manila (PH); Philip Scott Lyren, Bangkok (TH)</b>                                      |  | (56) <b>References Cited</b>                                                                                                                                                                                                                                                            |
| (72) Inventors: <b>Glen A. Norris, Manila (PH); Philip Scott Lyren, Bangkok (TH)</b>                                       |  | U.S. PATENT DOCUMENTS                                                                                                                                                                                                                                                                   |
| (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 71 days.  |  | 8,855,341 B2 * 10/2014 Kim ..... H04R 3/005<br>381/122<br>9,031,271 B2 * 5/2015 Pontoppidan ..... H04R 25/353<br>381/23.1<br>9,037,468 B2 * 5/2015 Osman ..... H04S 7/302<br>704/270<br>9,088,854 B2 * 7/2015 Enami ..... H04S 1/002<br>9,101,299 B2 * 8/2015 Anderson ..... A61B 5/121 |
| (21) Appl. No.: <b>14/311,532</b>                                                                                          |  | * cited by examiner                                                                                                                                                                                                                                                                     |
| (22) Filed: <b>Jun. 23, 2014</b>                                                                                           |  | Primary Examiner — Mark Blouin                                                                                                                                                                                                                                                          |
| (51) Int. CL <b>H04S 7/00</b> (2006.01)                                                                                    |  | (57) <b>ABSTRACT</b>                                                                                                                                                                                                                                                                    |
| (52) U.S. CL <b>H04S 7/303</b> (2013.01)                                                                                   |  | During an electronic call between two individuals, a sound localization point simulates a location in empty space from where an origin of a voice of one individual occurs for the other individual.                                                                                    |
| (58) Field of Classification Search<br>CPC ..... H04S 7/301; H04S 7/302; H04S 2420/01; H04S 7/303; H04S 7/30; H04S 2400/11 |  | 20 Claims, 18 Drawing Sheets                                                                                                                                                                                                                                                            |

Capture sound that will be provided to a listener.  
**100**

↓

Designate a sound localization point at a location in empty space that is away from and proximate to a location of the listener such that the sound localization point simulates an origin of the sound that the listener hears.  
**110**

↓

Adjust the sound so the sound originates from the sound localization point at the location in empty space that is away from and proximate to the location of the listener.  
**120**

↓

Provide the sound to the listener such that the listener localizes the origin of the sound at the sound localization point in empty space.  
**130**

attached to the electronic device. This sound is not comparable in quality to sound that the listeners would hear if they were communicating face-to-face with each other.

'090 Patent at 1:14-16.

**'090 Patent**

**Filed: Jun. 23, 2014**

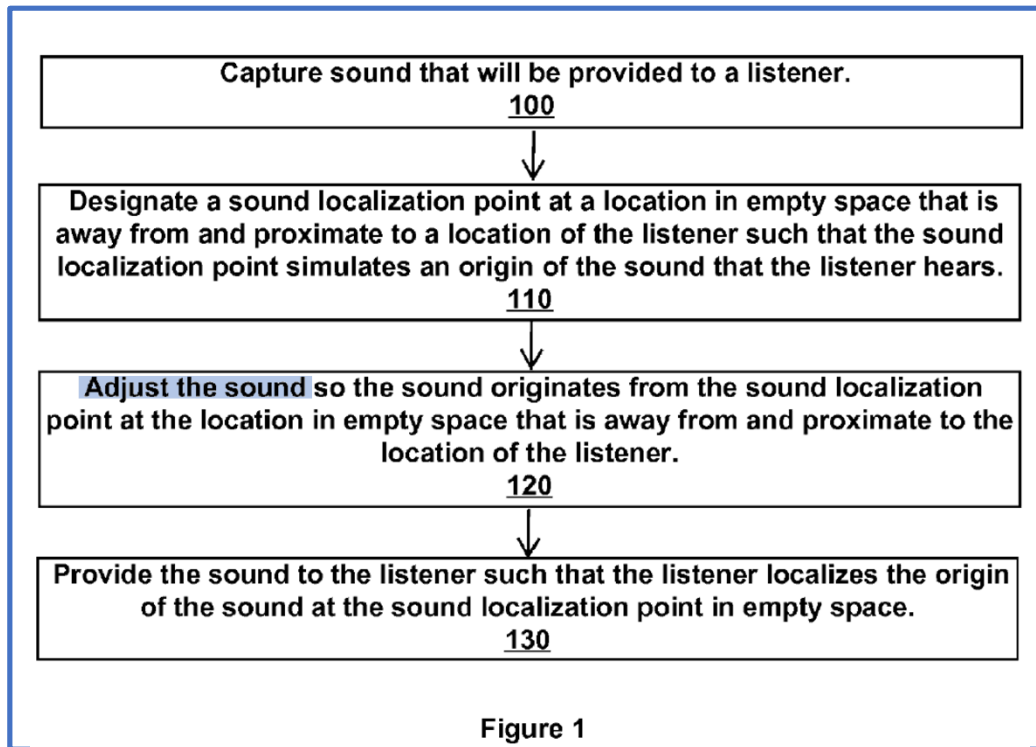
**Issued: Dec. 29, 2015**

Pet. 10-11.

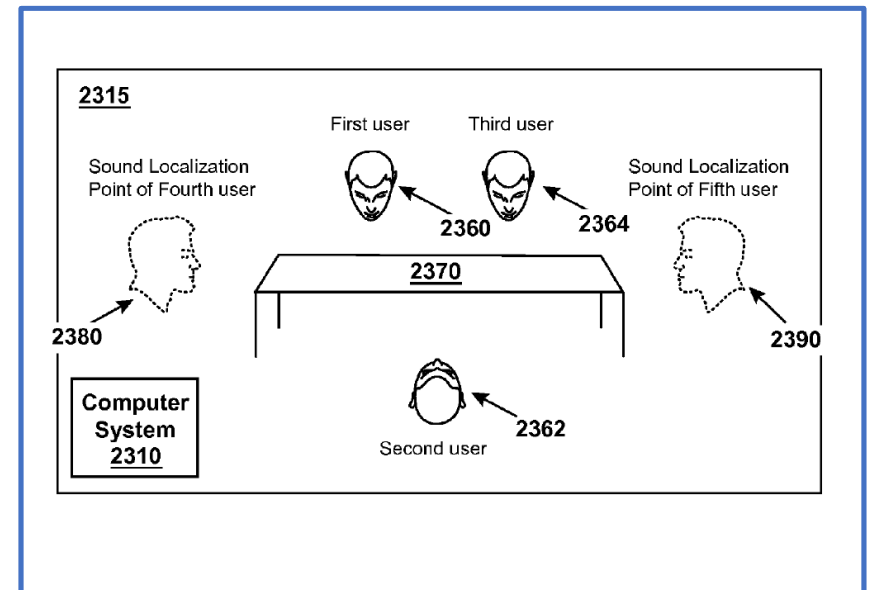
DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

4

## '090 Patent: Localization by Adjusting Sound



'090 Patent, Fig. 1 (annotated).

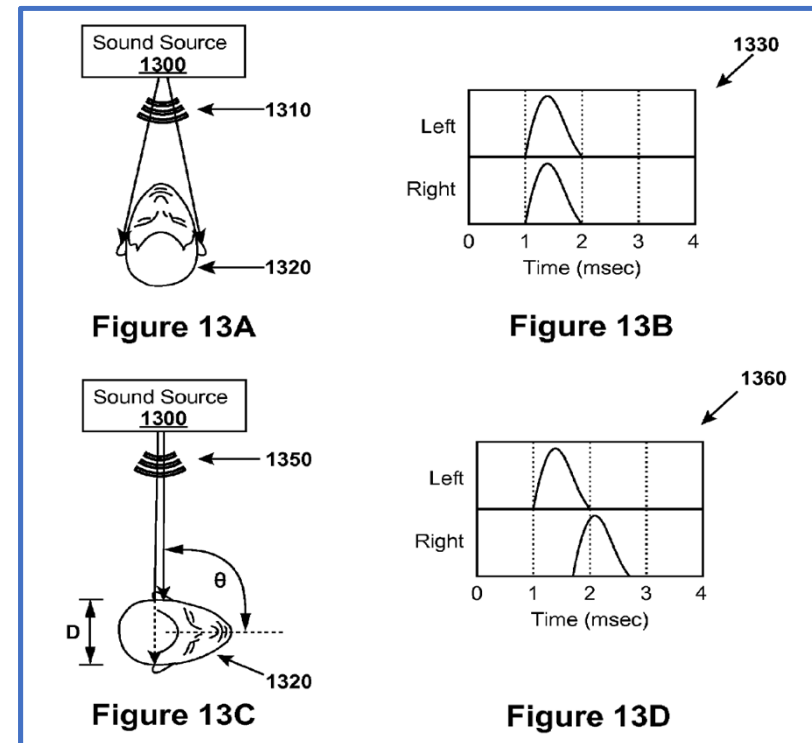


'090 Patent, Fig. 23 (excerpted);  
'090 Patent, 35:49-55.

## '090 Patent: Localization by Adjusting Sound

Adjustments are made to the sound for each of these users since they are located at different locations around the table with respect to the sound localization points. These adjustments include, but are not limited to, calculations for and changes to ITDs, ILDs, HRTFs, attenuation, reverberations, and *other aspects of sound* discussed herein.

EX1001 ('090 Patent), 35:49-55 (emphasis added)

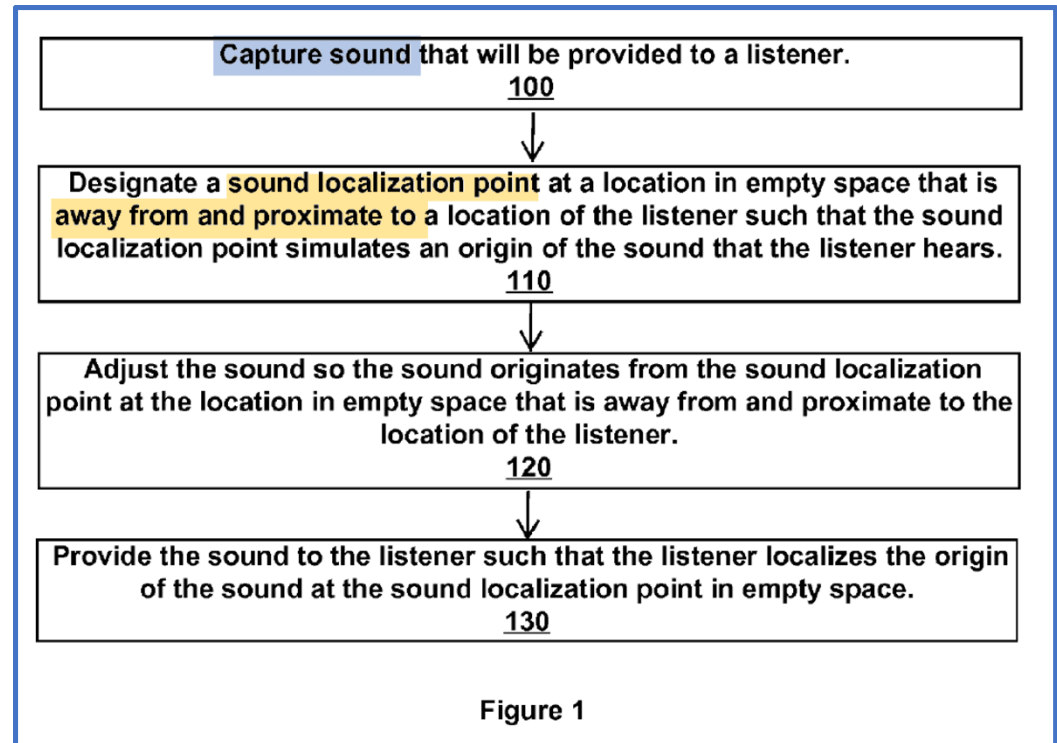


'090 Patent, Figs. 13A-D;  
EX1003 (Kyriakakis), ¶¶50-53.

## Relevant Claim Limitations

1. A method, comprising:  
capturing, with an electronic earphone located at a head of a talking person, binaural sound that will be provided to a listening person during a telephone call;  
designating, with a computer system, a sound localization point in empty space that is away from and proximate to the listening person such that the sound localization point simulates an origin of the binaural sound at the empty space that the listening person hears during the telephone call;  
adjusting, with the computer system, the binaural sound captured at the earphone of the talking person so the binaural sound originates during the telephone call from the sound localization point in empty space that is away from and proximate to the listening person; and  
providing, with an electronic earphone located at a head of the listening person, the binaural sound to the listening person during the telephone call such that the origin of the binaural sound for the listening person occurs at the sound localization point in empty space that is away from and proximate to the listening person.

'090 Patent, cl. 1.

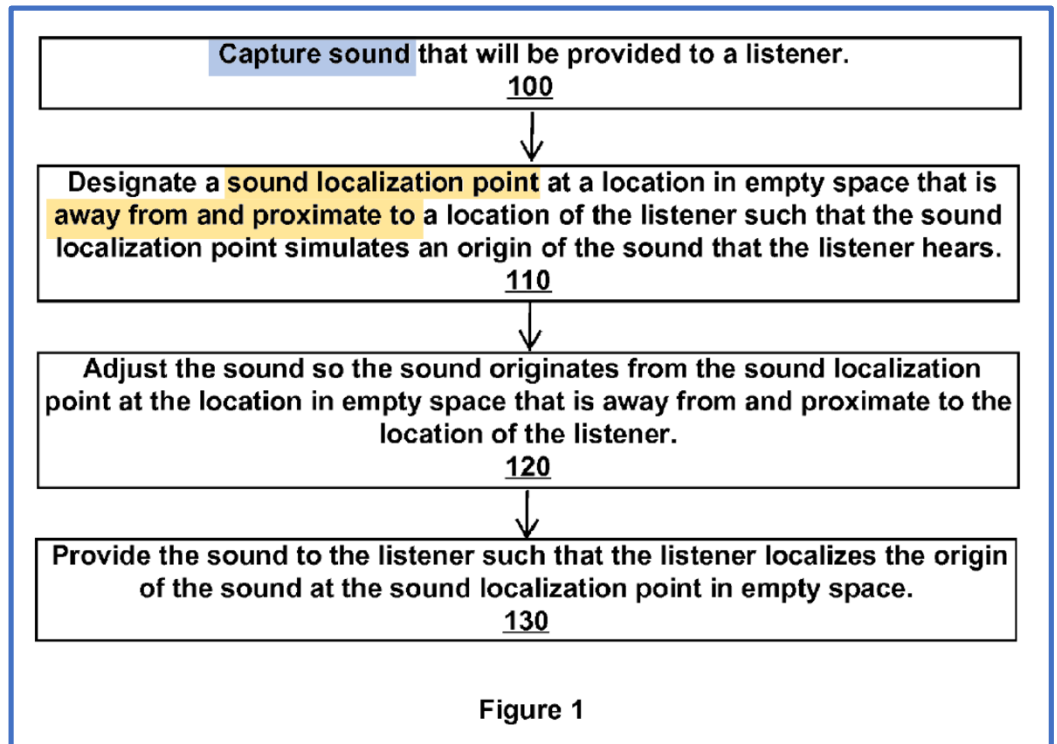


'090 Patent, Fig. 1 (annotated).

## Relevant Claim Limitations

**15.** A computer system, comprising:  
a first wearable electronic device that a first person wears;  
a second wearable electronic device that a second person wears and that captures a binaural voice of the second person during an electronic phone call with the first wearable electronic device that the first person wears;  
a memory that stores instructions; and  
a processor that executes the instructions to adjust the binaural voice of the second person during the electronic phone call in order to position a sound localization point of the binaural voice to a location that is away from and proximate to the first person, wherein the sound localization point represents an origin of the binaural voice of the second person to the first person.

'090 Patent, cl. 15.



'090 Patent at Fig. 1 (annotated).

## Relevant Claim Limitations

8. A non-transitory computer readable storage medium storing instructions that cause a computer system to execute a method, comprising:

commence an electronic call between a first individual wearing an electronic earphone and a second individual that are remote from each other;

designate, for the first individual, a sound localization point that simulates a location in empty space from where an origin of a voice of the second individual occurs for the first individual through the electronic earphone such that the sound localization point in empty space is located away from and proximate to the first individual;

execute the electronic call such that the origin of the voice of the second individual appears to the first individual to originate from a fixed location that is the sound localization point in empty space while the first individual moves and changes a location and a head orientation with respect to the sound localization point; and

maintain the origin of the voice of the second individual at the sound localization point but alter an interaural time difference of the voice that the first individual hears in response to the first individual moving the head orientation with respect to the sound localization point.

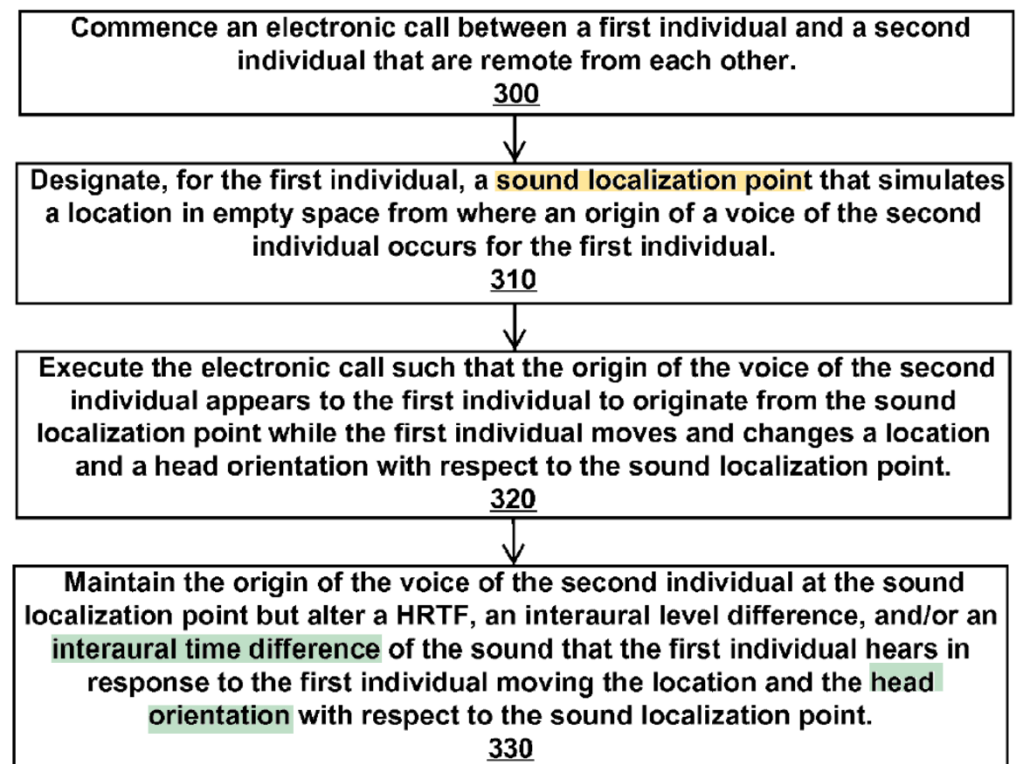


Figure 3

'090 Patent, cl. 8.

'090 Patent, Fig. 3 (annotated).

Pet. 11.

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

9

## Localization By Adjusting Sound Was Known

### PO's Expert Dr. Begault Deposition

8 Q. Would you agree that, in general, it was  
9 known by 2004 to adjust binaural sound so that it  
10 originates at an empty space that is away and  
11 proximate to a listening person?

12 MS. PARTRIDGE: Objection. Form.  
13 Objection. Legal conclusions.

14 THE WITNESS: It was known to adjust a  
15 sound localization point, virtual acoustic  
16 location, relative to a person -- to a listener.

EX1051 (Begault Tr.), 53:8-16

# Prior Art

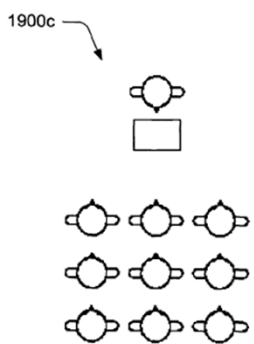
DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

11

# Bedingfield Discloses Localization By Adjusting Sound

|                                                                                                                                        |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|----------------------------------------------------------------------------------------------------------------------------------------|--|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| (12) <b>United States Patent</b><br><b>Bedingfield, Sr. et al.</b>                                                                     |  | (10) <b>Patent No.: US 8,406,439 B1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|                                                                                                                                        |  | (45) <b>Date of Patent: Mar. 26, 2013</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| (54) <b>METHODS AND SYSTEMS FOR SYNTHETIC AUDIO PLACEMENT</b>                                                                          |  | 7,012,630 B2 * 3/2006 Curry et al. .... 348/14.08                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|                                                                                                                                        |  | 7,266,207 B2 * 9/2007 Wilcock et al. .... 381/310                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|                                                                                                                                        |  | 7,548,354 B2 * 6/2009 Roy et al. .... 704/226                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|                                                                                                                                        |  | 7,991,161 B2 * 8/2011 Lovelace ..... 381/26                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| (75) Inventors: <b>James Carlton Bedingfield, Sr.</b> ,<br>Lilburn, GA (US); <b>Larry D. Woodring</b> ,<br>Decatur, GA (US)            |  | 2004/0039464 A1 * 2/2004 Virolainen et al. .... 709/94                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|                                                                                                                                        |  | 2006/0034463 A1 * 2/2006 Tillotson ..... 381/1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|                                                                                                                                        |  | * cited by examiner                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| (73) Assignee: <b>AT&amp;T Intellectual Property I, L.P.</b> ,<br>Reno, NV (US)                                                        |  | Primary Examiner — Xu Mei                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|                                                                                                                                        |  | Assistant Examiner — Lun-See Lao                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| (*) Notice: Subject to any disclaimer, the term of this<br>patent is extended or adjusted under 35<br>U.S.C. 154(b) by 1351 days.      |  | (74) Attorney, Agent, or Firm — Myers Bigel Sibley &<br>Sajovec, P.A.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| (21) Appl. No.: 11/696,510                                                                                                             |  | (57) <b>ABSTRACT</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| (22) Filed: <b>Apr. 4, 2007</b>                                                                                                        |  | Methods and systems for providing synthetic audio place-<br>ment are described herein. In different aspects, the methods<br>and systems may include a connection port to receive a plu-<br>rality of remote audio signals included in a conference call, at<br>least one of the plurality of remote audio connections being a<br>single channel audio signal, a processor configured with the<br>connection port to provide a sound field for placing the plu-<br>rality of audio signals, the sound field providing synthetic<br>audio placement of each of the plurality of remote audio<br>signals, and a rendering output configured with the processor<br>to project the plurality of remote audio within the sound field<br>to a listener. |
| (51) <b>Int. Cl.</b><br><b>H04R 5/02</b> (2006.01)                                                                                     |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| (52) <b>U.S. Cl.</b> ..... 381/310                                                                                                     |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| (58) <b>Field of Classification Search</b> ..... 381/1, 97,<br>381/17-22, 300, 307, 27, 98, 99, 309, 310,<br>381/119, 104, 107; 700/94 |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| See application file for complete search history.                                                                                      |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| (56) <b>References Cited</b>                                                                                                           |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| U.S. PATENT DOCUMENTS                                                                                                                  |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 5,930,370 A * 7/1999 Ruzicka ..... 381/18                                                                                              |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 6,011,851 A * 1/2000 Connor et al. .... 381/17                                                                                         |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|                                                                                                                                        |  | 12 Claims, 16 Drawing Sheets                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

1900c



tem 120 as heard by the listener 102. For example, if a listener 102a and participants 104a, 106a, 108a were in the same location and speaking to each other directly (without the communication system 116), then the listener 102a would 108. The multi-channel processing device 118 configured with the communication system 116 creates the sound field 122 that is substantially similar (or approximately similar) to an actual sound field where the listener 102 is present between all of participants 104, 106, 108.

EX1005 (Bedingfield), 4:31-5:3.

# Bedingfield Discloses Localization By Adjusting Sound

(12) **United States Patent**  
**Bedingfield, Sr. et al.**

(10) **Patent No.:** **US 8,406,439 B1**  
(45) **Date of Patent:** **Mar. 26, 2013**

(54) **METHODS AND SYSTEMS FOR SYNTHETIC AUDIO PLACEMENT**

(75) **Inventors:** **James Carlton Bedingfield, Sr.**,  
Lilburn, GA (US); **Larry D. Woodring**,  
Decatur, GA (US)

(73) **Assignee:** **AT&T Intellectual Property I, L.P.**,  
Reno, NV (US)

(\*) **Notice:** Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1351 days.

(21) **Appl. No.:** **11/696,510**

(22) **Filed:** **Apr. 4, 2007**

(51) **Int. Cl.** **H04R 5/02** (2006.01)

(52) **U.S. Cl.** **381/310**

(58) **Field of Classification Search** **381/1, 97, 381/17-22, 300, 307, 27, 98, 99, 309, 310, 381/119, 104, 107, 700/94**

See application file for complete search history.

(56) **References Cited**

**U.S. PATENT DOCUMENTS**

5,930,370 A \* 7/1999 Ruzicka 381/18  
6,011,851 A \* 1/2000 Connor et al. 381/17

7,012,630 B2 \* 3/2006 Curry et al. 348/14.08  
7,266,207 B2 \* 9/2007 Wilcock et al. 381/310  
7,548,354 B2 \* 6/2009 Roy et al. 704/226  
7,991,161 B2 \* 8/2011 Lovelace 381/26  
2004/0039464 A1 \* 2/2004 Virolainen et al. 709/94  
2006/0034463 A1 \* 2/2006 Tillotson 381/1

\* cited by examiner

**Primary Examiner** — Xu Mei  
**Assistant Examiner** — Lun-See Lao  
(74) **Attorney, Agent, or Firm** — Myers Bigel Sibley & Sajovec, P.A.

(57) **ABSTRACT**

Methods and systems for providing synthetic audio placement are described herein. In different aspects, the methods and systems may include a connection port to receive a plurality of remote audio signals included in a conference call, at least one of the plurality of remote audio connections being a single channel audio signal, a processor configured with the connection port to provide a sound field for placing the plurality of audio signals, the sound field providing synthetic audio placement of each of the plurality of remote audio signals, and a rendering output configured with the processor to project the plurality of remote audio within the sound field to a listener.

**12 Claims, 16 Drawing Sheets**

1900c

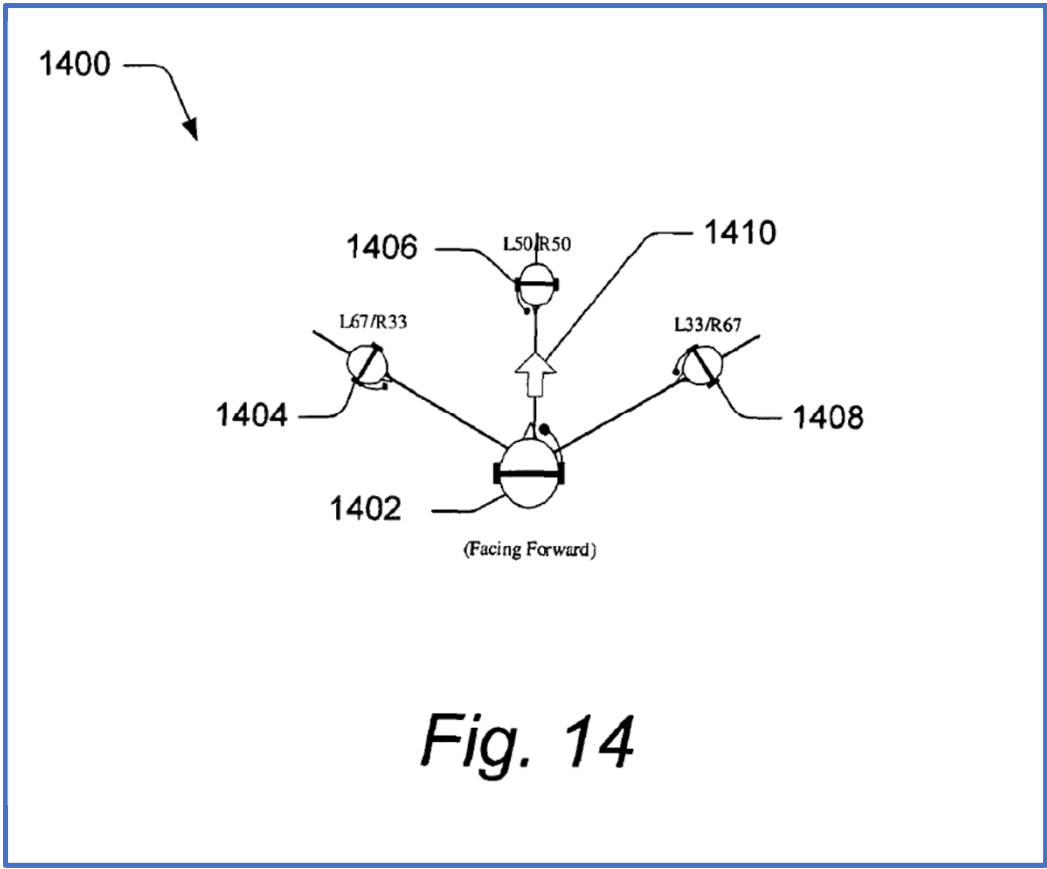


Fig. 14

EX1005 (Bedingfield), Fig. 14.

# Bedingfield Discloses Localization By Adjusting Sound

(12) **United States Patent**  
**Bedingfield, Sr. et al.**

(10) **Patent No.:** **US 8,406,439 B1**  
(45) **Date of Patent:** **Mar. 26, 2013**

(54) **METHODS AND SYSTEMS FOR SYNTHETIC AUDIO PLACEMENT**

(75) **Inventors:** **James Carlton Bedingfield, Sr.**,  
Liburn, GA (US); **Larry D. Woodring**,  
Decatur, GA (US)

(73) **Assignee:** **AT&T Intellectual Property I, L.P.**,  
Reno, NV (US)

(\*) **Notice:** Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1351 days.

(21) **Appl. No.:** 11/696,510

(22) **Filed:** **Apr. 4, 2007**

(51) **Int. Cl.**  
**H04R 5/02** (2006.01)

(52) **U.S. Cl.** 381/310

(58) **Field of Classification Search** 381/1, 97,  
381/17-22, 300, 307, 27, 98, 99, 309, 310,  
381/119, 104, 107; 700/94  
See application file for complete search history.

(56) **References Cited**  
**U.S. PATENT DOCUMENTS**  
5,930,370 A \* 7/1999 Ruzicka 381/18  
6,011,851 A \* 1/2000 Connor et al. 381/17

7,012,630 B2 \* 3/2006 Curry et al. 348/14.08  
7,266,207 B2 \* 9/2007 Wilcock et al. 381/310  
7,548,354 B2 \* 6/2009 Roy et al. 704/226  
7,991,161 B2 \* 8/2011 Lovelace 381/26  
2004/0079464 A1 \* 2/2004 Virolainen et al. 700/94  
2006/0034463 A1 \* 2/2006 Tillotson 381/1  
\* cited by examiner

**Primary Examiner** — Xu Mei  
**Assistant Examiner** — Lun-See Lao  
(74) **Attorney, Agent, or Firm** — Myers Bigel Sibley & Sajovec, P.A.

**ABSTRACT**  
Methods and systems for providing synthetic audio placement are described herein. In different aspects, the methods and systems may include a connection port to receive a plurality of remote audio signals included in a conference call, at least one of the plurality of remote audio connections being a single channel audio signal, a processor configured with the connection port to provide a sound field for placing the plurality of audio signals, the sound field providing synthetic audio placement of each of the plurality of remote audio signals, and a rendering output configured with the processor to project the plurality of remote audio within the sound field to a listener.

**12 Claims, 16 Drawing Sheets**

1900c

EX1005 (Bedingfield), Fig. 19b (excerpted);  
Reply 17-18.

Reply 17-18.

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

14

Meta Platforms, Inc. - Ex. 1056  
Meta Platforms, Inc. v. Eight KHZ, LLC  
IPR2023-01003, Page 14 of 67

# Li Discloses Localization By Adjusting Sound

|                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                 |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|
| (12) <b>United States Patent</b><br><b>Li et al.</b>                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | (10) <b>Patent No.:</b> <b>US 9,131,305 B2</b>  |
|                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | (45) <b>Date of Patent:</b> <b>Sep. 8, 2015</b> |
| (54) <b>CONFIGURABLE THREE-DIMENSIONAL SOUND SYSTEM</b>                                                                                                                                       | (56) <b>References Cited</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                 |
| U.S. PATENT DOCUMENTS                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                 |
| (71) Applicants: <b>Qi Li</b> , New Providence, NJ (US); <b>Yin Ding</b> , Brooklyn, NY (US); <b>Manli Zhu</b> , Pearl River, NY (US)                                                         | 7,391,876 B2 6/2008 Cohen et al.<br>2014/0146970 A1* 5/2014 Kim et al. 381/17<br>(Continued)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                 |
| (72) Inventors: <b>Qi Li</b> , New Providence, NJ (US); <b>Yin Ding</b> , Brooklyn, NY (US); <b>Manli Zhu</b> , Pearl River, NY (US)                                                          | FOREIGN PATENT DOCUMENTS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                 |
| (73) Assignee: <b>LI Creative Technologies, Inc.</b> , Florham Park, NJ (US)                                                                                                                  | EP 0880871 B1 11/2003<br>EP 2168396 A2 3/2010<br>EP 1466498 B1 3/2011                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                 |
| OTHER PUBLICATIONS                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                 |
| (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 372 days.                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                 |
| (21) Appl. No.: <b>13/743,551</b>                                                                                                                                                             | Brungart, D. S.; Rabinowitz, W. M. Auditory localization of nearby sources I: Head-related transfer functions. <i>Journal of the Acoustical Society of America</i> . 1999, vol. 106, pp. 1465-1479.<br>(Continued)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                 |
| (22) Filed: <b>Jan. 17, 2013</b>                                                                                                                                                              | Primary Examiner — Tan X Dinh<br>(74) Attorney, Agent, or Firm — Ash Tankha; Lipton, Weinberger & Husick                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                 |
| (65) <b>Prior Publication Data</b><br>US 2014/0198918 A1 Jul. 17, 2014                                                                                                                        | (57) <b>ABSTRACT</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                 |
| <b>Related U.S. Application Data</b>                                                                                                                                                          | A method and a system for simultaneously generating configurable three-dimensional (3D) sounds are provided. A 3D sound processing application (3DSPA) in operative communication with a microphone array system (MAS) is provided on a computing device. The MAS forms acoustic beam patterns and records sound tracks from the acoustic beam patterns. The 3DSPA generates a configurable sound field on a graphical user interface using recorded or pre-recorded sound tracks. The 3DSPA acquires user selections of configurable parameters associated with sound sources from the configurable sound field. The 3DSPA dynamically processes the sound tracks using the user selections to generate a configurable 3D binaural sound, surround sound, and/or stereo sound. The 3DSPA measures head related transfer functions (HRTFs) in communication with a simulator apparatus that simulates a human's upper body. The 3DSPA generates the binaural sound by processing the sound tracks with the HRTFs based on the user selections. |                                                 |
| (60) Provisional application No. 61/631,979, filed on Jan. 17, 2012, provisional application No. 61/690,754, filed on Jul. 5, 2012.                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                 |
| (51) <b>Int. Cl.</b><br><b>H04R 5/00</b> (2006.01)<br><b>H04R 5/027</b> (2006.01)<br><b>H04S 7/00</b> (2006.01)<br>(Continued)                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                 |
| (52) <b>U.S. Cl.</b><br>CPC <b>H04R 5/027</b> (2013.01); <b>H04S 7/30</b> (2013.01); <b>H04R 5/005</b> (2013.01); <b>H04R 2201/401</b> (2013.01); <b>H04S 3/008</b> (2013.01);<br>(Continued) |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                 |
| (58) <b>Field of Classification Search</b><br>None<br>See application file for complete search history.                                                                                       | <b>40 Claims, 39 Drawing Sheets</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                 |

Moreover, the configurable 3D sound system 900 provides a method of communication among multiple people, for example, in a conference call, by placing different speaking users at different spots to mimic a real conference room environment.

allows the user to enjoy the audio or music from an individually customized virtual scene, and to experience the synthesized and personalized 3D binaural sound. Through the configurable sound field provided on the GUI, the user configures the placements and movements of any available sound sources as the inputs in order to obtain a virtual reality scene. The configurable 3D sound system 900 renders the 3D binaural sound from the input configuration to provide the user with the reconstructed virtual audio 3D space he/she designed.

EX1006 (Li), 22:1-67.

# Andrea Discloses Capturing Binaural Sound

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |         |                                                  |               |        |              |         |               |        |                  |  |               |         |               |          |                |        |             |        |              |        |           |  |                   |        |                |        |                 |         |            |  |                   |        |               |          |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|--------------------------------------------------|---------------|--------|--------------|---------|---------------|--------|------------------|--|---------------|---------|---------------|----------|----------------|--------|-------------|--------|--------------|--------|-----------|--|-------------------|--------|----------------|--------|-----------------|---------|------------|--|-------------------|--------|---------------|----------|
| (12) <b>United States Patent</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |         | (10) <b>Patent No.:</b> <b>US 8,818,000 B2</b>   |               |        |              |         |               |        |                  |  |               |         |               |          |                |        |             |        |              |        |           |  |                   |        |                |        |                 |         |            |  |                   |        |               |          |
| <b>Andrea</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |         | (45) <b>Date of Patent:</b> <b>Aug. 26, 2014</b> |               |        |              |         |               |        |                  |  |               |         |               |          |                |        |             |        |              |        |           |  |                   |        |                |        |                 |         |            |  |                   |        |               |          |
| <p>(54) <b>SYSTEM, DEVICE, AND METHOD UTILIZING AN INTEGRATED STEREO ARRAY MICROPHONE</b></p> <p>(75) Inventor: <b>Douglas Andrea</b>, Sag Harbor, NY (US)</p> <p>(73) Assignee: <b>Andrea Electronics Corporation</b>, Bohemia, NY (US)</p> <p>(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 547 days.</p> <p>(21) Appl. No.: <b>12/916,470</b></p> <p>(22) Filed: <b>Oct. 29, 2010</b></p> <p>(65) <b>Prior Publication Data</b><br/>US 2011/0129097 A1 Jun. 2, 2011</p> <p><b>Related U.S. Application Data</b></p> <p>(63) Continuation-in-part of application No. 12/429,623, filed on Apr. 24, 2009.</p> <p>(60) Provisional application No. 61/048,142, filed on Apr. 25, 2008.</p> <p>(51) <b>Int. Cl.</b><br/><b>H04R 1/10</b> (2006.01)</p> <p>(52) <b>U.S. Cl.</b><br/>USPC ..... <b>381/74</b>; 381/92; 381/94.1; 381/71.1; 381/97</p> <p>(58) <b>Field of Classification Search</b><br/>USPC ..... 381/74, 91, 92, 72, 74, 119, 120, 122, 381/309, 311, 23.1, 313, 317, 318, 320, 381/321, 322, 324, 327, 328, 329, 330,</p> <p>(56) <b>References Cited</b><br/>U.S. PATENT DOCUMENTS</p> <table border="0"> <tr> <td>4,088,849 A *</td> <td>5/1978</td> <td>Usami et al.</td> <td>379,430</td> </tr> <tr> <td>5,815,582 A *</td> <td>9/1998</td> <td>Claybaugh et al.</td> <td></td> </tr> <tr> <td>5,825,897 A *</td> <td>10/1998</td> <td>Andren et al.</td> <td>381/71.6</td> </tr> <tr> <td>7,065,219 B1 *</td> <td>6/2006</td> <td>Albe et al.</td> <td>381/74</td> </tr> <tr> <td>7,092,529 B2</td> <td>8/2006</td> <td>Yu et al.</td> <td></td> </tr> <tr> <td>2006/0182287 A1 *</td> <td>8/2006</td> <td>Schulze et al.</td> <td>381/74</td> </tr> <tr> <td>2006/0270468 A1</td> <td>11/2006</td> <td>Hui et al.</td> <td></td> </tr> <tr> <td>2008/0175408 A1 *</td> <td>7/2008</td> <td>Mukund et al.</td> <td>381/94.1</td> </tr> </table> <p>* cited by examiner</p> <p><b>ABSTRACT</b><br/>(57) The invention relates to an audio device for use proximate a user's ears. The audio device includes first and second audio transmitting/receiving devices that are capable of operating in stereo. The audio device may be used within a system for manipulating audio signals received by the device. The manipulation may include processing received audio signals to enhance their quality. The processing may include applying one or more audio enhancement algorithms such as beam-forming, active noise reduction, etc. A corresponding method for manipulating audio signals is also disclosed.</p> <p><b>16 Claims, 34 Drawing Sheets</b></p> |         |                                                  | 4,088,849 A * | 5/1978 | Usami et al. | 379,430 | 5,815,582 A * | 9/1998 | Claybaugh et al. |  | 5,825,897 A * | 10/1998 | Andren et al. | 381/71.6 | 7,065,219 B1 * | 6/2006 | Albe et al. | 381/74 | 7,092,529 B2 | 8/2006 | Yu et al. |  | 2006/0182287 A1 * | 8/2006 | Schulze et al. | 381/74 | 2006/0270468 A1 | 11/2006 | Hui et al. |  | 2008/0175408 A1 * | 7/2008 | Mukund et al. | 381/94.1 |
| 4,088,849 A *                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 5/1978  | Usami et al.                                     | 379,430       |        |              |         |               |        |                  |  |               |         |               |          |                |        |             |        |              |        |           |  |                   |        |                |        |                 |         |            |  |                   |        |               |          |
| 5,815,582 A *                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 9/1998  | Claybaugh et al.                                 |               |        |              |         |               |        |                  |  |               |         |               |          |                |        |             |        |              |        |           |  |                   |        |                |        |                 |         |            |  |                   |        |               |          |
| 5,825,897 A *                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 10/1998 | Andren et al.                                    | 381/71.6      |        |              |         |               |        |                  |  |               |         |               |          |                |        |             |        |              |        |           |  |                   |        |                |        |                 |         |            |  |                   |        |               |          |
| 7,065,219 B1 *                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 6/2006  | Albe et al.                                      | 381/74        |        |              |         |               |        |                  |  |               |         |               |          |                |        |             |        |              |        |           |  |                   |        |                |        |                 |         |            |  |                   |        |               |          |
| 7,092,529 B2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 8/2006  | Yu et al.                                        |               |        |              |         |               |        |                  |  |               |         |               |          |                |        |             |        |              |        |           |  |                   |        |                |        |                 |         |            |  |                   |        |               |          |
| 2006/0182287 A1 *                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 8/2006  | Schulze et al.                                   | 381/74        |        |              |         |               |        |                  |  |               |         |               |          |                |        |             |        |              |        |           |  |                   |        |                |        |                 |         |            |  |                   |        |               |          |
| 2006/0270468 A1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 11/2006 | Hui et al.                                       |               |        |              |         |               |        |                  |  |               |         |               |          |                |        |             |        |              |        |           |  |                   |        |                |        |                 |         |            |  |                   |        |               |          |
| 2008/0175408 A1 *                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 7/2008  | Mukund et al.                                    | 381/94.1      |        |              |         |               |        |                  |  |               |         |               |          |                |        |             |        |              |        |           |  |                   |        |                |        |                 |         |            |  |                   |        |               |          |

For example, this embodiment may be advantageously used to produce a surround sound effect. Such a surround sound effect is made possible by virtue of the audio receiving devices being positioned on each side a user's head during operation. While a user is wearing the earbuds, the audio receiving means on each earbud may pick up the same sound emanating from a single sound source (i.e., the respective audio receiving means may create a binaural recording). Because of the spatial discrepancy between each of the audio receiving means, a distinct audio signal may be produced in each of the channels corresponding to the same sound.

EX1007 (Andrea), 14:55-58.

## Ballas Discloses Head Tracking To Maintain SLP

(19) **United States**  
 (12) **Patent Application Publication** (10) Pub. No.: US 2003/0059070 A1  
 Ballas (43) Pub. Date: Mar. 27, 2003

(54) **METHOD AND APPARATUS FOR PRODUCING SPATIALIZED AUDIO SIGNALS**  
 (57) **ABSTRACT**

(76) Inventor: James A. Ballas, Arlington, VA (US)

Correspondence Address:  
 NAVAL RESEARCH LABORATORY  
 ASSOCIATE COUNSEL (PATENTS)  
 CODE 1008.2  
 4555 OVERLOOK AVENUE, S.W.  
 WASHINGTON, DC 20375-5320 (US)

(21) Appl. No.: 09/962,158  
 (22) Filed: Sep. 26, 2001  
 Publication Classification  
 (51) Int. CL<sup>7</sup> H04R 5/02  
 (52) U.S. CL. 381/309; 381/310; 381/17

A method and apparatus for producing virtual sound sources that are externally perceived and positioned at any orientation in azimuth and elevation from a listener is described. In this system, a set of speakers is mounted in a location near the temple of a listener's head, such for example, on an eyeglass frame or inside a helmet, rather than in earphones. A head tracking system determines the location and orientation of the listener's head and provides the measurements to a computer which processes audio signals, from a audio source, in conjunction with a head related transfer function (HRTF) filter to produce spatialized audio. The HRTF filter maintains the virtual location of the audio signals/sound, thus allowing the listener to change locations and head orientation without degradation of the audio signal. The audio system of the present invention produces virtual sound sources that are externally perceived and positioned at any desired orientation in azimuth and elevation from the listener.

A method and apparatus for producing virtual sound sources that are externally perceived and positioned at any orientation in azimuth and elevation from a listener is described. In this system, a set of speakers is mounted in a location near the temple of a listener's head, such for example, on an eyeglass frame or inside a helmet, rather than in earphones. A head tracking system determines the location and orientation of the listener's head and provides the measurements to a computer which processes audio signals, from a audio source, in conjunction with a head related transfer function (HRTF) filter to produce spatialized audio. The HRTF filter maintains the virtual location of the audio signals/sound, thus allowing the listener to change locations and head orientation without degradation of the audio signal. The audio system of the present invention produces virtual sound sources that are externally perceived and positioned at any desired orientation in azimuth and elevation from the listener.

EX1008 (Ballas), Abstract.

# Claim Construction: HRTFs and 6DOF

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

18

# No Express Construction Necessary

Paper 19

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

META PLATFORMS, INC.,  
Petitioner,

v.

EIGHT KHZ, LLC,  
Patent Owner.

IPR2023-01003  
Patent 9,226,090 B1

PATENT OWNER'S RESPONSE

## PATENT OWNER'S RESPONSE

The claim terms should be given their “ordinary and customary meaning” as understood by a PHOSITA in view of the patent claims, specification and prosecution history. *Phillips v. AWH Corp.*, 415 F.3d 1303, 1312-14 (Fed.Cir.2005) (*en banc*); 37 C.F.R. §42.100(b). There is a “heavy presumption” that the ‘090 Patent’s disputed claim terms “are to be given their ordinary and customary meaning.” See *Aylus Networks, Inc. v. Apple Inc.*, No. 2016-1599, 856 F.3d 1353 (Fed.Cir. (Cal.) May 11, 2017). The ordinary meaning may be readily apparent to a PHOSITA, and claim construction can involve merely accepting the meaning of commonly understood words. *Phillips*, 415 F.3d at 1314 ... Accordingly, no express constructions of the claims are necessary. To the extent that any term needs construction, the plain and ordinary meaning of the term should be adopted.

POR 3-4.

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

19

## Legal Standard To Construe Terms

[A]lthough the claims are construed objectively and without reference to the accused device, only those terms need be construed that are in controversy, and ***only to the extent necessary to resolve the controversy.***

*Vivid Techs., Inc. v. Am. Sci. & Eng'g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999) (emphasis added).

## No Dispute Identified for Plain Meaning of “HRTF”

### Petitioner’s Expert Dr. Kyriakakis

16 Q So what is the plain and ordinary meaning  
17 of HRTF?

18 MS. WANG: Asked and answered.

19 A It is what the words say. It is a  
20 transfer function related to the head.

21 Q Okay. So your definition of HRTF as a  
22 person of ordinary skill -- of plain and ordinary  
1 meaning is head-related transfer function?

2 A That --

3 MS. WANG: Vague, mischaracterizes  
4 testimony.

5 A That is the plain and ordinary meaning,  
6 yes.

EX2016 (Kyriakakis Tr.), 90:16-91:6 (cited by Sur-Reply 4).

## Dr. Kyriakakis Applied Plain Meaning

### Patent Owner's Sur-Reply

**No Citation**



But Dr. Kyriakakis admitted that he did not use this definition in his declaration. Instead, he adopted a Petitioner-provided definition without disclosing this in his declaration. Ex.2016, 74:13-19; 76:8-16; 77:19-78:7. Sharp practice. “Expert testimony that does not disclose the underlying facts or data on which the opinion is based is entitled to little or no weight.” 37 C.F.R. §42.65(a).

Sur-Reply 4.

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

22

## Parties' Proposed Constructions

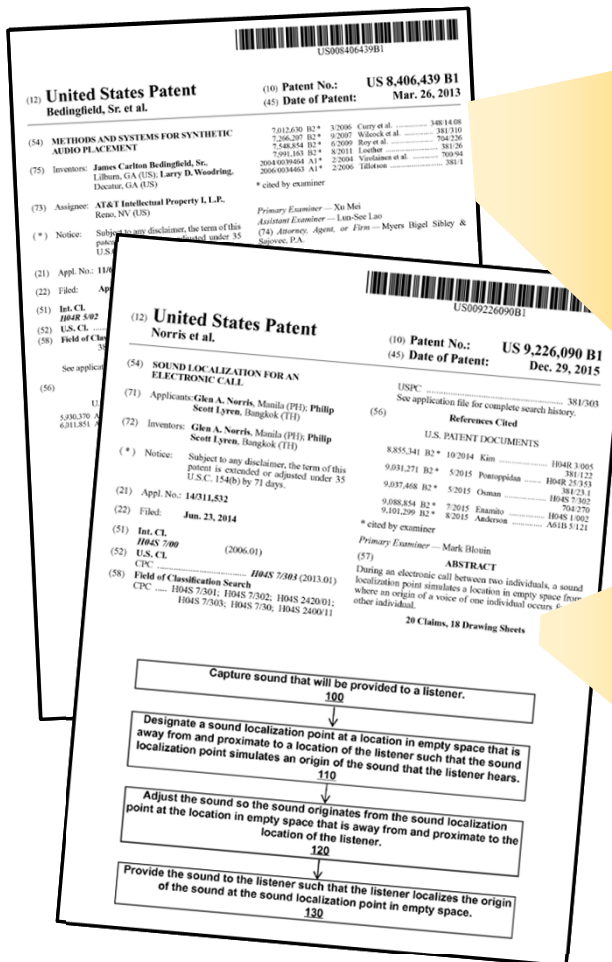
### Whether Independent Claims Require HRTFs

| Petitioner's Construction  | Patent Owner's Construction                                                                                               |
|----------------------------|---------------------------------------------------------------------------------------------------------------------------|
| plain and ordinary meaning | "externalization of sound through HRTFs and 6DOF tracking of the listener relative to the SLP that represents the talker" |

Pet. 15-16.

Begault Decl. ¶¶79 (cl. 8);  
see also ¶¶64-65 (cl. 1), ¶85 (cl. 15);  
POR 43; Sur-Reply 7.

# Primary Dispute: Whether Independent Claims Require HRTFs and 6DOF



The multi-channel processing device 118 may separate the single channel audio signal into a multi-channel signal, thus creating a sound field 122 for the listener 102 when the listener hears the audio signal from the multi-channel processing device 118, and then through the speaker system 120 ... The multi-channel processing device 118 configured with the communication system 116 creates the sound field 122 that is substantially similar (or approximately similar) to an actual sound field where the listener 102 is present between all of participants 104, 106, 108.

EX1005 (Bedingfield), 4:31-5:3.

1. A method, comprising: ...

designating, with a computer system, a sound localization point in empty space that is away from and proximate to the listening person such that the sound localization point simulates an origin of the binaural sound at the empty space that the listening person hears during the telephone call ...

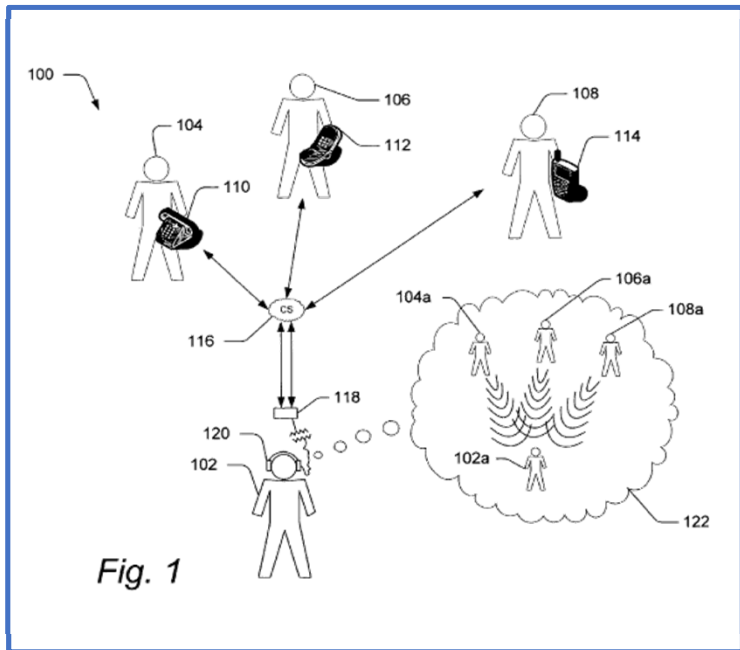
EX1001 ('090 Patent), cl. 1.

Pet. 22-26.

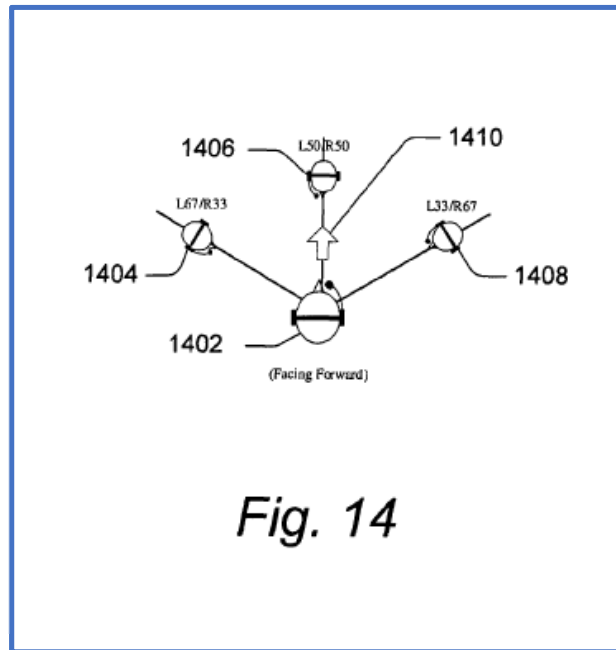
DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

24

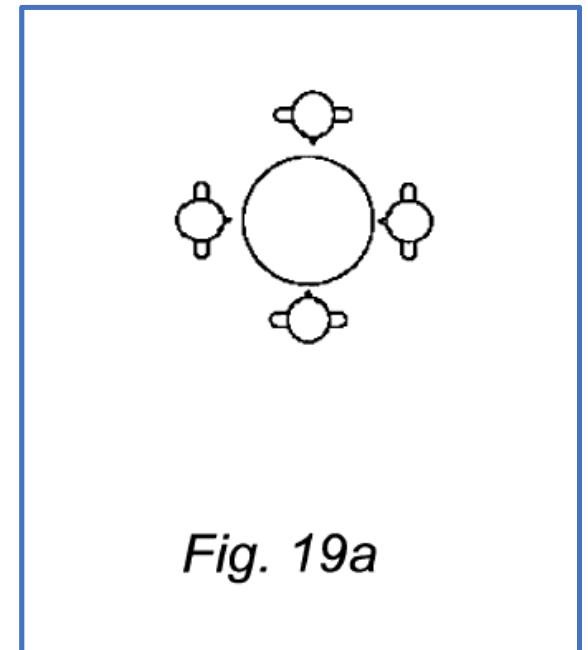
## PO Attempts to Improperly Narrow Adjusting Sound To HRTFs



EX1005 (Bedingfield), Fig. 1.



EX1005 (Bedingfield), Fig. 14 (excerpted).



EX1005 (Bedingfield), Fig. 19a (excerpted).

## Intrinsic Evidence – Claims

### No requirement for HRTFs and 6DOF tracking

2. The method of claim 1 further comprising ...  
adjusting an **interaural time difference** of the sound that the listening person hears in response to the listening person changing the head orientation with respect to the sound localization point.
5. The method of claim 1 further comprising ...  
adjusting an **interaural level difference** of the binaural sound that the listening person hears in response to the talking person moving closer to and away from the sound receiving point.
17. The computer system of claim 15, wherein the processor further executes the instructions to change an **interaural time difference (ITD)**, an **interaural level difference (ILD)**, and a **head-related transfer function (HRTF)** in order to position the sound localization point of the binaural voice to the location that is away from and proximate to the first person.

EX1001 ('090 Patent), cls.2, 5, 17.

## Intrinsic Evidence – Specification

### No requirement for HRTFs and 6DOF tracking

A location of sound and/or a direction to the sound can be altered or created using one or more of head-related transfer functions (HRTFs), accounting for differences in arrival times between the ears (interaural time differences), differences in amplitude or level of the sound between the ears (interaural level differences), asymmetrical spectral reflections from parts of the body (such as torso, shoulders, and pinnae), phase delays, group delays, and a ratio of the direct signal to the reverberated signal.

EX1001 ('090 Patent), 3:59-67.

Adjustments are made to the sound for each of these users since they are located at different locations around the table with respect to the sound localization points. These adjustments include, but are not limited to, calculations for and changes to ITDs, ILDs, HRTFs, attenuation, reverberations, and *other aspects of sound* discussed herein.

EX1001 ('090 Patent), 35:49-55 (emphasis added).

## Intrinsic Evidence – Specification

### No requirement for HRTFs and 6DOF tracking

Block 120 states adjust the sound so the sound originates from the sound localization point at the location in empty space that is away from and proximate to the location of the listener.

Adjustments to the sound are made so the sound emanates or originates from the sound localization point. For example, the sound is processed so sound localization occurs for the listener to emanate from or originate at the sound localization point. For instance, the sound is processed to alter, add, or generate head-related transfer functions (HRTFs), interaural time differences, and/or interaural level differences to correspond to a fixed or variable distance from the listener, a coordinate location or a GPS location of the sound localization point.

EX1001 ('090 Patent), 4:20-39.

in response to an action or event. As the listener moves a head orientation and/or a location with respect to the sound localization point, the sound continues to appear to emanate or originate from the sound localization point. For example, adjustments are made to amplitude of the sound, interaural time differences, interaural level differences, and head-related transfer functions (HRTFs). These adjustments are made in real-time as the listener moves.

EX1001 ('090 Patent), 6:56-63.

As the first individual moves with respect to the sound localization point, one or more aspects of the sound are altered to compensate for the movements such that the sound the first individual hears continues to be localized at the sound localization point. For example, one or more of a HRTF, an interaural level difference, and/or an interaural time difference are altered.

EX1001 ('090 Patent), 9:54-61.

## Extrinsic Evidence – PO's Expert's Admission

### Externalization (Localization) Does Not Require HRTFs

#### PO's Expert Dr. Begault Deposition

Q. So you cannot accomplish sound externalization with stereo processing or stereo speakers, correct?

A. Well, just to be accurate, if you use loud speakers, then the sound is going to be external at one point because the loud speakers are external from the human. So the sound will be externalized somewhere in between the two loud speakers, but otherwise, over headphones, you need to have HRTFs to be able to externalize the sound on the side of your head ...

EX1051 (Begault Tr.) 68:23-69:8, 70:8-10.

## Construction Unnecessary: Bedingfield Discloses HRTF

### Petitioner's Expert Dr. Kyriakakis's Declaration

173. Bedingfield further discloses *HRTF*, by describing a “way the human ear detects the position of a signal is a change in frequencies heard as a sound moves from the front of a listener’s ear, where most frequencies are received with equal strength, to a position behind the listener’s ear, where higher frequencies are attenuated and the lower frequencies seem more apparent.” Ex. 1005, 3:49-54. A POSA would have understood that Bedingfield’s reference to using relative strength and attenuation of different frequencies (for each direction) of a sound for sound localization is the same as an *HRTF*, which was well-known in the art.

EX1003 (Kyriakakis), ¶¶173-174.

## Claim Construction: “capturing . . . binaural sound”

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

31

## Parties' Proposed Constructions

**“capturing ... binaural sound”**

| Petitioner's Construction  | Patent Owner's Construction                                             |
|----------------------------|-------------------------------------------------------------------------|
| Plain and ordinary meaning | “capturing each and every sound wave at the talker's system binaurally” |

Pet. 15-16.

POR 1.

## Intrinsic Evidence: “Sound” Includes A Voice

1. A method, comprising:
  - capturing, with an electronic earphone located at a head of a talking person, binaural sound that will be provided to a listening person during a telephone call;
  - designating, with a computer system, a sound localization point in empty space that is away from and proximate to the listening person such that the sound localization point simulates an origin of the binaural sound at the empty space that the listening person hears during the telephone call;
  - adjusting, with the computer system, the binaural sound captured at the earphone of the talking person so the binaural sound originates during the telephone call from the sound localization point in empty space that is away from and proximate to the listening person; and
  - providing, with an electronic earphone located at a head of the listening person, the binaural sound to the listening person during the telephone call such that the origin of the binaural sound for the listening person occurs at the sound localization point in empty space that is away from and proximate to the listening person.

## Intrinsic Evidence: “Sound” Includes A Voice

For example, the first person 2110 holds an HPED 2105 that captures, records, and transmits sound (such as a voice of the first person).

EX1001 ('090 Patent), 33:7-8.

The binaural recordings of the three sounds (i.e., footsteps, voice, and opening door) can be stored to preserve their original sound localization points. As such, a listener of the recording would hear the footsteps at the first coordinate, the voice at the second coordinate, and the opening door at the third coordinate.

EX1001 ('090 Patent), 5:67-6:2.

## Extrinsic Evidence: “Sound” Includes A Voice

### PO's Expert Dr. Begault Deposition

Q. And you consider speech a type of sound, correct?

A. Yes. Speech is considered a type of sound.

EX1051 (Begault Tr.) 41:3-5.

## Construction Unnecessary: '090 Patent Disclosure Is The Same As Andrea

Ambient noise and attenuation due to environmental conditions can be filtered.

The vocal sound captured from the third microphone is used to enhance the sound captured by the fourth microphone, to isolate and cancel non-vocal components of sound, and to improve the clarity of a vocal part of the signal that is ultimately provided to the listener.

EX1001 ('090 Patent), 25:39-41, 39:65-40:3.

A sound is picked up by the audio receiving means on each earbud, converted into audio signals, and transmitted to an external device, such as a computing device, for processing ... because the objective of ANR is to minimize unwanted sound perceived by the user, the most advantageous placement of each audio receiving means is at a location where the audio receiving means most closely approximate the sound perceived by the user.

EX1007 (Andrea), 14:55-61, 15:34-37.

... the sound picked up by the audio receiving means on the earbuds may be converted to audio signals that are transmitted to an external device comprising a processor for processing. The processor may execute executable instructions causing it to generate an audio signal that substantially fails to reflect noise generated from an area outside of the beam width.

EX1007 (Andrea), 16:21-28.

Reply 11-12, 14-15.

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

36

## Bedingfield-Andrea Captures, Adjusts, and Provides Binaural Sound

125. A POSA implementing Bedingfield would have been motivated to *capture binaural sound* taught by Andrea because doing so would have enhanced the sound quality by reducing noise. *See* Section IX.A (Ground 1, Motivation to Combine). A POSA would have reasonably expected to successfully modify the Bedingfield communication system by adding an additional microphone to Bedingfield's *electronic earphone* and a software module to process the *binaural sound* as taught by Andrea. *See* Section IX.A (Ground 1, Motivation to Combine).

EX1003 (Kyriakakis), ¶125; Pet. 22;  
Reply 15-16.

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

37

# Disputes

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

38

## Overview of Instituted Bedingfield Grounds

- Ground 1: Claims 1, 15 obvious over Bedingfield in view of Andrea
- Ground 2: Claim 18 obvious over Ground 1 references and Ballas
- Ground 3: Claim 19 obvious over Ground 1 references and Sandgren
- Ground 4: Claims 8-10, 12, 13 obvious over Bedingfield in view of Ballas

## Bedingfield Grounds: PO Arguments

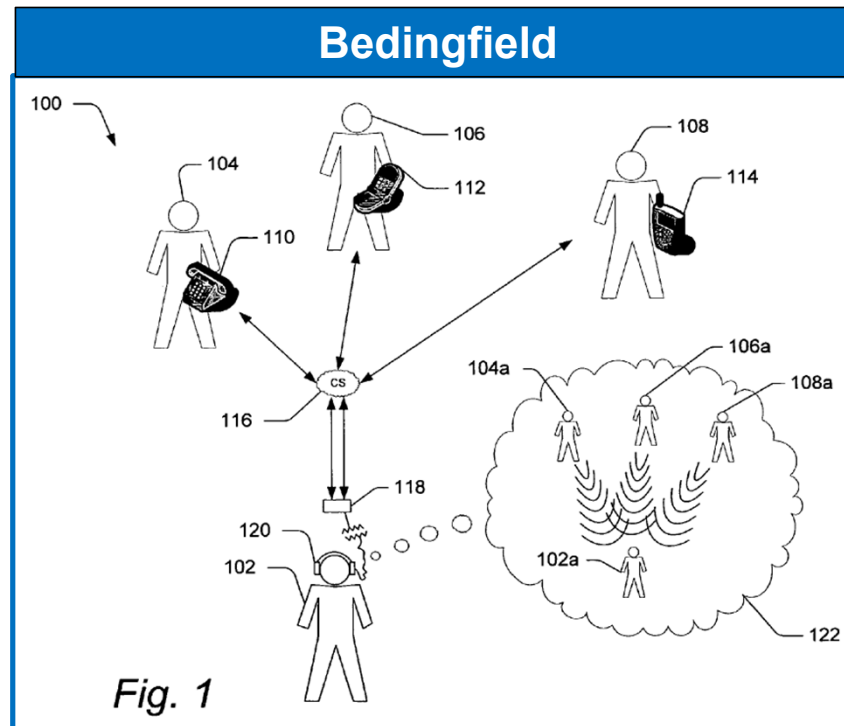
### Grounds 1-4

- Bedingfield does not teach binaural synthesis / Bedingfield is not binaural
- Bedingfield creates “perception” of externalization, not an externalized sound

### Ground 4

- Bedingfield does not teach ITD
- No reasonable likelihood of success to combine Bedingfield and Ballas

## '090 Patent Disclosure Is the Same as Bedingfield



EX1005 (Bedingfield).

## '090 Patent and Bedingfield Disclose “Adjusting ... Binaural Sound”

### '090 Patent

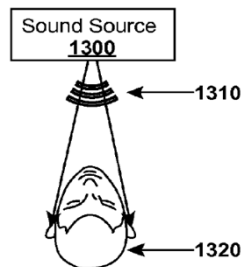


Figure 13A

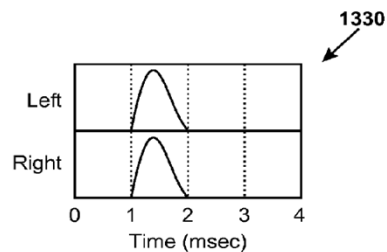


Figure 13B

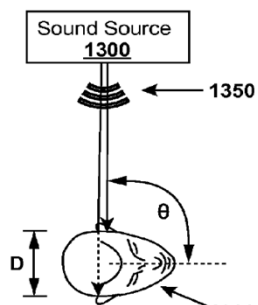


Figure 13C

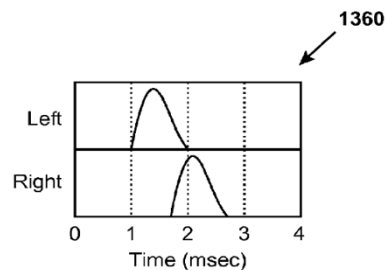


Figure 13D

'090 Patent, Figs. 13A-D;  
Ex. 1003 ¶¶50-53.

### Bedingfield

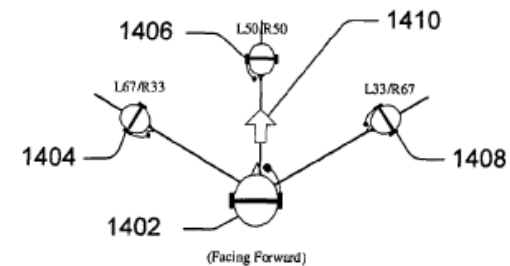


Fig. 14

EX1005 (Bedingfield), Fig. 14 (excerpted).

## '090 Patent and Bedingfield Disclose “Adjusting ... Binaural Sound”

### '090 Patent

fifth user **2368** at the sound localization point **2390**. Adjustments are made to the sound for each of these users since they are located at different locations around the table with respect to the sound localization points. These adjustments include, but are not limited to, calculations for and changes to ITDs, ILDs, HRTFs, attenuation, reverberations, and other aspects of sound discussed herein. Further, these adjustments can

EX1001 ('090 Patent), 35:49-55.

### Bedingfield

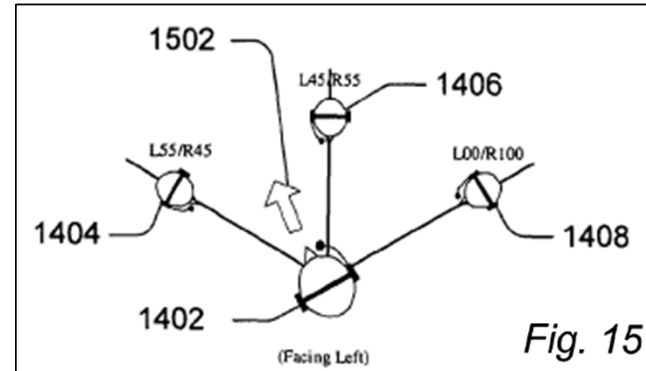
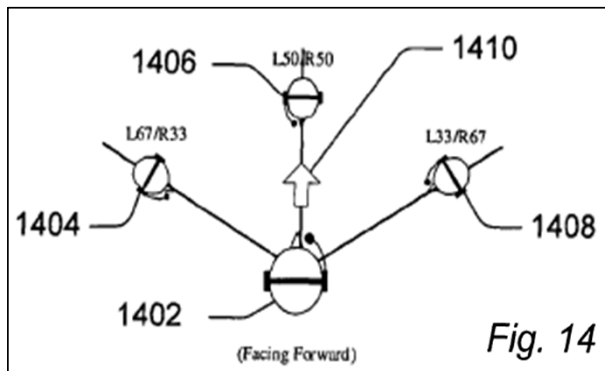
One way the human hearing mechanism (including the ears, nerves and brain processing, subsequently referred to as “the ear”) detects placement of a speaker (or source of sound)

...

allow for “near-left or far-right” positioning of a sound source. A third way the human ear detects the position of a signal is a change in frequencies heard as a sound moves from the front of a listener’s ear, where most frequencies are received with equal strength, to a position behind the listener’s ear, where the higher frequencies are attenuated and the lower frequencies seem more apparent. In a virtual environment, this effect, combined with a decrease in volume and left-right positioning, may give the listener the impression that a sound source has moved “behind” the listener, even with a two channel stereo system. Additionally, changes to delay and echo may heighten this effect. Further, other parameter changes may provide the sensation that one participant is located behind another participant.

EX1005 (Bedingfield), 3:35-61.

## Bedingfield Is A Binaural Reference



[T]he human hearing mechanism (including the ears, nerves and brain processing, subsequently referred to as ‘the ear’) detects placement of a speaker (or source of sound)...by detecting [differences]...perceived by the listener’s two ears ... the listener may hear a second speaker, located at the 3 o’clock position relative to the listener, in stereo sound with an increased volume level in the right audio channel and a decreased volume level in the left audio channel, as compared to the right and left volume levels received from the first speaker.

I'm using the word "stereo" here as it is sometimes used colloquially to mean two channels. Stereo only is stereo if you play it back over loudspeakers, as we said early on today, but it is often used this way.

EX1007 (Bedingfield),  
3:35-4:12, Figs. 14, 15.

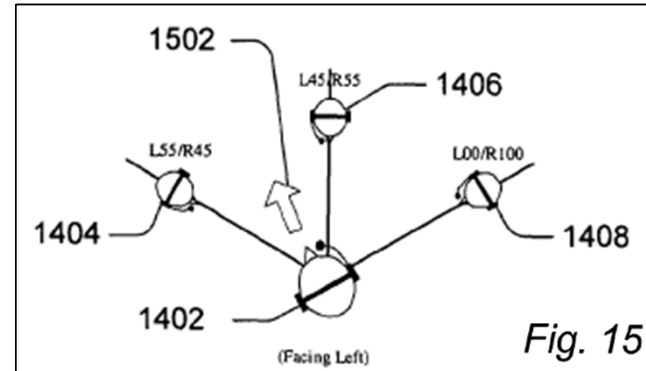
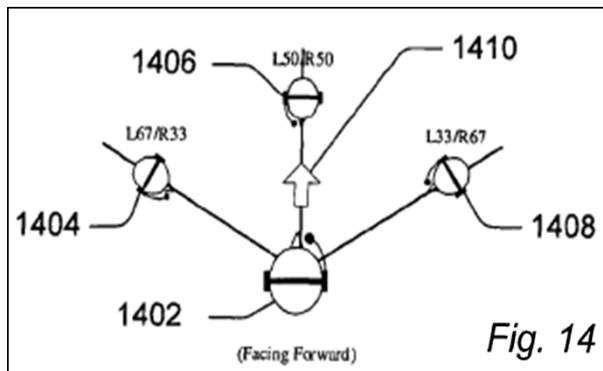
EX2016 (Kyriakakis Tr.), 160-161.

Reply 16-18.

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

44

## Bedingfield Is A Binaural Reference



[T]he human hearing mechanism (including the ears, nerves and brain processing, subsequently referred to as ‘the ear’) detects placement of a speaker (or source of sound)...by detecting [differences]...perceived by the listener’s two ears ... the listener may hear a second speaker, located at the 3 o’clock position relative to the listener, in stereo sound with an increased volume level in the right audio channel and a decreased volume level in the left audio channel, as compared to the right and left volume levels received from the first speaker.

EX1007 (Bedingfield), 3:35-4:12, Figs. 14, 15.

The word [binaural] has two parts: ‘bi’ meaning ‘two,’ and ‘aural’ meaning ‘of or relating to the ear or to the sense of hearing.’

EX1027, 18.

## Bedingfield Uses Sound Cues, Not Imagination

### Patent Owner's Response

participant is known in the field. *Id.* 24-25. But Petitioner fails to mention that in all these examples (including Bedingfield's Figs. 19a-c), the imagination of the listener—as opposed to manipulation of auditory cues—allows the listener to perceive the stereo sound as externalized. Ex.2011, ¶¶45-46. This perception is guided by either memory and familiarity or visual cues.<sup>15</sup> For example, Dr.

POR 57.

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

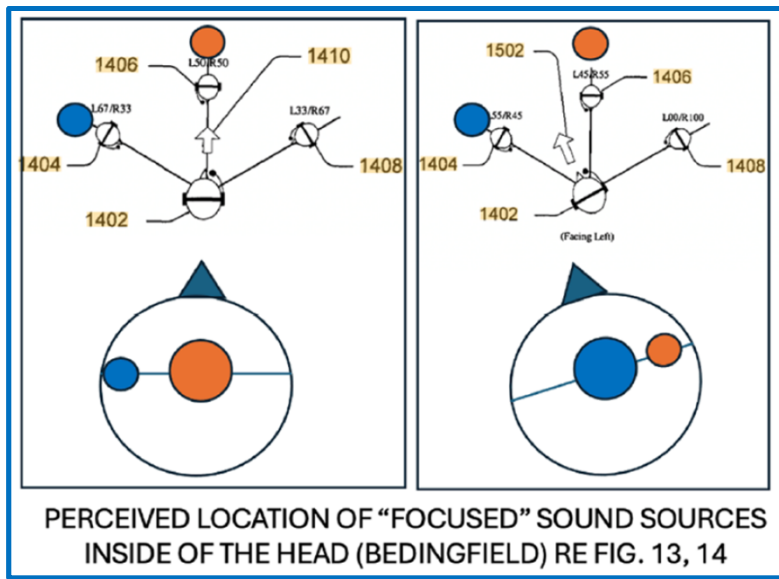
46

## Bedingfield Uses Sound Cues, Not Imagination

that is speaking. As shown in FIG. 15, after the listener 1402 changes the focus, the sound field may correspondingly change to reflect the new sound field orientation, thus providing more balanced left and right sound volume. Next, the participant 1408 may begin speaking. In the current sound field orientation shown in FIG. 15, the participant 1408 that is now speaking will sound as if the speaker were located behind the listener 1402 until the listener 1402 changes the focus direction 1502.

EX1005 (Bedingfield), 14:35-43.

## Bedingfield Teaches “away from and proximate to,” Not Inside The Head



PO-Modified EX1005, Figs. 14, 15 (EX2011, ¶82).

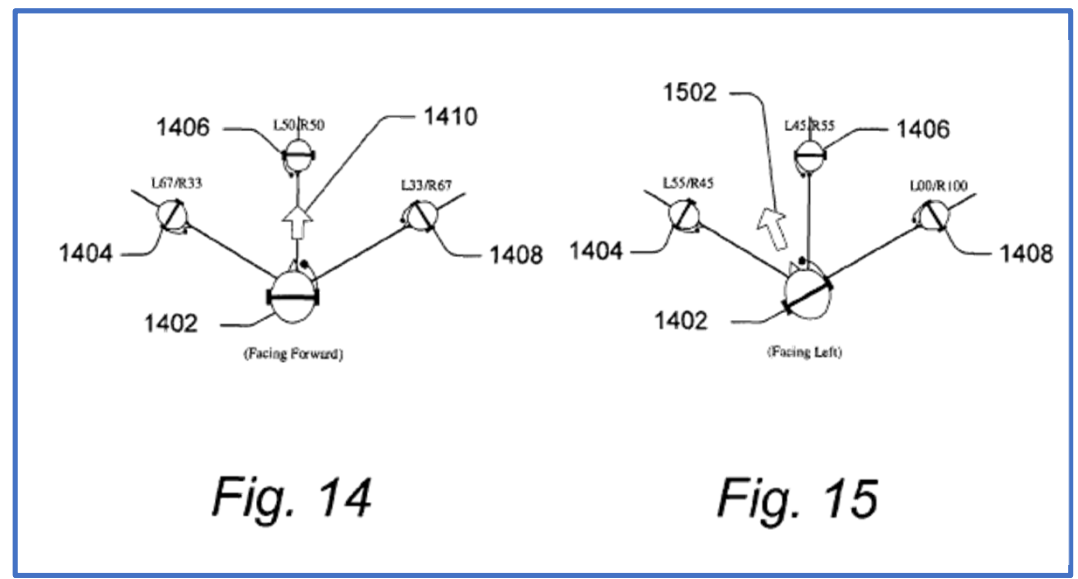


Fig. 14

Fig. 15

EX1005, Figs. 14, 15.

## Patent Owner's Arguments

First, Petitioner's experts agreed with Dr. Begault that a listener's perception of sound is different from how that sound is provided to the listener. Petitioner's

Sur-Reply 57.

perspective is transmitted to the listener during a call. Since the talker perceives the sound of the environment (e.g., chirping sound of a bird) as external to them, the listener also perceives the sound captured by the electronic earphone as external, when the same is provided to the listener. *Id.* However, while the electronic earphone

POR 40.

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

49

## Bedingfield Teaches “Interaural Time Difference”

In a virtual environment, this effect, combined with a decrease in volume and left-right positioning, may give the listener the impression that a sound source has moved behind the listener, even with a two channel Stereo system. Additionally, changes to delay and echo may heighten this effect. Further, other parameter changes may provide the sensation that one participant is located behind another participant.

For example, the participants may be placed in a circular configuration within the sound field. In other embodiments, the participants may be placed in other configurations within the Sound field Such as in a rectangular configuration or along a linear axis, using various audio techniques such as volume, balance, parametric equalization, delay, echo and the like to produce the effects described above with reference to FIG. 1.

EX1005 (Bedingfield), 3:54-61; 5:35-41.

## Like Bedingfield, '090 Patent Refers to ITD as Delay

This equation does not take into account that sound travels around the head, and this added distance causes additional delay. If an assumption is made that the head is spherical, then the ITD is given by the following equation:

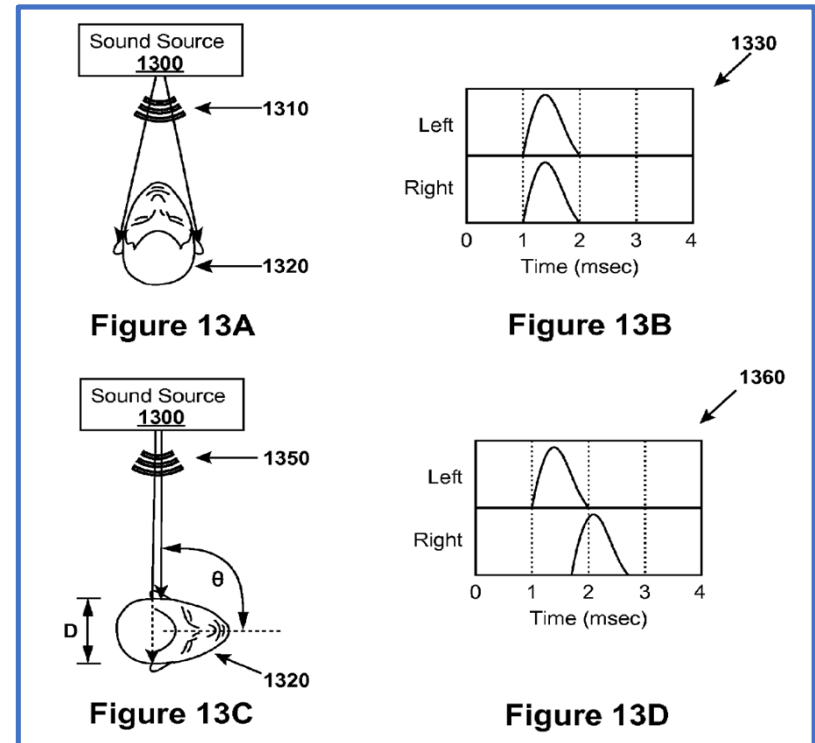
$$ITD = r(\theta + \sin(\theta)) / R,$$

where ITD is the interaural time delay,  $r$  is half the distance between the ears,  $\theta$  is the angle of arrival of the sound from the source, and  $R$  is the speed of sound.

EX1001 ('090 Patent), 27:51-59.

“difference in arrival times between the ears”

EX1001 ('090 Patent), 3:59-67.



EX1001 ('090 Patent), Figs. 13A-D;  
EX1003 ¶¶50-53.

## Motivation to Combine: Ballas Teaches Binaural Techniques

The amplified signals are binaural in nature (i.e., left channel signals are supplied to the left ear and right channel signals are supplied to the right ear).

EX1008 (Ballas), ¶25.

2. The apparatus as in claim 1, wherein the audio signals generated by the speakers is binaural so that audio signals from right and left speakers are delivered to right and left ears of the user, respectively.

EX1008 (Ballas), cl. 2.

## Motivation to Combine: Ballas Teaches Binaural Techniques

Transaural audio is a three-dimensional sound spatialization technique which is capable of reproducing binaural signals over loudspeakers. It is based on the cancellation of the acoustic paths occurring between loudspeakers and the listeners ears.

EX1054, 30 (cited in EX1005, ¶52).

### Petitioner's Expert Dr. Kyriakakis's Reply Declaration

Transaural sound is binaural sound processed and delivered through speakers instead of headphones.

EX1055 (Kyriakakis Reply), ¶52.

## Motivation to Combine: Ballas Does Not Teach Away

### Petitioner's Expert Dr. Kyriakakis's Reply Declaration

a POSITA designing a spatialized headphone system would have looked at known methods used in spatialized speaker systems [such as cross-talk cancellation, to adjust filters for headphones to speakers], and the other way around, including Ballas

EX1055 (Kyriakakis Reply), ¶¶51-57.

## Overview of Instituted Li Grounds

- Ground 5: Claims 1, 3, 6, 15-17 obvious over Li in view of Andrea
- Ground 6: Claims 2, 18 obvious over Ground 5 references and Ballas
- Ground 7: Claim 19 obvious over Ground 5 references and Sandgren
- Ground 8: Claim 8-10, 12, 14 obvious over Li in view of Ballas

## Li Grounds: PO Arguments

### Grounds 5-8

- Whether Li discloses telephone/electronic call
- Whether the Petition sufficiently address certain limitations

## Li Discloses “telephone call” / “electronic call”

The 3D binaural sound recording performed by the configurable 3D sound system 900 disclosed herein provides special effects and acoustic experiences to a user, for example, by allowing the user to move the sound source around the user 1703, move the sound source up and down, etc., on the configurable sound field 1700. The configurable 3D sound system 900 enhances the dramatic performance of radio drama shows and podcasts. Moreover, the configurable 3D sound system 900 provides a method of communication among multiple people [located remotely from one another], for example, in a conference call, by placing different speaking users at different spots to mimic a real conference room environment.

EX1006 (Li), 21:51-22:5; Pet. 58-59.

As used herein, the term ‘sound sources’ refers to similar or different sound generating devices or sound emitting devices, for example, musical instruments, loudspeakers, televisions, music systems, home theater systems, theater systems, a person’s voice, pre-recorded multiple soundtracks, pre-recorded stereo soundtracks, etc. The sound sources may also comprise sources from where sound originates and can be transmitted.

EX1006 (Li), 4:58-66.

## “Recording” in Li Means Live and Pre-Recorded

Consider an example in which a listener sits at his kitchen table and has an **electronic telephone call** with his mother. Both the listener and the mother wear electronic devices in or near their ears that capture, transmit, and provide sound for the telephone call. These electronic devices **record binaural sound** of the speaker and provide binaural Sound to the listener.

John and Paul both wear electronic earpieces that **record and provide binaural sound**. When the **call** initiates, the voice of Paul is localized to his empty chair in John’s apartment

The WED 2115 **records and transmits** this sound at the head of the second person 2120 ...

EX1001 ('090 Patent), 5:32-38, 8:7-11, 33:42-45.

In the context of [the '090 Patent], [‘record’] clearly is talking about a **real-time interaction** and not talking about ‘record’ in a sense that sometimes the word ‘record’ is used, to talk about pre-stored sound.

EX1051 (Begault Tr.), 55:6-19.

## Claim 1 Replicates Terms Throughout

1. A method, comprising:

[a] capturing, with an electronic earphone located at a head of a talking person, binaural sound that will be provided to a listening person during a telephone call;

[b] designating, with a computer system, a sound localization point in empty space that is away from and proximate to the listening person such that the sound localization point simulates an origin of the binaural sound at the empty space that the listening person hears during the telephone call;

[c] adjusting, with the computer system, the binaural sound captured at the earphone of the talking person so the binaural sound originates during the telephone call from the sound localization point in empty space that is away from and proximate to the listening person; and

[d] providing, with an electronic earphone located at a head of the listening person, the binaural sound to the listening person during the telephone call such that the origin of the binaural sound for the listening person occurs at the sound localization point in empty space that is away from and proximate to the listening person.

EX1001 ('090 Patent), cl. 1.

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

59

## Li Disclosures for Similar Limitations

<sup>16</sup> The mapping for the phrase *SLP in empty space that is away from and proximate to the listening person*, also applies to 1[c], 1[d], 3, 6[b], 8[b], 8[c], 12[b], 14, 15[d1], 17, which recite the same or similar phrase, and the mapping is not repeated in those sections, *infra*.

Pet. 63.

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

60

## Li Disclosures for 1[c]

As explained for 1[b], Li's configurable 3D sound system (*computer system*) designates an SLP and processes sound using HRTFs (*adjusting the binaural sound*) to generate localized sound to the first user (*listening person*). See Section XII.C.3 (Ground 5, 1[b]); Kyriakakis ¶262; EX1027, 39-40. Li's configurable 3D sound system 900 includes a computing device 901, on which a "3D sound processing application" uses HRTFs to reproduce 3D binaural sound 909. EX1006, 17:1-4, 17:22-37, 17:45-49, 18:11-13, 20:26-36, Fig. 16; *see also id.*, 5:22-28; Kyriakakis ¶262.

Pet. 64.

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

61

## Li Disclosures for 1[d]

As explained for 1[a], Li contemplates that the first user (*listening person*) has a headset (*an electronic earphone located at a head of the listening person*). See Section XII.C.2 (Ground 5, 1[a]); Kyriakakis ¶265. As explained for 1[b]-1[c], Li discloses placing the sound sources at “different spots to mimic a real conference room environment” over headsets. See Sections XII.C.3-4 (Ground 5, 1[b]-1[c]); Kyriakakis ¶265.

Pet. 66.

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

62

# New Evidence and Arguments

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

63

## Exhibits 2029-30 Submitted by PO in Sur-Reply

|                     |                                 |                                                                                                  |
|---------------------|---------------------------------|--------------------------------------------------------------------------------------------------|
| <b>Exhibit 2029</b> | IPR2023-01023<br>(US10,798,509) | Transcript of cross-examination deposition testimony of Dr. Gregory Welch                        |
| <b>Exhibit 2030</b> | IPR2023-01019<br>(US10,368,179) | Transcript of cross-examination deposition testimony of Dr. Agnieszka Roginska                   |
| <b>Exhibit 2031</b> | IPR2023-01003<br>(US9,226,090)  | Transcript of cross-examination deposition testimony of Petitioner's expert Dr. Chris Kyriakakis |

<sup>i</sup> These Exhibits were introduced during the cross-examination of Dr. Kyriakakis. PO includes these Exhibits “only for the limited purpose of allowing the Board to understand the context of the cross-examination.”

Sur-Reply, v-vi.

# Exhibits 2029-30 Submitted by PO in Sur-Reply

“Statements That Are Not Hearsay. A statement that meets the following conditions is not hearsay [] An Opposing Party’s Statement. The statement is offered against an opposing party and [] was made by a person whom the party authorized to make a statement on the subject”

Fed. R. Evi. 801(d)(2)(C).

## “subject” vs. “subject matter”

|                |                    |
|----------------|--------------------|
| Subject        | '090 Patent        |
| Subject Matter | Sound localization |

## PO's New Theories

Dr. Kyriakakis's opinion is questionable—his newly-formulated opinion contradicts the testimony of Petitioner's other experts in concurrent IPR proceedings and also conflicts with his earlier statements.

Petitioner's other experts all agreed with Dr. Begault that sound externalization requires binaural synthesis—only Dr. Kyriakakis disagrees.

Petitioner's other experts have all agreed with Dr. Begault ...

All of Petitioner's experts, except Dr. Kyriakakis, acknowledged the scientific fact that stereo sound cannot simulate the "origin" of sound at an SLP "away from and proximate to" the listener.

This inability, acknowledged by all experts except Dr. Kyriakakis, shows that stereo sound cannot "position sound in three-dimensional space."

Sur-Reply, 5:14-17; 7:5-8; 11:10-11; 20:8-10; 21:3-5.

## No Evidence of Disagreement by Experts

**Cited Testimony at Sur-Reply, 7:** "I would disagree...that this is the only way to externalize. But I doubt that's what she's saying. I don't know the context."

**Cited Testimony at *id.*, 10:** "I just don't want to make it sound like the HRTFs is the only way to do that. But I do agree with what he's saying."

**Cited Testimony at *id.*, 20:** "I disagree with that particular sentence...But the whole paragraph, when read together, seems to match what I said before."

**Cited Testimony at *id.*, 21:** "I'm reading it out of context, so I'm not sure what she means by three-dimensional space."

Petitioner's Motion to Strike, 2 (citing Sur-Reply).

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

66

## Exhibits 1047-50, 52-54, 55 (certain paras.)

|                     |                                                                                                                                                                                                                                                                                                                                                                                       |
|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Exhibit 1047</b> | D. Begault, et al., Headphone Localization of Speech Stimuli, Proceedings of the Human Factors Society 35th Annual Meeting, 82- 86 (1991)                                                                                                                                                                                                                                             |
| <b>Exhibit 1048</b> | Durand R. Begault, et al., Headphone Localization of Speech, Human Factors, 35(2), 361-776 (1993)                                                                                                                                                                                                                                                                                     |
| <b>Exhibit 1049</b> | Improved HRTF-Based Pseudostereophony, Monaural are filtered digitally to obtain pseudosterophonic output signals (April 2000)                                                                                                                                                                                                                                                        |
| <b>Exhibit 1050</b> | Areti Andreopoulou, et al., <i>Inter-Laboratory Round Robin HRTF Measure Comparison</i> , 9(5) 895-906 (2015)                                                                                                                                                                                                                                                                         |
| <b>Exhibit 1052</b> | U.S Patent No. 4,136,260 to Asahi (“Asahi”)                                                                                                                                                                                                                                                                                                                                           |
| <b>Exhibit 1053</b> | B.B. Bauer, Stereophonic Earphones and Binaural Loudspeakers, Journal of the Audio Engineering Society, 2 (9) 148-151 (April 1961)                                                                                                                                                                                                                                                    |
| <b>Exhibit 1054</b> | Fabio Kaiser, Transaural Audio – The reproduction of binaural signals over loudspeakers, 1-34 (March 2011)                                                                                                                                                                                                                                                                            |
| <b>Exhibit 1055</b> | Declaration of Chris Kyriakakis in Support of Petitioner’s Reply (“Kyriakakis Reply”) <p>¶¶ 1-5, 11-16, 17, 21-24, 29, 42 Cited for opinions, analysis, support, context</p> <p>¶¶ 8, 13, 16, 24, 33, 35, 40, 45, 47, 49, 52-56 PO makes improper argument suitable for Sur-Reply</p> <p>¶¶ 7-8, 33, 35, 44, 52, 5-56 Provide Dr. Kyriakakis’ opinions re EX1052-54, not hearsay.</p> |

Authored  
by PO’s expert

Self-  
Authenticating  
Publications

Petitioner’s Opp. to PO’s MTE, 1-10.

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE