

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SAMSUNG ELECTRONICS CO., LTD., SAMSUNG ELECTRONICS,
AMERICA, INC., HARMAN INTERNATIONAL INDUSTRIES, INC.

Petitioners

v.

STATON TECHIYA, LLC,

Patent Owner

Case IPR2024-01015

U.S. Patent No. 11,665,493

Petition for *Inter Partes* Review of

U.S. Patent No. 11,665,493

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1001	U.S. Patent 11,665,493 (“’493”)
1002	Declaration of Dr. Kyriakakis (“Kyriakakis”)
1003	Curriculum Vitae of Dr. Kyriakakis
1004	File History of U.S. Patent 11,665,493 (“’493FH”)
1005	U.S. Provisional Application 61/098,250
1006	U.S. Application 12/555,864
1007	U.S. App. Pub. No. 2007/0299362 (“Epley”)
1008	U.S. App. Pub. No. 2005/0096899 (“Padhi”)
1009	U.S. App. Pub. No. 2005/0123146 (“Voix”)
1010	Certified Translation of Japanese Patent Application Publication 2002-204500 (“Hayashi”)
1011	Japanese Patent Application Publication 2002-204500
1012	U.S. Patent 5,182,774 (“Bourk”)
1013	U.S. Patent App. Pub. No. 2008/0107287 (“Beard”)
1014	U.S. Patent No. 10,979,836 (“’836 patent”) <i>Ex Parte Reexamination</i> , Final Rejection (07/28/2023)
1015	U.S. Patent No. 6,567,524 (“Svean”)
1016	U.S. Patent No. 7,039,195B1
1017	<i>Staton Techiya, LLC et al v. Samsung Electronics Co., Ltd. et al</i> , Case No. 2-21-cv-00413, (E.D. Tex, Feb. 8, 2023), Claim Construction Order Dkt. No. 285 (regarding U.S. Patent No. 9,609,424 (“the ’424 patent”))

Exhibit No.	DESCRIPTION
1018	Patent Owner appeal – '836 EPR
1019	U.S. Patent No. 6,671,643
1020	United States District Courts - National Judicial Caseload Profile
1021	Sotera Stipulation

LISTING OF CHALLENGED CLAIMS

Claim 1	
1.pre	An audio device configured to test a seal of an earphone comprising:
1.1	a memory that stores instructions; and
1.2	a processor, wherein the processor is configured to execute the instructions to perform operations, the operations comprising:
1.2.1	generating a test signal,
1.2.1.1	wherein the test signal includes multiple frequency components, wherein at least one component lies between a range of 30 Hz and 200 Hz;
1.2.2	sending the test signal to a speaker of an earphone,
1.2.3	wherein the earphone includes a first microphone, the speaker, and a sealing section, and wherein the sealing section is configured to form an acoustic barrier between a first side of the earphone and a second side of the earphone when the earphone is worn by a user,
1.2.4	receiving a first microphone signal from the first microphone;
1.2.5	calculating a value, using a first signal and a second signal, wherein the value is the result of a non phase calculation of at least one of a coherence, a correlation, a cross-correlation, a difference, or a combination;
1.2.6	comparing the value to a threshold to determine a seal quality between the first side and the second side;
1.2.7	generating a message to convey the seal quality; and sending the message to the user.
Claim 2	
2	The audio device according to claim 1, wherein the message is an acoustic message.
Claim 3	
3	The audio device according to claim 1, wherein the message is a visual message sent to a display of the audio device.

Claim 4	
4	The audio device according to claim 1, wherein the speaker plays the test signal from the first side.
Claim 5	
5	The audio device according to claim 4, wherein the first microphone measures sound from the first side.
Claim 6	
6	The audio device according to claim 4, wherein the first microphone measures sound from the second side.
Claim 7	
7	The audio device according to claim 1, wherein the first signal is the test signal and the second signal is the first microphone signal.
Claim 8	
8	The audio device of claim 1, wherein the first signal is the test signal and the second signal is a modified first microphone signal.
Claim 9	
9	The audio device according to claim 8, wherein the modified first microphone signal is generated by applying a low pass filter to the first microphone signal, wherein the upper cutoff frequency is less than or equal to 200 Hz.
Claim 10	
10	The audio device of claim 1, wherein the first signal is a modified test signal and the second signal is the first microphone signal.
Claim 11	
11	The audio device according to claim 1, wherein the first signal is a modified test signal and the second signal is a modified first microphone signal.
Claim 12	
12	The audio device according to claim 11, wherein the first microphone signal is generated by applying a low pass filter to the first microphone

	signal, wherein the upper cutoff frequency is less than or equal to 200 Hz.
Claim 13	
13	The audio device according to claim 1, wherein the earphone includes a second microphone.
Claim 14	
14.pre	The audio device according to claim 13, wherein the operations further comprise:
14.1	receiving a second microphone signal from the second microphone.
Claim 15	
15	The audio device according to claim 14, wherein the first signal is the first microphone signal and the second signal is the second microphone signal.
Claim 16	
16	The audio device of claim 14, wherein the first signal is a modified first microphone signal and the second signal is the second microphone signal.
Claim 17	
17	The audio device of claim 14, wherein the first signal is a modified first microphone signal and the second signal is a modified second microphone signal.
Claim 18	
18	The audio device of claim 1, wherein the seal quality is good if the value is at or above the threshold value.
Claim 19	
19	The audio device of claim 1, wherein the sealing section is composed of at least one of rubber, silicone, a flexible polymer, or a combination thereof.
Claim 20	
20	The audio device of claim 1, wherein the sealing section is an eartip.

I. INTRODUCTION

The '493's purported invention is a device that "evaluate[s] a seal quality" between an earphone and an ear. '493, Abstract, 2:4-14. A test signal including frequencies below 200 Hz is generated and played by the speaker of the earphone. '493, 12:14-34, Fig. 3 (below). The device receives a microphone signal and calculates a value based on two signals (e.g., the microphone signal and test signal) using, e.g., "a cross-correlation" calculation. '493, 10:44-64. The calculated value is compared to a threshold to determine seal quality. '493, 16:27-35, Fig. 4 (below). A message is sent to the user conveying seal quality. '493, 15:66-16:2. Kyriakakis, ¶¶39-47.

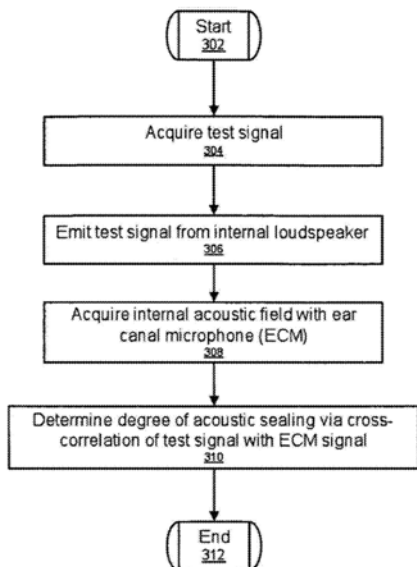


FIG. 3

'493, Figure 3

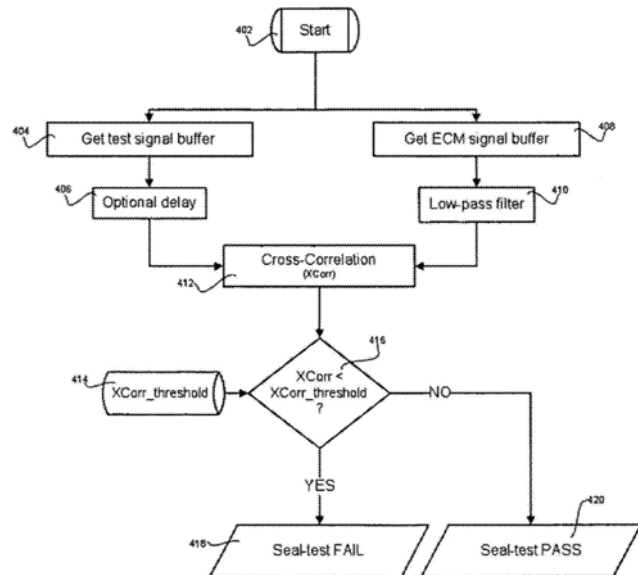


FIG. 4

'493, Figure 4

But the concept of evaluating seal quality of an earphone based on a calculation using two signals was already known in the art. *Kyriakakis*, ¶43. For example, **Epley** discloses a device checking “proper sealing” of ear probes. *Epley*, [0070]; *Kyriakakis*, ¶69. **Epley** describes outputting a “known sound” and “measuring the acoustic response” input from a microphone, and performing a “straightforward comparison of input and output sound parameters determine whether the ear probe is properly sealed.” *Epley*, [0070]; *Kyriakakis*, ¶69. Such a “straightforward comparison” was taught by **Padhi**, which describes “comparing audio signals” through “cross-correlation.” *Padhi*, Abstract, [0012], Fig. 4; *Kyriakakis*, ¶70. Moreover, **Voix** teaches a “broadband reference sound source [that] provides” a known sound for use in a seal test includes a frequency range of “about 100 Hz to about 10000 Hz.” *Voix*, [0100]; *Kyriakakis*, ¶127-129.

Further, comparing the resulting value to a threshold was also known. *Kyriakakis*, ¶43. **Voix** describes “indicating presence of acoustic seal when attenuation between said first and second sound levels is equal to or larger than a predetermined threshold value.” *Voix*, [0039]. *Kyriakakis*, ¶89.

The claims are directed to this known mechanism of testing seal quality.¹

Kyriakakis, ¶43. Accordingly, Samsung Electronics Co., Ltd., Samsung Electronics America, Inc. (together “Samsung”), and Harman International Industries, Inc. (“Harman”) (collectively, “Petitioners”) request *inter partes* review (“IPR”) of claims 1-20 (“Challenged Claims”) of U.S. Patent No. 11,665,493 (“’493”). *Kyriakakis*, ¶1.

II. MANDATORY NOTICES UNDER 37 C.F.R. §42.8

A. Real Parties-in-Interest

Petitioners identify themselves as the real parties-in-interest.

1. Related Matters

’493 is the subject of the following district court litigations:

- *Staton Techiya, LLC v. Samsung Elecs. Co., Ltd. et al.*, 2:23-cv-00319-JRG-RSP (E.D. Tex.), filed July 10, 2023 (“Samsung Litigation”)
- *Staton Techiya, LLC v. Harman Int’l Indus., Inc. et al.*, 1:23-cv-00802-JCG (D. Del.), filed July 25, 2023 (“Harman Litigation”)

¹ While the claims generally relate to this functionality, Petitioners do not agree the claims satisfy §112.

U.S. Patent No. 10,979,836, the parent to the '493pat, is currently on appeal after a final rejection in *ex parte* reexamination. See Control No. 90/015,146.

Trial in *Inter Partes* Review Case No. IPR2022-00410 was denied.

The following chart identifies all patents/application that are in the same family as the '493pat:

U.S. Patent No. 11,889,275, which issued from U.S. App. No. 18/092,645
U.S. App. No. 18/515,254, which is a continuation of U.S. App. No. 17/182,570, and is pending
U.S. Patent No. 10,979,836, which issued from U.S. App. No. 16/838,277
U.S. Patent No. 10,701,499, which issued from U.S. App. No. 16/414,499
U.S. Patent No. 10,299,053, which issued from U.S. App. No. 15/700,511
U.S. Patent No. 9,781,530, which issued from U.S. App. No. 14/827,332
U.S. Patent No. 9,113,267, which issued from U.S. App. No. 14/054,015
U.S. Patent No. 8,600,067, which issued from U.S. App. No. 12/555,964
U.S. Provisional App. 61/098,250, filed September 19,2008.

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B. Power of Attorney

Powers of attorney are filed herewith according to 37 C.F.R. §42.10(b).

III. PAYMENT OF FEES

The undersigned authorizes the Office to charge the fee required by §42.15(a) and any additional fees that might be due to Deposit Account No. 18-1945, under Order No. 104537-0034-656.

IV. REQUIREMENTS FOR INTER PARTES REVIEW

A. Grounds for Standing

Pursuant to §42.104(a), Petitioners certify the '493 is available for IPR. Petitioners and any real parties-in-interest are not barred or estopped from requesting IPR challenging the Claims on the Grounds identified herein.

B. Identification of Challenge

Pursuant to §§42.104(b)-(b)(1), Petitioners request IPR of Claims 1-20 and that the Board cancel the same as unpatentable.

C. Specific Art on Which the Challenge Is Based

Petitioners rely on the following prior art (*Kyriakakis*, ¶¶17-20, 24-38):

Name	Ex.	Publication/Title	Published	Prior art under at least
<i>Epley</i>	1007	U.S. 2007/0299362	12/27/2007	§102(a)(1)
<i>Padhi</i>	1008	U.S. 2005/0096899	05/05/2005	§102(a)(1)
<i>Voix</i>	1009	U.S. 2005/0123146	06/09/2005	§102(a)(1)
<i>Hayashi</i>	1010/1011	JP2002204500A	07/19/2002	§102(a)(1)

<i>Bourk</i>	1012	U.S. Patent No. 5,182,774	01/26/1993 (issued)	§102(a)(1)
<i>Beard</i>	1013	U.S. 2008/0107287	05/08/2008	§102(a)(1)

Each of these references was published before the '493's parent's 9/19/2008 provisional filing date.²

D. Statutory Grounds on Which the Challenge Is Based³

Petitioners respectfully request review and cancellation under 35 U.S.C. §311 of the Challenged Claims in view of:

Ground	Claims	Basis	References
1	1, 3-5, 7-8, 10-11, 18-20	§103	<i>Epley in view of Padhi and Voix</i>
2	9, 12	§103	<i>Epley in view of Padhi, Voix, and Bourk</i>
3	2	§103	<i>Epley in view of Padhi, Voix, and Hayashii</i>
4	1, 4, 6, 13-14	§103	<i>Beard in view of Epley, Padhi and Voix</i>
5	15-17	§103	<i>Beard in view of Epley, Padhi, Voix, and Hayashi</i>

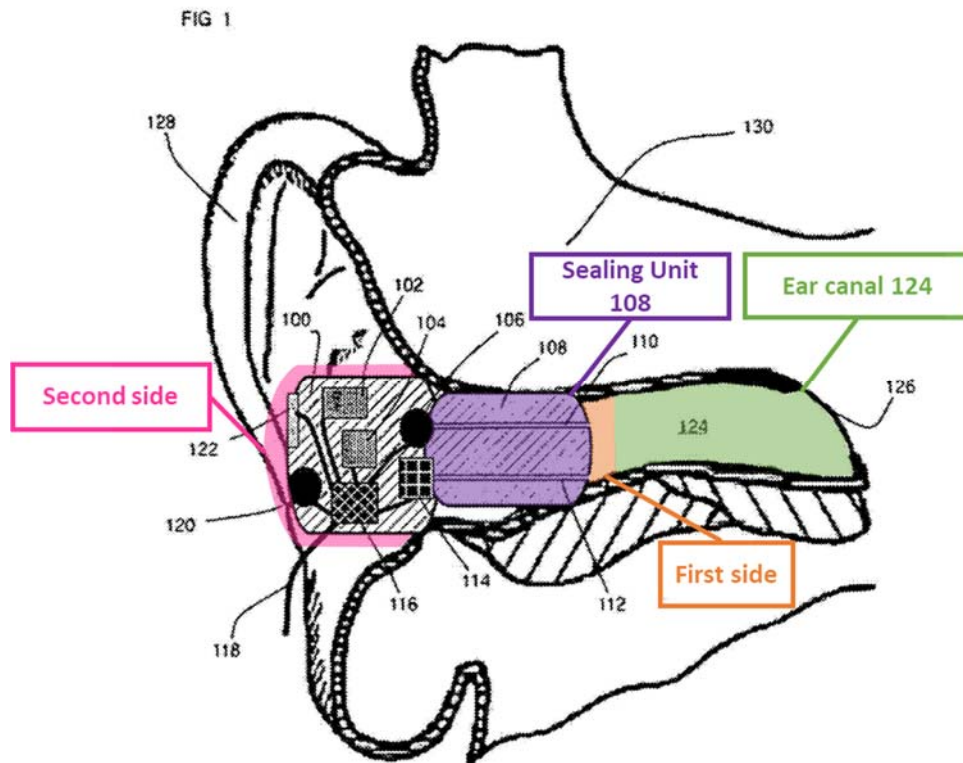
² PO has not established the '493 Claims are entitled to the 9/19/2008 filing date of the '493's earliest filed application (Provisional Application No. 61/098,250).

³ See *Kyriakakis*, ¶38.

V. '493 PATENT AND PROSECUTION HISTORY

A. Specification

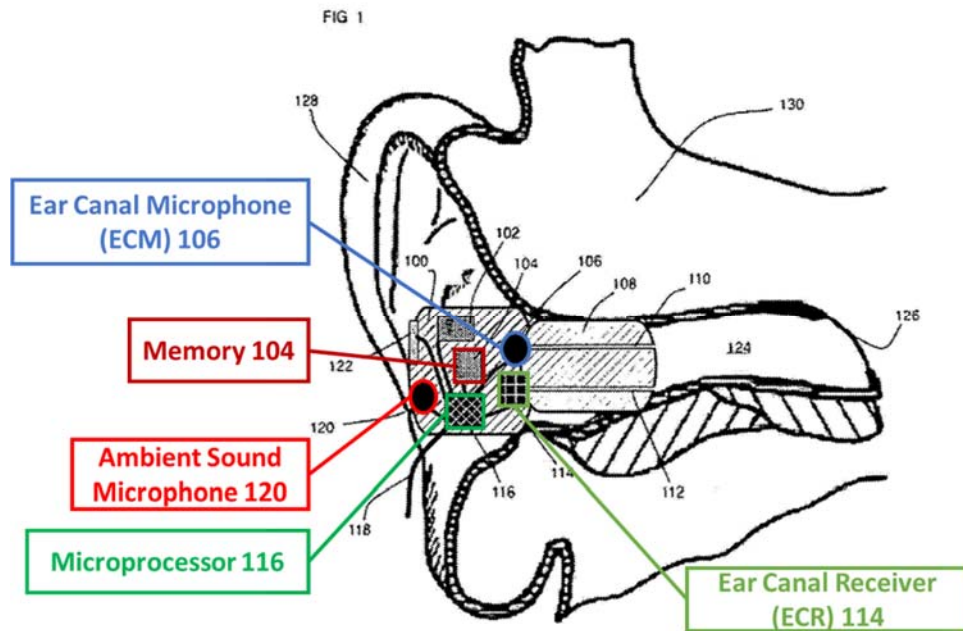
The '493 relates to “testing the seal of an orifice-inserted device....” '493, 1:24-27. As depicted in Figure 1, the earpiece comprises **sealing unit 108** “having a **first side** corresponding to **ear canal 124** and a **second side** corresponding to the ambient environment.” *Id.*, 4:34-36. *Kyriakakis*, ¶¶39-41.



'493, Figure 1.

The earpiece includes “**Ambient Sound Microphone (ASM) 120** to capture ambient sound, an **Ear Canal Receiver (ECR) 114** to deliver audio to an ear canal 124, and an **Ear Canal Microphone (ECM) 106** to capture and assess a sound exposure level within the ear canal 124.” *Id.*, 4:19-23. These components are

housed in electronic housing unit 100, which contains **microprocessor 116** operatively coupled to these components and **memory 104**. *Id.*, 4:55-64. These components may also be “in a separate system.” *Id.* Kyriakakis, ¶42.



'493, Figure 1.

The '493 discloses exemplary techniques for seal detection, *e.g.*, with respect to Figures 3, 4, and 14. *Id.*, 7:54-8:40 (Figure 3); 9:14-52 (Figure 4); 15:58-17:4 (Figure 14). Regarding Figure 3, the '493 discloses determining the degree of acoustic sealing via cross-correlation of a test signal with an ECM signal. *Id.*, 7:54-8:40. Kyriakakis, ¶¶43-45.

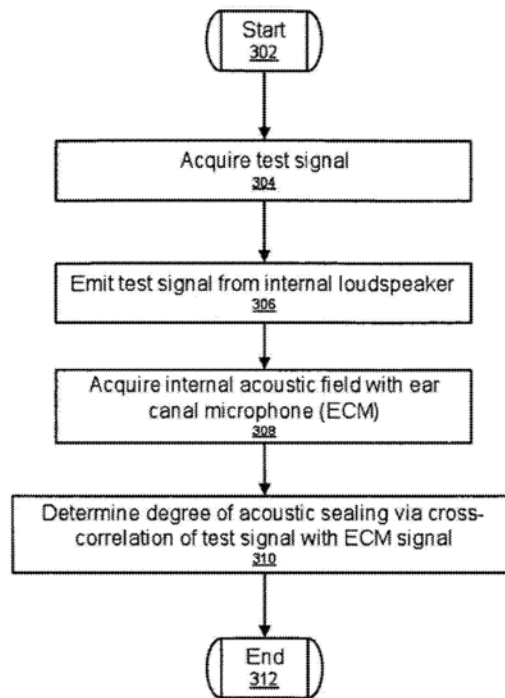


FIG. 3

'493, Figure 3.

Regarding Figure 4, the '493 discloses cross-correlating a test signal and an ECM signal and comparing to a threshold to determine whether the seal test result is FAIL or PASS. *Id.*, 9:14-52. *Kyriakakis*, ¶46.

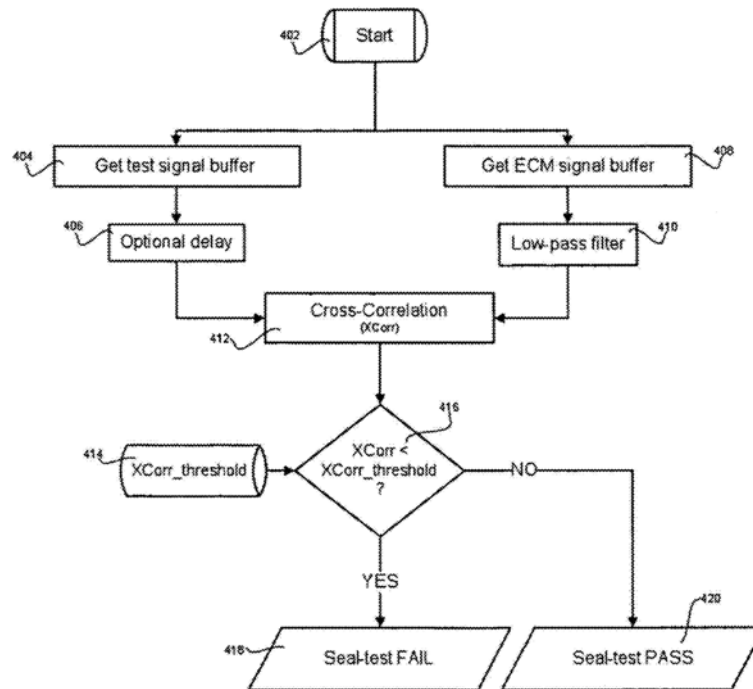
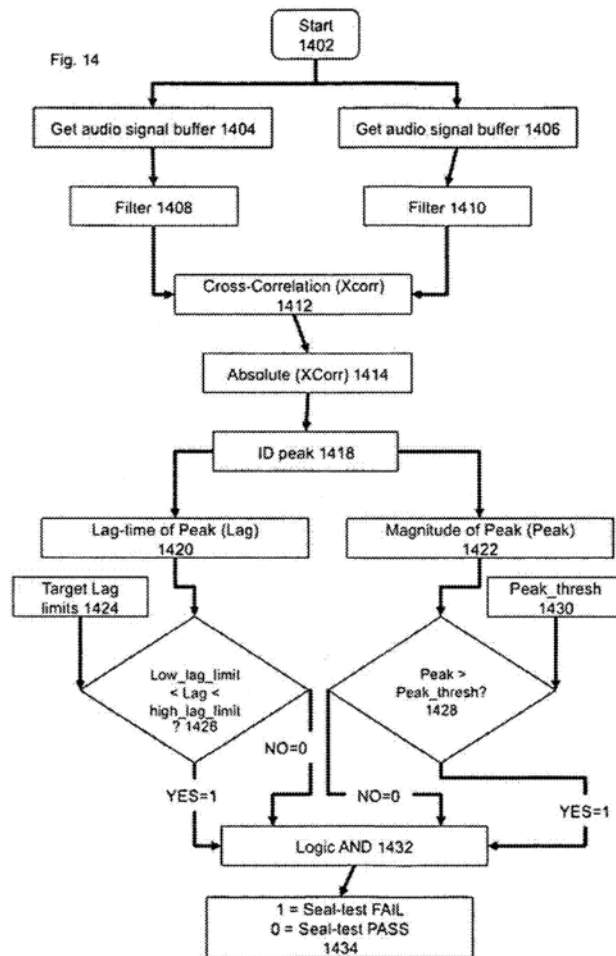


FIG. 4

'493, Figure 4.

Regarding Figure 14, the '493 discloses another technique involving cross-correlating signals and comparing to a threshold to determine whether the seal is proper. *Id.*, 15:58-17:4. *Kyriakakis*, ¶47.



'493, Figure 14.

B. Prosecution History

The '493 issued from U.S. Application No. 17/182,570 ('570 application), filed 2/23/2021. '493, Cover. The '570 Application is a continuation of U.S. Application No. 16/838,277 (issued 10,979,836), filed 4/2/2020. The '493 claims

priority through a series of applications to U.S. Provisional Application No. 61/098,250, filed 9/19/2008.⁴ *Kyriakakis*, ¶¶48-51, 63.

The Office did not issue any rejections during prosecution of the '570 application. *Kyriakakis*, ¶52.

In a notice of allowance on 12/23/2022, the Examiner stated the following “prior art made of record and not relied upon is considered pertinent to applicant’s disclosure”: “Ryan (US Pub. 20040196992),” “Siltmann (US Pub. 20070019817),” “Padhi (US Pub. 20050096899),” “Oliveira (US Pat. 5002151),” and “Rast (US Pub. 20010046304).” ’493FH, 222, 228-29. The Examiner stated *Padhi* “discloses an apparatus, method, and computer program for comparing audio signals.” *Id.*, 229. The Examiner also considered the request for *ex parte* reexamination of the parent ’836 patent on 12/13/2022. ’493FH, 238. While the Examiner initialed **Voix** in a submitted IDS, he did not comment on **Voix**. ’493FH, 376. *Kyriakakis*, ¶¶53-57.

The ’493 issued on 5/30/2023. ’493FH, 380-387; *Kyriakakis*, ¶58-59.

⁴ The prior art here predates the filing date of Provisional Application No. 61/098,250. *Kyriakakis*, ¶¶17-20. Petitioners reserve all rights to challenge any priority date of ’493 and raise §112 arguments in district court litigation.

VI. §325(d) AND §314(a) DISCRETION DOES NOT APPLY

A. §325(d)

Under the two-part *Advanced Bionics* framework, the Board should not exercise discretion.

The Grounds raised by this Petition are not the same or substantially the same as the art or arguments raised during '493's prosecution. Epley, Hayashi, Bourk, and Beard were not considered during prosecution. Though the Examiner identified **Padhi** and **Voix**, the Examiner did not consider either in combination with newly-identified **Epley**. '493FH, 229, 231; *Sony v. MZ Audio Scis., LLC*, IPR2022-01544, Pap. 12, *7 (§325(d) discretion improper where “Examiner did not consider the specific combination of references asserted”). *Kyriakakis*, ¶53.

Furthermore, the disclosures considered by the Examiner are not substantially the same as any of the references relied upon in the Grounds of this Petition. For example, unlike **Epley**, the cited art does not teach a system that (1) works with earpieces with integrated speakers and microphones, (2) sends a message indicating seal quality, and (3) compares two audio signals as part of a seal test, which would naturally motivate combination with **Padhi's** disclosures of comparing audio signals through cross-correlation. *Kyriakakis*, ¶¶65-86.

Even if the art or arguments were substantially the same, the Examiner erred in a manner material to the patentability of the Claims. Because the Examiner did not issue any rejections based on the cited art in this petition, it is “impossible...to determine the consideration the Examiner gave” to any cited reference and “the absence of further evidence of the Examiner’s consideration of” the art supports finding “the Office erred in a manner material to patentability.” *Ecobee Techs. v. Causam Enterprises, Inc.*, IPR2022-01339, Pap. 20, *20-21 (declining to exercise §325(d) discretion). And though the Examiner identified *Voix*, the Examiner did not address *Voix*’s disclosures. ’493FH, 3, 85, 165, 170, 376, 460. Indeed, the Examiner did not recognize any art teaching a comparison of a calculated value to a threshold to determine seal quality, despite *Voix* explicitly disclosing such. ’493FH, 135-136, 227-228. To the extent art considered by the USPTO was substantially the same as the references identified in the Grounds, the Examiner erred by not rejecting the Claims based on the Grounds for the reasons discussed in §IX. *Kyriakakis*, ¶¶64-362.

B. §314(a)

The PTAB should not exercise its §314(a) discretion. The PTAB will not discretionarily deny institution under *Fintiv* where, as here, Samsung presents a *Sotera* stipulation (EX1021) and no schedule has been set in the Harman litigation, and the median time to trial in Delaware is three years, which would set the

Harman trial in about July 2026, seven months after an expected FWD. (EX1020, 14).

VII. LEVEL OF ORDINARY SKILL IN THE ART

For purposes of this Petition only, Petitioners assume the Claims are entitled to the 9/18/2008 filing date.

A person of ordinary skill in the art at the time of the alleged invention of the '493 ("POSITA") would have had a bachelor's degree in electrical engineering, computer science, audio engineering, or a similar field and at least two years of experience with hearing instruments such as earphones, hearing aids and/or hearing protectors. The POSITA could have also obtained similar knowledge and experience through other means. *Kyriakakis*, ¶¶7-16, 21-23.

VIII. CLAIM CONSTRUCTION

Only terms necessary to resolve the controversy need construction. *Nidec Motor Corp. v. Zhongshan Broad Ocean Motor*, 868 F.3d 1013, 1017 (Fed. Cir. 2017). Because the prior art asserted herein discloses embodiments within the Claims' indisputable scope, the Board need not construe the Claims' outer bounds. All claim terms should be construed according to their plain and ordinary meaning. *Kyriakakis*, ¶62.

Petitioners are unaware of any "prior claim construction determination" by a District Court or the International Trade Commission. *See* 37 C.F.R. §42.100(b).

Petitioners note as to the parent '836 patent and an unrelated patent Patent Owner ("PO") asserted against Samsung (U.S. Patent No. 9,609,424 ("the '424 patent")), the court construed the following terms, also in the '493 Challenged Claims:

- “*a processor ... the processor*” ('836 patent, claims 1, 9, 14): “The same processor must perform each of the recited functions.”

EX1017, 48.

- “*seal quality*” ('424 patent, claim 1): “[S]eal quality’ is not binary in nature. Otherwise, this term will be given its plain and ordinary meaning.”

Id., 39, 50. *Kyriakakis*, ¶60.

In currently pending *ex parte* reexamination of the '836 patent (90/015,146), the Examiner asserted in a final rejection the term “the processor is configured to execute the instructions to perform operations, the operations comprising” should be interpreted subject to §112(f). EX1014, 8-9. PO appealed and disputed the term is subject to §112(f). EX1018. To the extent the term “processor” is subject to §112(f), and to the extent there is corresponding structure in the '493, that structure includes a processor or application specific integrated chip ('493, 5:53-67) performing the algorithm illustrated in Figs. 3 and 4, which includes generating a test signal (step 304), emitting the test signal to a speaker (step 306), obtaining a microphone signal from a microphone (step 308), calculating a value using cross-

correlation (step 310/412), comparing the value to a threshold (step 414), and generating a message and sending the message to the user (step 418/420). '493, 8:6-40, 9:15-52. A similar algorithm applicable to cross-correlation, correlation and coherence is described in the context of Fig. 14. '493, 16:6-17:4. *Kyriakakis*, ¶61.

IX. GROUNDS OF UNPATENTABILITY

This Petition is supported by the Declaration of Dr. Kyriakakis, which describes the prior art's scope and content at the time of the '493. *Kyriakakis*, ¶¶1-367. The prior art renders the Claims unpatentable based on the below Grounds.

A. Ground 1: Epley in view of Padhi and Voix (Claims 1, 3-5, 7-8, 10-11, 18-20)

1. Overview of Epley

Epley is directed to a “Stimulus-Evoked Vestibular Evaluation (SEVE)” system for detection of vestibular (inner ear) disorders. *Epley*, [0015]. The SEVE system includes **ear probes** and “sound/pressure generator/feedback mechanism 24.” *Epley*, [0066]. The ear probes **seal** an ear, and play audio as part of diagnosis. *Epley*, [0004]. Each ear probe includes “**speaker 74** and **microphone 76**.” *Epley*, [0065], Figs. 2, 3. *Kyriakakis*, ¶¶64-68.

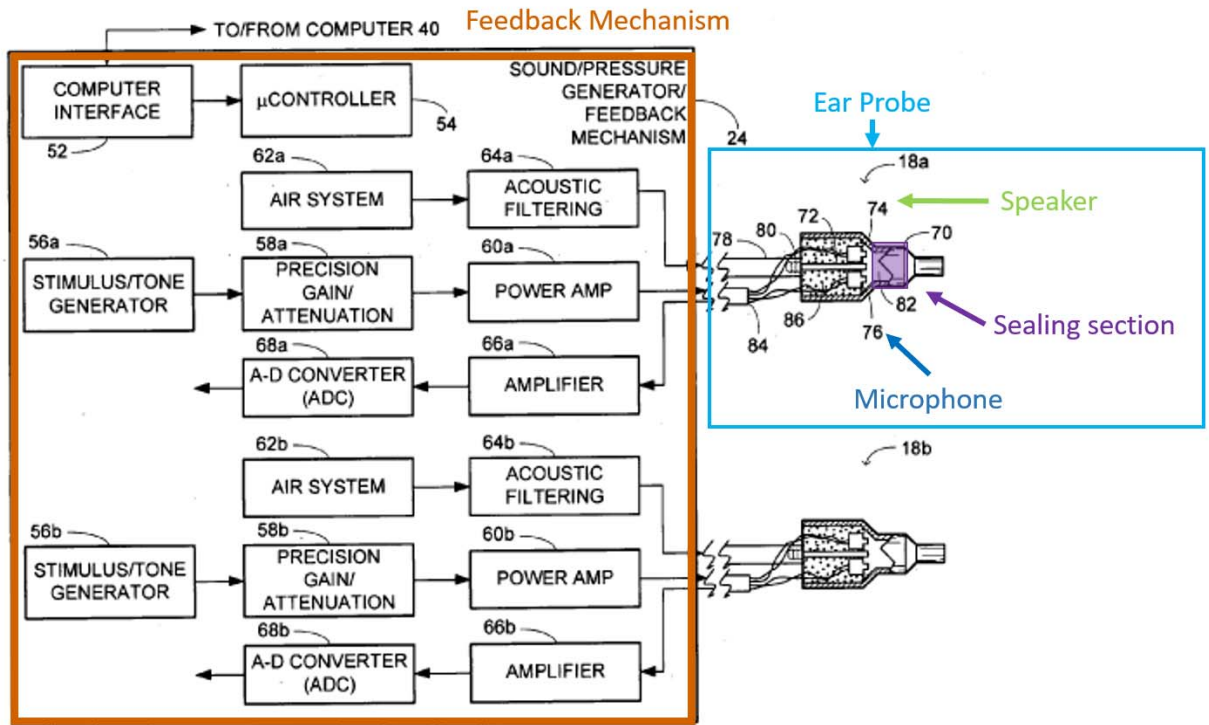


Fig. 3

Epley, Figure 3 (annotated)

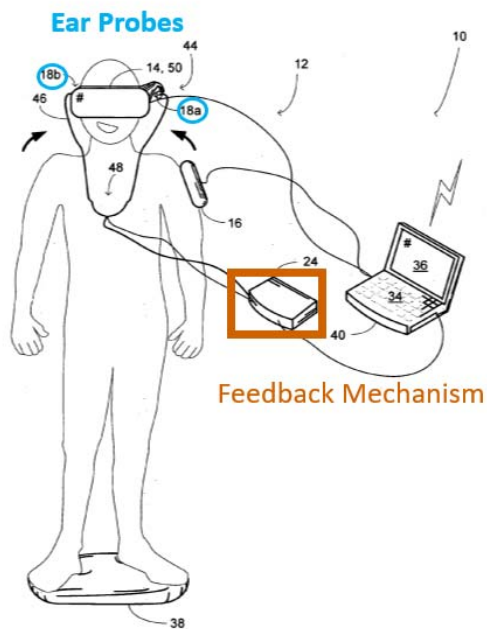


Fig. 2

Epley, Figure 2 (annotated)

Epley teaches, “to ensure proper sealing of **left** and **right ear probes 18a and 18b**,” the “**feedback mechanism**” tests the seal “by applying a known sound and volume and measuring the acoustic response within the subjects ear as picked up by the microphone,” and “straightforward comparison of input and output sound parameters determine whether the ear probe is properly sealed.” *Epley*, [0070]. A “display produces a warning to the operator” when appropriate. *Id.* *Kyriakakis*, ¶69.

2. Overview of **Padhi**

Padhi is directed to a system for “comparing audio signals,” and discloses “receiving and cross-correlating a first audio signal and a second audio signal.” *Padhi*, Abstract, [0001]. Figure 1 illustrates **Padhi**’s apparatus, which includes **pre-processing section 110**, **parameter extraction section 112**, **parameter comparison section 114**, and **display 148**. *Id.*, [0020]; *id.*, [0033]. *Kyriakakis*, ¶¶70-71.

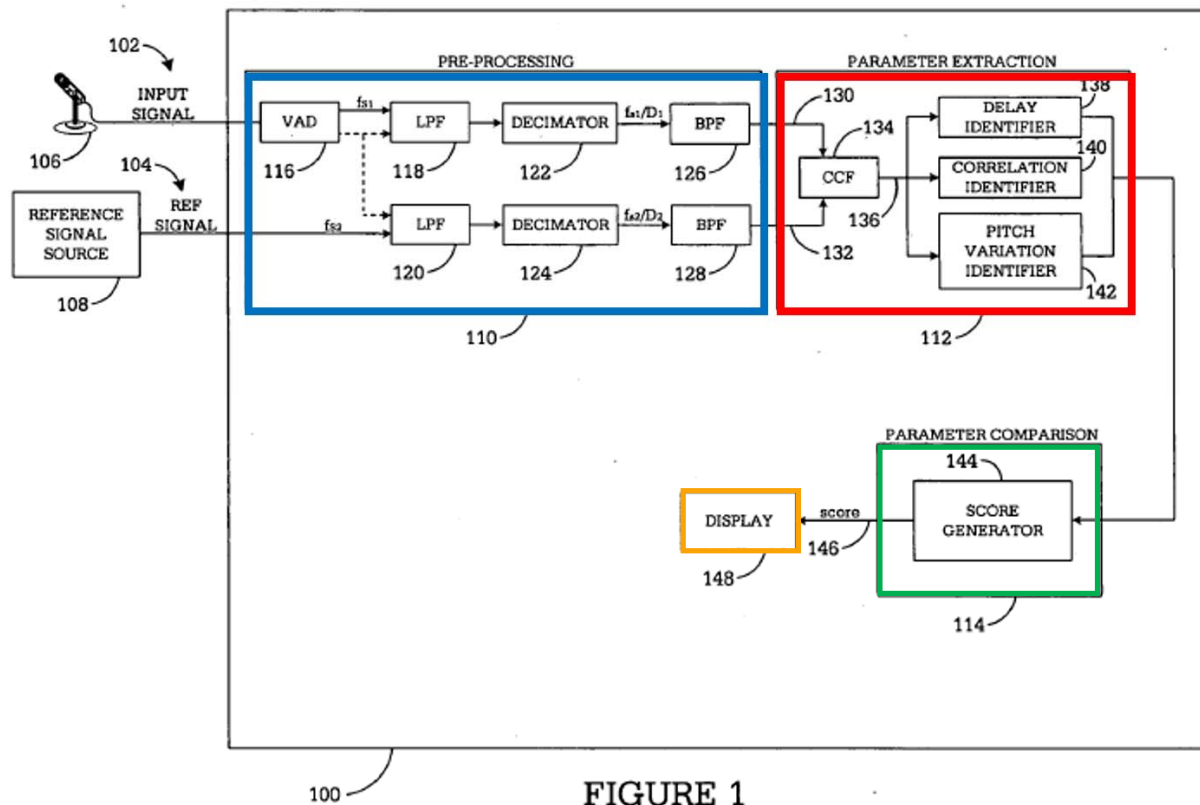


FIGURE 1

Padhi discloses the various components in Figure 1 “may represent software routines executed by one or more processors.” *Id.*, [0034]. Further, **Padhi** discloses “various changes may be made to Fig. 1,” and “[v]arious components can be omitted or combined and additional components can be added according to particular needs.” *Id.*, [0035]. *Kyriakakis*, ¶¶72-73.

Padhi’s apparatus of Figure 1 receives input audio signal 102 via a microphone. *Id.*, [0018]. Reference signal 104 is supplied by a reference signal source. *Id.* The signals “could be replaced by any suitable audio signals provided by any suitable source or sources.” *Id.* Before performing cross-correlation, the

microphone and reference signals may be pre-processed via low pass filtering, decimating, and/or band pass filtering. *Id.*, [0023], [0025], [0071]. The apparatus cross-correlates the two signals to determine how much they match. *Id.*, [0017], [0027], [0028], [0030]. *Kyriakakis*, ¶¶74-76.

The amount of correlation between the signals is a component of an overall “score.” *Id.*, [0032]. The apparatus presents the score to an end user via a **display**. *Id.*, [0033]. **Padhi** discloses more details regarding an example technique for generating a score in Figure 6. *Id.*, [0069]-[0079]. *Kyriakakis*, ¶¶77-79.

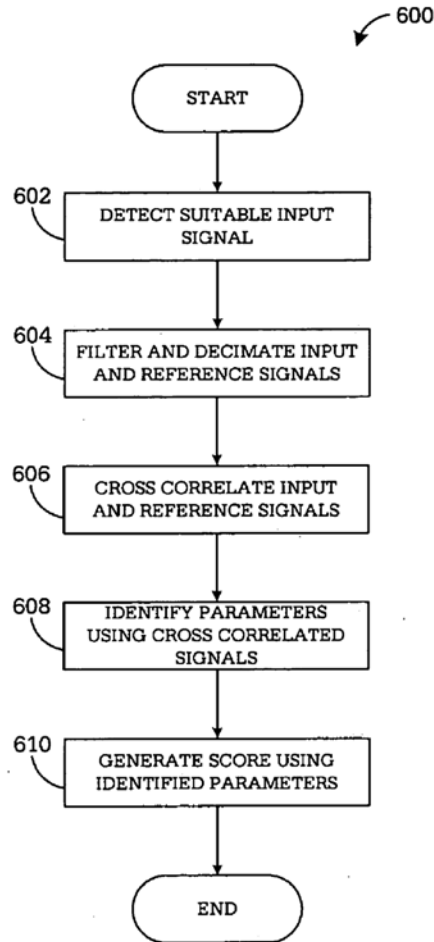


FIGURE 6

Padhi, Fig. 6.

3. Motivation to apply *Padhi*'s teachings to *Epley*

Padhi and **Epley** are analogous prior art, in the same field as the '493, which includes audio systems, and are reasonably pertinent to alleged problems addressed by the '493 of comparing signals for audio applications. *E.g.*, '493, 3:32-37; *Epley*, [0070]; *Padhi*, [0032], Fig. 1; '493FH at 228 (recognizing *Padhi* as "pertinent art"). For example, **Padhi** is directed to techniques for comparing the

similarity of two audio signals (Padhi, [0001], [0004]-[0006]), which is pertinent to the acoustic seal analysis problem addressed by the '493 because—as references like **Epley** disclose—assessing acoustic seal involves determining the similarity of audio signals. *Epley*, [0070]. *Kyriakakis*, ¶80.

A POSITA would have been motivated to apply **Padhi's** comparison of a reference signal and microphone signal through “cross-correlation” to obtain a value α to **Epley's** audio device for several reasons. First, **Epley** leaves the details of its “comparison of input and output sound parameters” for its seal test to the POSITA to implement, and a POSITA would have been motivated to look to analogous art—including **Padhi**—for how to carry out such comparison. *Epley*, [0070]; *Padhi*, [0027]. In fact, the Examiner in the *EPR* of parent '836 patent found **Padhi's** cross-correlation applicable to a seal test and cross-correlation “was a notoriously well-known method of comparing audio signals at the time of the invention.” EX1014, 28. Second, **Padhi** explains its cross-correlation technique improves over other audio signal comparisons, “which do[] not provide an accurate comparison of the actual contents of the signals” and “are often computationally intensive.” *Padhi*, [0003]. Third, **Padhi's** comparison of a reference signal and input signal is directly applicable to **Epley's** comparison of a “known sound” (“output parameter”) and “the acoustic response...picked up by the microphone”

(“input parameter”). *See, e.g., Padhi*, [0027]-[0029]; *Epley*, [0070]. *Kyriakakis*, ¶¶81-85.

Thus, a POSITA would have found it routine, straightforward and advantageous to apply **Padhi’s** teachings of cross-correlating a reference signal and an input signal to **Epley’s** teachings of a comparing a known sound with a microphone signal, and would have known such a combination (yielding the claimed limitations) would predictably work and provide the expected functionality. *Kyriakakis*, ¶86.

4. Overview of Voix

Voix teaches “an apparatus for assessing in situ an acoustic seal of an in-ear device.” *Voix*, [0092]. The apparatus includes “sound source 24 provid[ing] a sound typically having a frequency range varying from about 100 Hz to about 10000 Hz.” *Voix*, [0100]. *Kyriakakis*, ¶87.

To assess an acoustic seal, “a first sound level outside the ear canal” and “a second sound level inside the ear canal” are measured, and the second sound level is subtracted from the first sound level. *Voix*, [0036]. *Kyriakakis*, ¶88.

Voix teaches “indicating presence of acoustic seal when attenuation between said first and second sound levels is equal to or larger than a predetermined threshold value within a predetermined frequency range.” *Voix*, [0039]. *Kyriakakis*, ¶89.

5. Motivation to apply *Voix*'s teachings to *Epley* and *Padhi*

Like **Epley** and **Padhi**, **Voix** is analogous prior art and in the same field of acoustic devices as the '493, and is reasonably pertinent to alleged problems addressed by the '493 of comparing signals for audio applications. *E.g.*, '493, 3:32-37; **Voix**, [0036], [0044], [0050]. *Kyriakakis*, ¶¶90-91.

A POSITA would have been motivated to apply **Voix**'s seal test signal frequency range of 100 Hz to 10,000 Hz to **Epley**'s audio system (as modified by **Padhi**'s cross-correlation teachings) for several reasons. First, while **Epley** discloses “applying a known sound” in seal assessment, **Epley** leaves the particular frequencies of the known sound to the POSITA. *Epley* [0070]. A POSITA would have been motivated to look to other art—including **Voix**—to identify a suitable sound frequency. *Kyriakakis*, ¶92.

Second, **Voix** explains “sound typically having a frequency range varying from about 100 Hz to 10,000 Hz” produces “preferred octave bands which enclose most audible sounds.” *Voix* [0100]. Thus, a POSITA would have recognized this frequency range ensures the seal is tested for frequencies that impact user experience. Moreover, **Epley** teaches its speaker emits audio in the range “20 Hz and 8 kHz or perhaps even twice the upper limit,” *i.e.*, 20 Hz to 16,000 Hz, encompassing **Voix**'s test signal frequency range. *Epley*, [0074]. Thus, **Epley**'s

speaker produces a “known sound” with a signal frequency range of “100 Hz to 10,000 Hz.” *Kyriakakis*, ¶93.

A POSITA would have been motivated to apply **Voix’s** comparison of a value to a threshold when checking seal quality to the audio system taught by **Epley** in view of **Padhi** to determine when to send a “warning” to the user. *Kyriakakis*, ¶94. **Epley** describes a “**display**” “produces a warning to the operator” in response to a “comparison” as part of a seal test, but does not disclose what triggers this “warning.” *Epley*, [0070]; *Kyriakakis*, ¶94. Thus, a POSITA would have been motivated to look to other art—including **Voix**—to determine when to elicit a “warning.” *Kyriakakis*, ¶94; EX1016, 10:17-20 (sending warning when threshold exceeded). **Voix’s** teaching the “presence of acoustic seal when attenuation...is equal to or larger than a predetermined threshold value” indicates a warning of low seal quality is provided if the value is below the threshold. *Voix*, [0039]; *Kyriakakis*, ¶95. A POSITA would have further understood comparing a value (in particular, **Padhi’s** α) to a threshold would be predictably implemented. *See Padhi*, [0078] (describing comparison of α (based on its cross-correlation calculation) to a threshold). *Kyriakakis*, ¶¶95-96.

Further, a POSITA would have been motivated to apply **Voix’s** “silicone” composition to the audio system taught by **Epley** in view of **Padhi** for **Epley’s** “ear-canal-easy-cushion.” *Epley*, [0065]; *Voix*, [0099]. **Epley** describes “probes

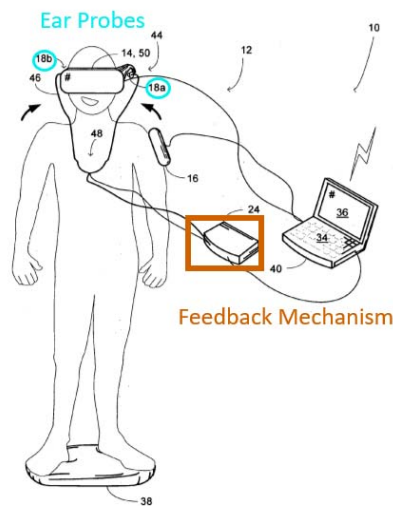
18 a/b” including “earpiece 70” “configured to be inserted into a subject's ear,” and discloses “earpiece 70 is configured to have an ear-canal-easy cushion,” but **Epley** leaves the material of the “cushion” to the POSITA. *Epley*, [0004], [0065]. A POSITA would have been motivated to look to other art—including **Voix**—and would have recognized earpieces are “typically made out of generally soft materials such as silicones.” *Voix*, [0099]. *Kyriakakis*, ¶97.

Thus, a POSITA would have had a reasonable expectation of success in applying **Voix**’s teachings of a test signal with a frequency ranging from 100-10,000 Hz, a threshold comparison to determine seal quality, and silicone ear tips to **Epley**’s device (using *Padhi*’s cross-correlation teachings) and would have known such a combination (yielding the claimed limitations) would predictably work and provide the expected functionality. *Kyriakakis*, ¶98.

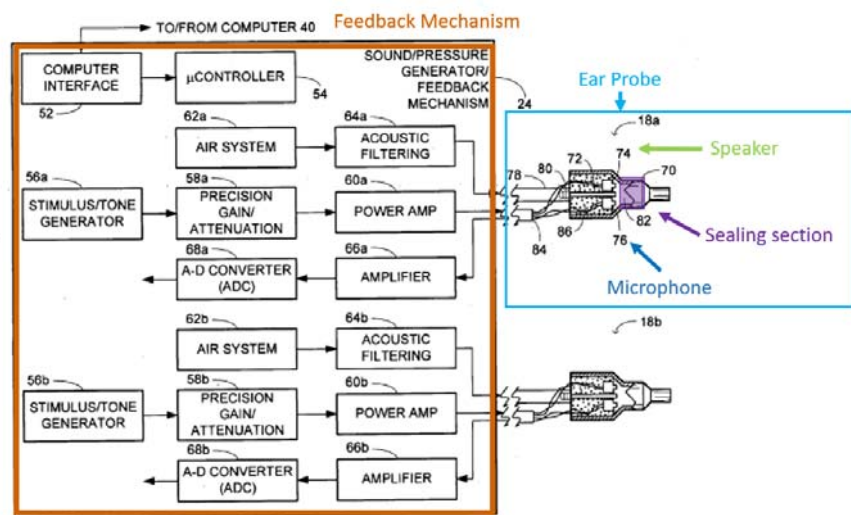
6. Claim Chart – *Epley* in view of *Padhi* and *Voix*

Claim Elements	Ground 1: <i>Epley</i> in view of <i>Padhi</i> and <i>Voix</i> .
[1.pre]: An audio device configured to test a seal of an earphone comprising	To the extent the preamble is limiting, Epley discloses an audio device (<i>e.g.</i>, “sound and pressure generator and feedback mechanism 24”) configured to test a seal of an earphone (<i>e.g.</i>, “determine whether the ear probe is properly sealed”). <u>E.g., Epley:</u> Epley discloses “sound and pressure generator and feedback mechanism 24” “determine[s] whether the ear probe is properly sealed.” <i>Kyriakakis</i>, ¶¶99-105.

• Fig. 2



• Fig. 3



- [0051] (“[E]ar probes 18 include...an umbilical cord feeding sound...from sound and pressure generator 24”)
- [0029] (“[S]ound and pressure generator 24 can be battery operated and can be separate from computer 40 or integrated therein....”)
- [0061] (“FIG. 3 is a detailed schematic diagram of *sound and pressure generator and feedback mechanism 24*.”)
- [0070] (“[M]icrophone 76, amplifier 66a/b and ADC 68a/b that form part of *the feedback mechanism* are used...to ensure *proper sealing of left and right ear probes*.... This is

	accomplished, for example, <i>by applying a known</i> sound and volume and measuring the acoustic response.... A straightforward comparison of input and output sound parameters <i>determine whether the ear probe is properly sealed</i> and further testing is avoided if the seal is not secure.”)
[1.1]: a memory that stores instructions; and	Epley discloses a memory (e.g., “memory,” “ROM”) that stores instructions (e.g., “instructions being stored”). <u>E.g., Epley:</u> Epley discloses feedback mechanism 24 includes microcontroller 54 using “read-only memory (ROM),” and more generally the functionality is implemented by a “computer program in the form of instructions residing in a memory.” Kyriakakis, ¶¶106-109. • [0061] (“Generator/feedback mechanism 24 includes...microcontroller (μCONTROLLER) 54.... [M]icrocontroller 54 can implement a state machine or other flow control mechanism that is...<i>firmware-controlled (e.g. as by use of a read-only memory (ROM))....</i>”) • [0099] (“<i>[T]he method, system and apparatus of the invention may be implemented by a computer or microprocessor process in which instructions are executed, the instructions being stored for execution on a computer-readable medium</i> and being executed by any suitable instruction processor.”) • See also [0006].
[1.2]: a processor, wherein the processor is configured to execute the instructions to perform operations, the	Epley discloses a processor (e.g., “processor” or “microcontroller”) is configured to execute the instructions to perform operations (e.g., “instructions...for execution”; see [1.1]). <u>E.g., Epley:</u> Epley further discloses the functionality in its system (including the feedback mechanism 24 and its functionality described below) is “implemented by a computer or microprocessor process in which instructions are executed.” [0099]. The processor is implemented as “microcontroller 54” ([0061]), controlling operations performed by the

operations comprising:

components inside “feedback mechanism 24...to ensure proper sealing of the left and right ear probes.” [0070]. Thus, Epley’s processor is configured to execute instructions to perform the operations including those described in elements [1.2.1]-[1.2.7], and in dependent claims described below. Moreover, as described below, to the extent the “processor” limitation is subject to §112(f), **Epley** discloses the ’493’s disclosed algorithm. *Kyriakakis*, ¶¶110-116.

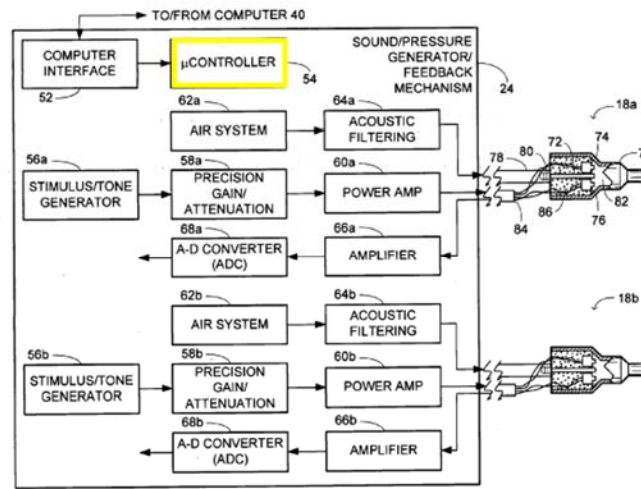


Fig. 3

- [0061] (“**Generator/feedback mechanism 24** includes...microcontroller (μCONTROLLER) 54....
[M]icrocontroller 54 is programmed to provide control and monitoring interconnections with the remaining functional blocks to be described below, although for the sake of clarity no such operative interconnections are shown. For example, **microcontroller 54** can implement a state machine or other flow control mechanism that is...firmware-controlled (e.g. as by use of a read-only memory (ROM)...”)
- [0070] (“**[F]eedback mechanism...used in accordance with one embodiment of the invention to ensure proper sealing of left and right ear probes. 18 a and 18 b.**”)
- [0099] (“**[T]he method, system and apparatus of the invention may be implemented by a computer or microprocessor process in which instructions are executed**, the instructions being stored for execution on a computer-readable medium and **being executed by any suitable instruction processor.**”)

[1.2.1]: generating a test signal,	Epley discloses instructions (see [1.2]) for generating a test signal (e.g., “applying a known sound”/“output sound parameter[]” to “determine whether the ear probe is properly sealed”). <u>E.g., Epley:</u> See [1.2]. Epley further discloses “applying a known sound” to “determine whether the ear probe is properly sealed.” [0070]. A POSITA would have understood a “known sound” for purposes of making a determination is a test signal, and to “apply[]” such a test signal requires generating the test signal. [0070]. Epley further discloses “stimulating one or more of a subject’s ears with sound...by executing in a suitable processor instructions that [are] stored in memory.” [0093]. A POSITA would have thus understood (and at least found it obvious) the processor executes instructions for generating the “known sound.” Kyriakakis, ¶¶117-121. In the same way, the ’493 algorithm step 304 requires “test signal...generated by a microprocessor.” ’493, 8:6-8. Kyriakakis, ¶¶117-125. • [0062] (“<i>[S]timulus/tone generator 56a</i>, precision gain/attenuation device 58a and power amp 60a <i>producing programmed sound levels, tonal qualities and dynamics....</i>”) • [0070] (“[M]icrophone 76, amplifier 66a/b and ADC 68a/b that <i>form part of the feedback mechanism are used...to ensure proper sealing of left and right ear probes. 18a and 18b.</i> This is accomplished, for example, by <i>applying a known sound</i> and volume and measuring the acoustic response within the subjects ear as picked up by the microphone. A straightforward comparison of input and <i>output sound parameters determine whether the ear probe is properly sealed....</i>”) • See also [0093]
[1.2.1.1]: wherein the test signal includes multiple frequency components	Voix discloses the test signal (e.g. “first sound level...submitted to a sound source 24”) includes multiple frequency components (e.g., “sound typically having a frequency range”), wherein at least one component lies between a range of 30 Hz and 200 Hz (e.g., “100 Hz to about 10000 Hz”). <u>E.g., Voix:</u>

, wherein at least one component lies between a range of 30 Hz and 200 Hz;	<i>Voix</i> discloses “a method for assessing in-situ an acoustic seal of an in-ear device” including “measuring a first sound level...submitted to sound source 24,” and “broadband reference sound source 24...provides a sound typically having a frequency range varying from about 100Hz to about 10000Hz.” [0036], [0100]. A POSITA would have understood a sound with a frequency range includes multiple frequency components. <i>Kyriakakis</i>, ¶¶126-130. This is consistent with the ’493’s disclosure of a signal with multiple frequency components. ’493, 15:43-46 (referring to “a frequency range of the test signal”). As discussed in §IX.A.5, a POSITA would have been motivated to apply <i>Voix</i>’s teachings of a test signal range to <i>Epley</i>’s feedback mechanism. <i>Kyriakakis</i>, ¶¶126-132. • [0036] (“[A] <i>method for assessing in-situ an acoustic seal of an in-ear device</i>...said method comprises: ...b) <i>measuring a first sound level</i> outside the ear canal with said sound measurement device <i>when submitted to the sound source</i>...”) • [0100] (“The apparatus 10 typically includes a controller unit 22 operatively connected to a broadband reference <i>sound source 24</i> to control operation thereof. The <i>sound source 24</i> provides a sound typically having a frequency range varying from about 100 Hz to about 10000 Hz such that the following preferred octave bands which enclose most audible sounds are essentially covered: 125 Hz....”) • See also [0092].
[1.2.2]: sending the test signal to a speaker of an earphone,	Epley discloses instructions (see [1.2]) for sending the test signal (e.g., “applying a known sound” as “output sound parameter”) to a speaker (e.g., “speaker 74”) of an earphone (e.g., “ear probe[] 18a”). <u>E.g., Epley:</u> See [1.2]. Epley further discloses “applying a known sound” (or “output sound parameter”) to “ear probe 18a.” [0070]. Epley further discloses “stimulating one or more of a subject’s ears with sound...by executing in a suitable processor instructions that [are] stored in memory.” [0093]. A POSITA would have understood (and at least found it obvious) that to apply a “known sound” such that the “acoustic

response” is “picked up by the microphone,” the signal is played by “speaker 74” of “ear probe 18a,” based on instructions in the processor. In the same way, the ’493 algorithm step 306 requires “test signal is provided to the acoustic transducer [speaker].” ’493, 8:9-10. Kyriakakis, ¶¶133-144.

• Fig. 3

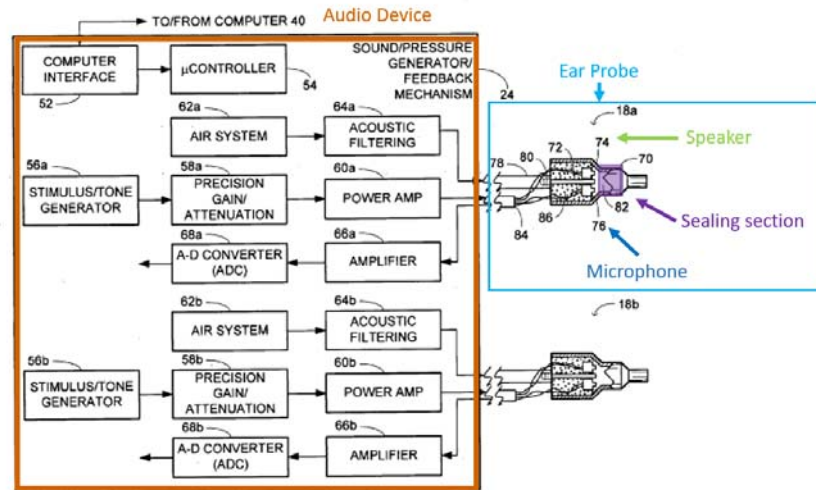


Fig. 3

- [0064] (“*Left ear probe 18 a includes...a miniature speaker (referred to in the audiology literature as a “receiver”) 74....*”)
- [0070] (“[M]icrophone 76, amplifier 66a/b and ADC 68a/b that form part of the feedback mechanism are...*ensure proper sealing of left and right ear probes. 18a and 18b. This is accomplished, for example, by applying a known sound and volume and measuring the acoustic response within the subjects ear as picked up by the microphone. A straightforward comparison of input and output sound parameters determine whether the ear probe is properly sealed....*”)
- [0093] (“The method further includes a) at 604, stimulating one or more of a subject's ears with sound.... *[A]t least the stimulating and the monitoring steps 604 and 606 (along with the looping or repeating step 608) are computer-assisted, e.g. accomplished by executing in a suitable processor instructions that stored in memory.*”)

[1.2.3]:
wherein the

Epley discloses the earphone (e.g., “ear probe 18a”) includes a first microphone (e.g., “microphone 76”), the speaker (e.g., “speaker 74”),

earphone includes a first microphone, the speaker, and a sealing section, and wherein the sealing section is configured to form an acoustic barrier between a first side of the earphone and a second side of the earphone when the earphone is worn by a user	and a sealing section (e.g., “earpiece 70”) to form an acoustic barrier between a first side of the earphone (e.g., inside “ear canal”) and a second side of the earphone (e.g., outside “ear canal”) when the earphone is worn by a user (e.g., “sealingly engage” for “continuously sealed acoustic engagement with the subject’s ear canals”). <u>E.g., Epley:</u> Epley discloses “ear probe 18[a/b]” includes a first “microphone 76,” the “speaker 74,” and “earpiece 70,” where “earpiece 70 is configured to have an ear-canal-easy cushion.” [0065] The probe with earpiece 70 “sealingly engage[s] the subject’s right and/or left ear canal walls” for “continuously sealed acoustic engagement with the subject’s ear canals,” as confirmed by the shape of earpiece 70 illustrated in Fig. 3. To the extent other components of ear probe 18a are also involved in sealing, they are also part of the claimed “sealing section.” Such acoustic sealing engagement with the ear canal walls creates a barrier between inside and outside of the ear, <i>i.e.</i>, between two sides of the ear probe 18[a/b]. Moreover, use of a “known sound” to test the seal only works if the sealing engagement creates an “acoustic” barrier. Kyriakakis, ¶¶133-144. • [0004] (“<i>[E]ach probe is configured to be inserted into a subject's ear in an operational alignment with the subject's ear canal and sealing engagement with the wall of the subject's ear canal....</i>”) • [0017] (“<i>[E]ar probes sealingly engage the subject's right and/or left ear canal walls and operate to convey aural pressure or sound thereto, as will be seen.</i>”) • [0042] (“Those of skill in the art also will appreciate that providing bilateral ear stimulus devices within the headgear that forms a part of the invented system and apparatus <i>makes testing more repeatable and standardized because the stimulus devices</i> automatically, reliably (and <i>sealingly, in the case of the insertable ear probes 18</i> described and illustrated herein) <i>seat themselves within the subject's corresponding ear canals</i> once and for the duration of a complete test session.”)
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- [0065] (“[A]ir tube 72, *speaker 74* and *microphone 76* are *secured within earpiece 70* by potting compound 86.... Those of skill in the art will appreciate that *earpiece 70 is configured to have an ear-canal-easy cushion*, not shown, slipped over its distal end for the comfort of a test subject.”)
- [0070] (“Those of skill in the art will appreciate that *microphone 76*...form part of the feedback mechanism are used...to ensure *proper sealing of left and right ear probes. 18a and 18b*. This is accomplished, for example, by *applying a known sound* and volume and measuring the acoustic response within the subjects ear as picked up by the *microphone*.... Thus a first use for this circuitry is during *placement of the headset on the subject and during testing of the subject to ensure initial and continuously sealed acoustic engagement with the subjects ear canals.*”)
- Fig. 3

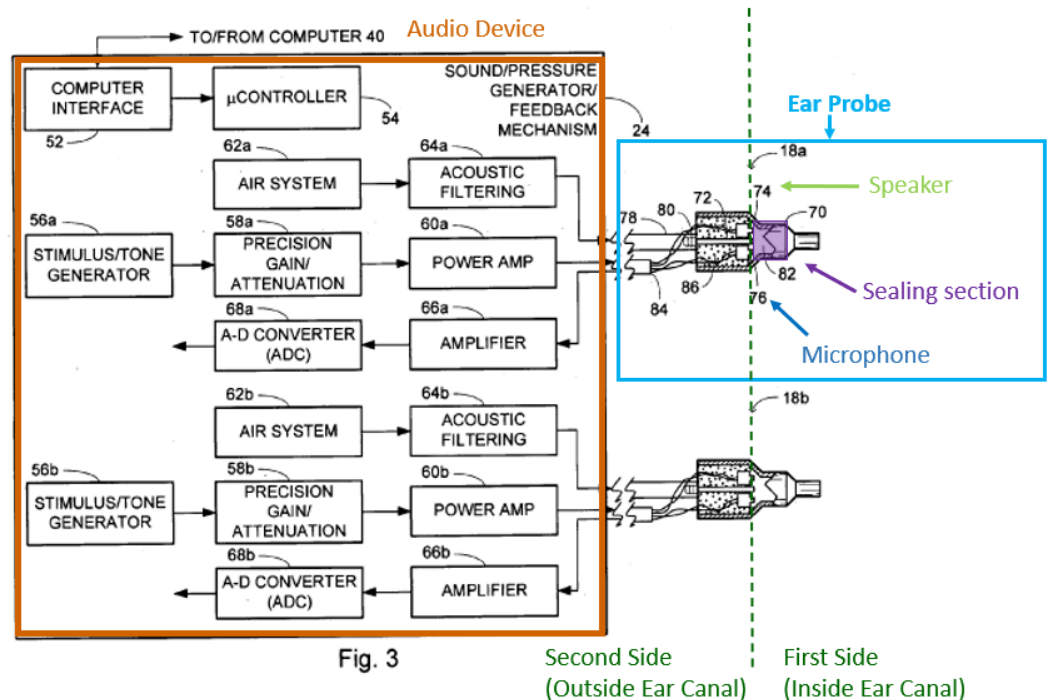


Fig. 3

[1.2.4]:
receiving a
first

Epley discloses instructions (see [1.2]) for receiving a first microphone signal from the first microphone (e.g., “measuring the

microphone signal from the first microphone ;

acoustic response within the subject's ear as picked up by the microphone,"; "input...sound parameter" from "microphone 76").

E.g., Epley:

See [1.2]. Epley further discloses "microphone 76" "pick[s] up" "the known sound," "measur[es] the acoustic response within the subject's ear," and provides this as an "input...sound parameter" to feedback mechanism 24 via "wiring harness 84" as illustrated in Fig. 3. In the same way, the '493 algorithm step 308 requires "acquir[ing] internal acoustic field with...ECM," and the processor receives the signal from the ECM. '493, 8:58-60, Fig. 3. Kyriakakis, ¶¶145-152.

• Fig. 3

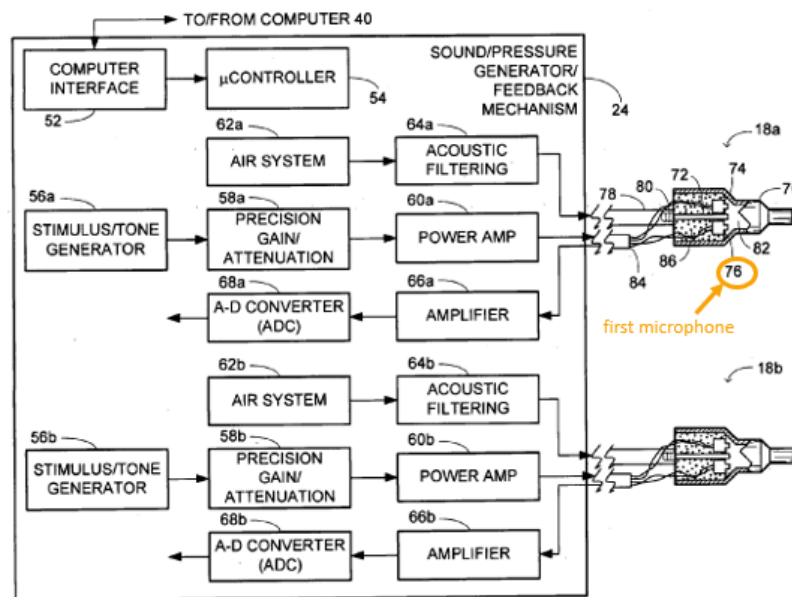


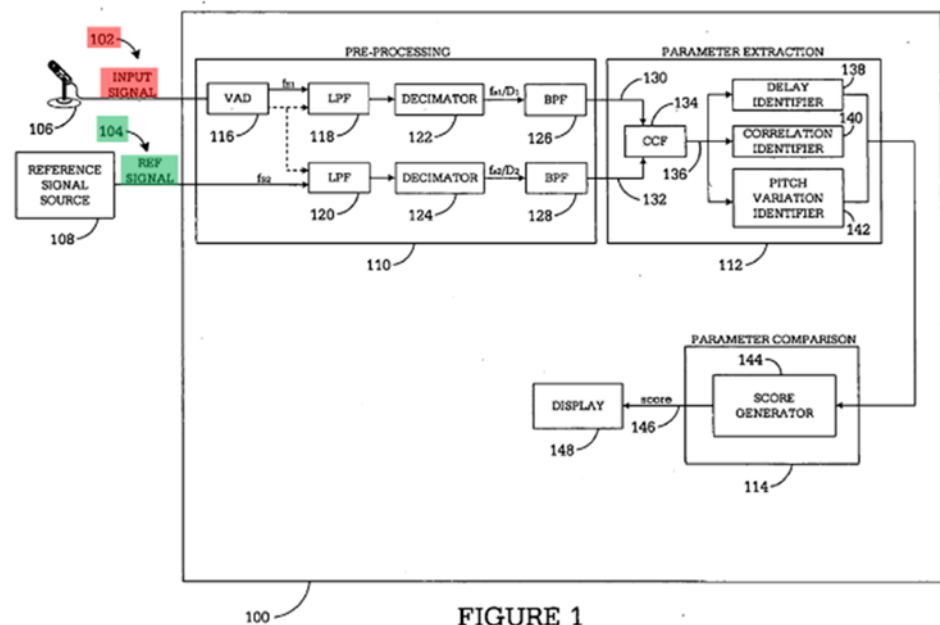
Fig. 3

- [0070] ("*[M]icrophone 76...measuring the acoustic response within the subjects ear as picked up by the microphone. A straightforward comparison of **input** and output **sound parameters** determine whether the ear probe is properly sealed....*")
- [0064] ("*Speaker 74 and **microphone 76** are respectively connected to power amp 60 a/b and amplifier 66 a/b via a wiring harness 84 containing at least two signal wire pairs, e.g. twisted signal wire pairs, as shown.*")

[1.2.5]: calculating a value, using a first signal and a second signal, wherein the value is the result of a non phase calculation of at least one of a coherence, a correlation, a cross-correlation, a difference, or a combination;	Epley discloses instructions (see [1.2]) for comparing a first signal and a second signal (e.g., “comparison” of the “known sound” and “acoustic response...as picked up by the microphone”). <u>E.g., Epley:</u> See [1.2]. Epley further discloses “comparison” of the “known sound” and “acoustic response...as picked up by the microphone.” <i>Kyriakakis</i>, ¶¶153-157. • [0070] (“[M]icrophone 76, amplifier 66a/b and ADC 68a/b that form part of the feedback mechanism are used...to ensure proper sealing of left and right ear probes. 18a and 18b. This is accomplished, for example, by <i>applying a known sound and volume and measuring the acoustic response</i> within the subjects ear <i>as picked up by the microphone. A straightforward comparison of input and output sound parameters determine whether the ear probe is properly sealed</i> and further testing is avoided if the seal is not secure.”) Padhi discloses calculating a value (e.g., “value α”) using a first signal and a second signal (e.g., “input signal 102 and reference signal 104”), wherein the value is the result of a non phase calculation of at least one of a coherence, a correlation, a cross-correlation, a difference, or a combination (e.g., “cross-correlation”). <u>E.g., Padhi:</u> Padhi discloses calculating a “value α” using “input signal 102 and reference signal 104,” wherein α is the result of a “cross-correlation.” <i>Padhi</i>, [0074], [0078]; <i>Kyriakakis</i> ¶¶158-161. Regardless of how this limitation is interpreted, Padhi’s cross-correlation teaches or at minimum renders obvious a non-phase calculation when performed on the multi-frequency component test signal and microphone signal as taught by Epley in view of Voix (see [1.2.1.1]). <i>Kyriakakis</i>, ¶162. To the extent PO takes the position cross-correlation is a non-phase calculation, Padhi discloses this. <i>Id.</i> To the extent a non-phase calculation is interpreted to require a calculation performed on two signals without phase, this is disclosed or at least rendered
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obvious. *Id.* For example, Epley leaves it to a POSITA to determine what “known signal” to use, and one example of a known test signal was a “pseudorandom sequence,” which a POSITA would have understood to not have a phase and to be included as a “known signal.” *Id.*; *Svean* 12:38-48; 12:51-13:5 (disclosing a “pseudorandom sequence” as test signal). Further, because the microphone signal includes the pseudorandom test signal and random background sound, it also has no phase. *Kyriakakis*, ¶162. A POSITA would have been motivated to use such a test signal because this was one known technique of implementing a known sound, testing with a pseudorandom sequence is advantageously immune to background noise, and would have yielded predictable results. *Id.* As discussed in §IX.A.3, a POSITA would have been motivated to apply **Padhi’s** teachings of comparing audio signals through cross-correlation to **Epley’s** seal analyzer. In the same way as obtained through applying **Padhi’s** cross-correlation to **Epley’s** seal analyzer, the ’493 algorithm step 310 requires “[d]etermin[ing] degree of acoustic sealing via cross-correlation of test signal with ECM signal.” ’493, Fig. 3; *Kyriakakis*, ¶163-164.

- Fig. 1



- [0017] (“In one aspect of operation, the apparatus 100 receives audio signals, such as an input signal 102 and a reference signal

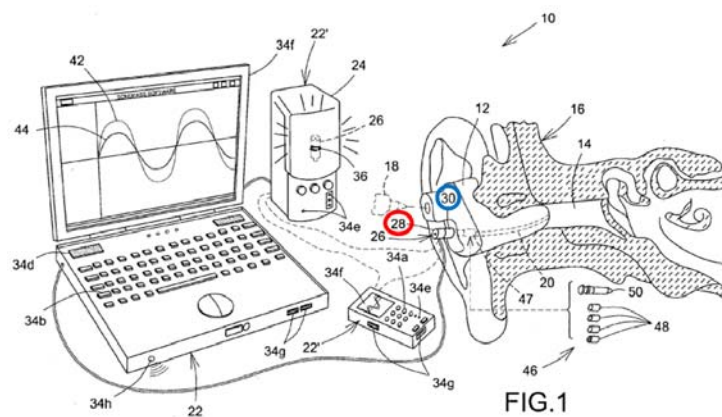
	104. The apparatus 100 <i>cross-correlates the audio signals and uses the cross correlation to identify various characteristics or parameters of the audio signals.</i>”) • [0072] (“<i>The apparatus 100 cross-correlates the processed signals at step 606....</i>”) • [0073] (“<i>The apparatus 100 identifies a plurality of parameters using the cross-correlated signals at step 608. This may include, for example, the identifiers 138-142 using the cross-correlated signal 136 to identify a delay between the signals 130, 132, an amount of correlation between the signals 130, 132, and a pitch variation between the signals 130, 132. Other or additional parameters could also be identified.</i>”) • [0074] (“<i>The apparatus 100 uses the identified parameters to generate a score at step 610. The score identifies the extents to which the signals 102, 104 match. This may include, for example, the score generator 144 receiving the identified parameters from the identifiers 138-142 and generating the score using the parameters.</i>”) • [0077] (“...[T]he score generator 144 <i>generates a value α using the information from the delay identifier 138 and the correlation identifier 140....</i>”) • See also [0018], [0071], [0078]-[0082].
[1.2.6]: comparing the value to a threshold to determine a seal quality between the first side and the second side;	Epley discloses instructions (see [1.2]) for determining a seal quality between the first side and the second side (e.g., “determine whether the ear probe is properly sealed”). <u>E.g., Epley:</u> See [1.2]. Epley further discloses “determin[ing] whether the ear probe is properly sealed.” As noted above, the sealing is between the first and second sides. See [1.2.3]. Kyriakakis, ¶¶166-167. • [0070] (“A straightforward comparison of input and output sound parameters <i>determine whether the ear probe is properly sealed....</i>”) Voix discloses comparing a value to a threshold (e.g., determining whether “attenuation...is equal to or larger than a predetermined

threshold value”) **to determine a seal quality** (e.g., “assessing in-situ an acoustic seal”) **between the first side and the second side** (e.g., between “an external sound pressure level in proximity to the earplug 12” and “an internal sound pressure level inside the ear canal 14”).

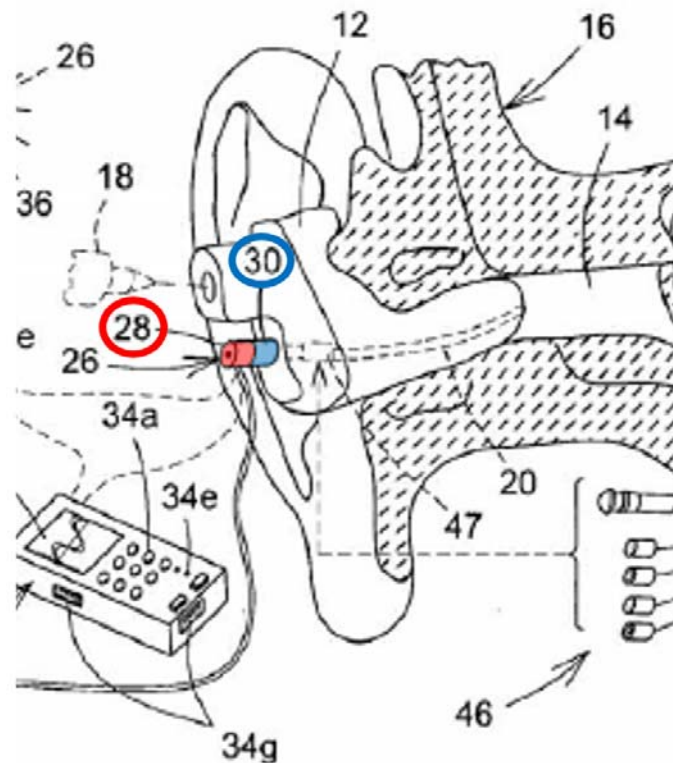
E.g., Voix:

Voix discloses comparing the “attenuation between the first and second sound levels” to a “predetermined threshold value,” for purposes of an “acoustic seal test.” [0140]. The “first and second sound levels” are collected from “microphones mounted in a back-to-back relationship relative to one another such that the first microphone 28 measures an external sound pressure level in proximity to the earplug 12 and the second microphone 30 measures an internal sound pressure level inside the ear canal 14.” [0100]. As discussed in §IX.A.5, a POSITA would have been motivated to apply **Voix’s** teachings of using a threshold to determine seal quality to **Epley’s** feedback mechanism. In the same way as obtained through applying **Voix’s** use of threshold to **Epley’s** seal analyzer, the ’493 algorithm step 416 requires “cross-correlation...is compared with the cross-correlation threshold value.” ’493, Fig. 3; *Kyriakakis*, ¶¶168-176.

- Fig. 1



- Fig. 1 (exploded)



- [0036] (“In accordance with an aspect of the present invention, there is provided a **method for assessing in-situ an acoustic seal** of an in-ear device ...”)
- [0100] (“A dual microphone probe 26 that is removably engageable into the passageway 20 of the earplug 12 operatively connects to the controller 22. **The probe 26 typically includes first 28 and second 30 sound measurement devices or microphones mounted in a back-to-back relationship relative to one another such that the first microphone 28 measures an external sound pressure level in proximity to the earplug 12 and the second microphone 30 measures an internal sound pressure level inside the ear canal 14** when the earplug 12 is inserted therein, respectively.”)
- [0140] (“**[I]ndicating presence of acoustic seal when attenuation between the first and second sound levels is equal to or larger than a predetermined threshold value** within a predetermined frequency range.”)
- See also [Abstract], [0039], [0043], [0147].

To the extent the Board finds “seal quality” is not binary in nature, it would have been obvious to use a non-binary seal quality to provide

	more information to a user. <i>See, e.g.</i>, EX1019, 2:45-51 (“To provide a conclusion as to the result of the test, the hearing aid emits a monitoring signal...produced in audible form, for example by emitting specific...tone combinations....”); <i>Kyriakakis</i>, ¶174.
[1.2.7]: generating a message to convey the seal quality; and sending the message to the user.	Epley discloses instructions (see [1.2]) for generating a message to convey seal quality and sending the message to the user (<i>e.g.</i>, “[t]he display produces a warning to the operator” regarding “whether the ear probe is properly sealed”). <u>E.g., Epley:</u> <i>See [1.2].</i> Epley further discloses a “display produces a warning to the operator” according to “whether the ear probe is properly sealed.” In the same way, the ’493 algorithm steps 416 and 420 send a message to a user indicating “PASS” or “FAIL” according to whether the cross-correlation is above or below the threshold. ’493, 9:48-52, 15:66-16:2; <i>Kyriakakis</i>, ¶¶177-182. • [0070] (“A straightforward comparison of input and output sound parameters <i>determine whether the ear probe is properly sealed</i> and further testing is avoided if the seal is not secure. <i>The display produces a warning to the operator.</i>”) • <i>See also</i> [0024]. To the extent the Board finds “seal quality” is not binary in nature, it would have been obvious to implement Epley to provide a non-binary “warning” conveying seal quality. <i>See</i> [1.2.6]. <i>Kyriakakis</i>, ¶180.
[3] The audio device according to claim 1, wherein the message is a visual message sent to a display of	<i>See [1].</i> Epley discloses the message (<i>e.g.</i>, “a warning to the operator”) is a visual message (<i>e.g.</i>, “presented”) sent to a display (<i>e.g.</i>, “display 36”) of the audio device (<i>e.g.</i>, “feedback mechanism 24/pressure generator 24” “integrated” in “computer 40”). <u>E.g., Epley:</u> Epley discloses “a warning to the operator” regarding “whether the ear probe is properly sealed” is “presented” on “display 36 of computer

the audio device.

40.” [0024], [0070]; Kyriakakis, ¶¶185-187. Epley further discloses “pressure generator 24” can be “integrated” in “computer 40,” such that the claimed audio device includes the computer 40. [0029]; Kyriakakis, ¶¶183-188.

- Fig. 2

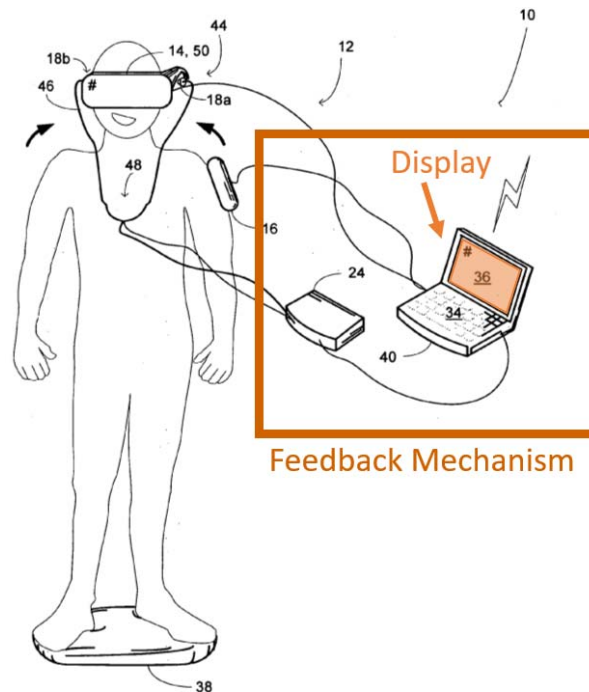
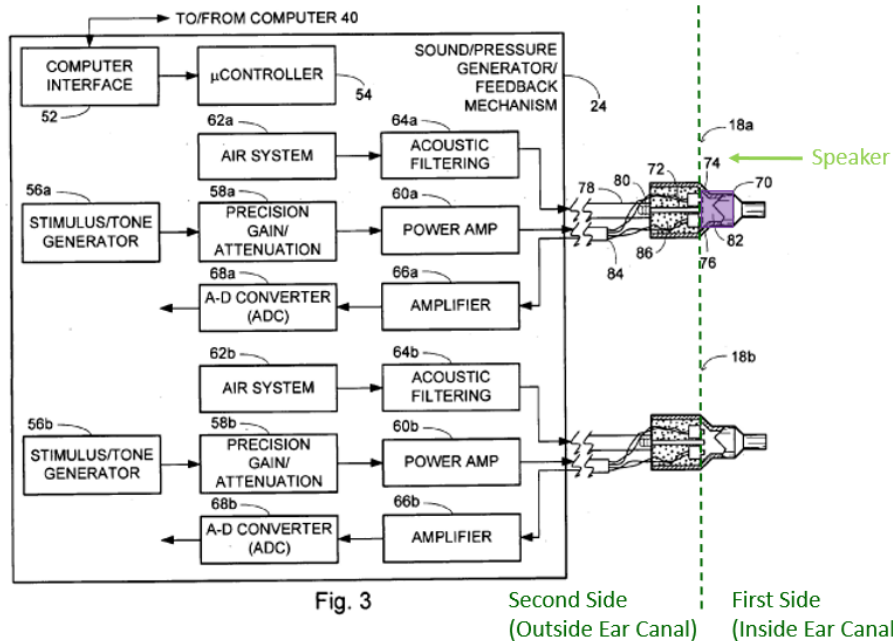


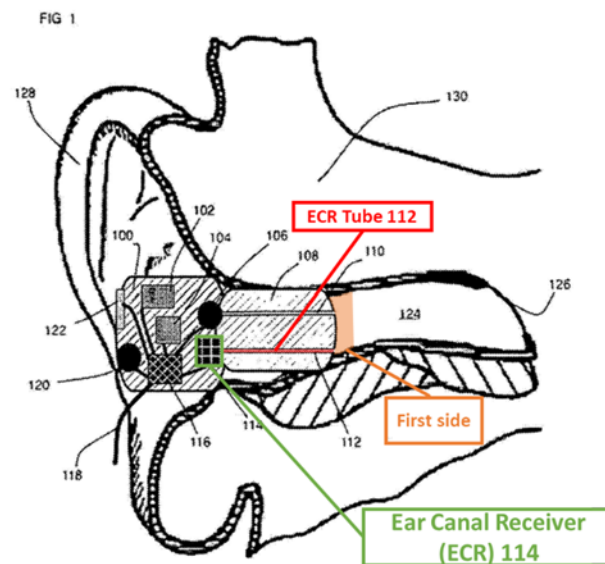
Fig. 2

- [0024] (“System 10 further includes a *display screen 36 to enable display and presentation of data, text and graphic representations of stimulus/response or other subject or test condition data to the operator.*”)
- [0029] (“*[S]ound and pressure generator 24 can be battery operated and can be separate from computer 40 or integrated therein....*”)
- [0060] (“More important, perhaps, *processed data can be presented in representational form on a display screen integral with the system* for instant analysis and detection by the operator or the machine (e.g. the computer), and for possible treatment.”)

	• [0070] (“A straightforward comparison of input and output sound parameters determine whether the ear probe is properly sealed and further testing is avoided if the seal is not secure. <i>The display produces a warning to the operator.</i>”)
[4] The audio device according to claim 1, wherein the speaker plays the test signal from the first side.	<i>See [1].</i> Epley discloses the speaker (e.g., “speakers 74”) plays the test signal (e.g., “known sound”) from the first side (e.g., inside “ear canal”). <u>E.g., Epley:</u> Epley discloses “speakers 74” ([0067]) playing the “known sound” ([0070]) is in the “earpiece 70” ([0065]), which has “sealing engagement with the wall of the subject’s ear canal.” [0004]. The “speaker 74” is used “to deliver sound...to the subject’s ears.” [0067] Kyriakakis, ¶¶189-193. • [0004] (“<i>[S]ealing engagement with the wall of the subject’s ear canal...</i>”) • [0065] (“[S]peaker 74 and microphone 76 are secured within earpiece 70...[E]arpiece 70 is configured to have an ear-canal-easy cushion...for the comfort of a test subject.”) • [0067] (“<i>[S]peakers 74</i> are used in accordance with the invention to <i>deliver sound</i> and/or pressure stimuli <i>to the subject’s ears.</i>”) • [0070] (“This is accomplished, for example, by <i>applying a known sound</i> and volume and measuring the acoustic response <i>within the subject’s ear</i> as picked up by the microphone.”) • Fig 3



In the same way, '493 discloses "ECR 114 outputs an acoustic signal through ECR tube 112 and into ear canal 124." '493, 5:6-8; Kyriakakis, ¶¶192-193.



[5] The audio device according to claim 4, wherein the first

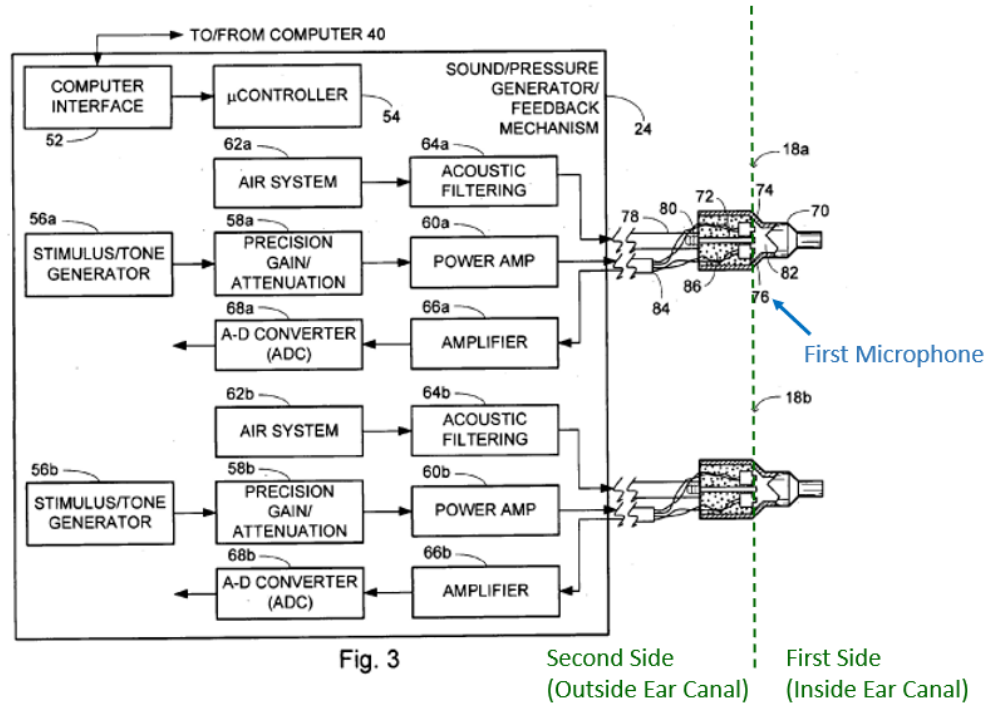
See [4].

Epley discloses the first microphone (e.g., “microphone 76” (see, [1.2.4]) **measures sound from the first side** (e.g., “measuring the acoustic response within the subject’s ear,” see [4]). Kyriakakis, ¶¶194-199.

microphone measures sound from the first side.

E.g., Epley:

- See [1.2.4], [4].
- Fig. 3 (annotated)

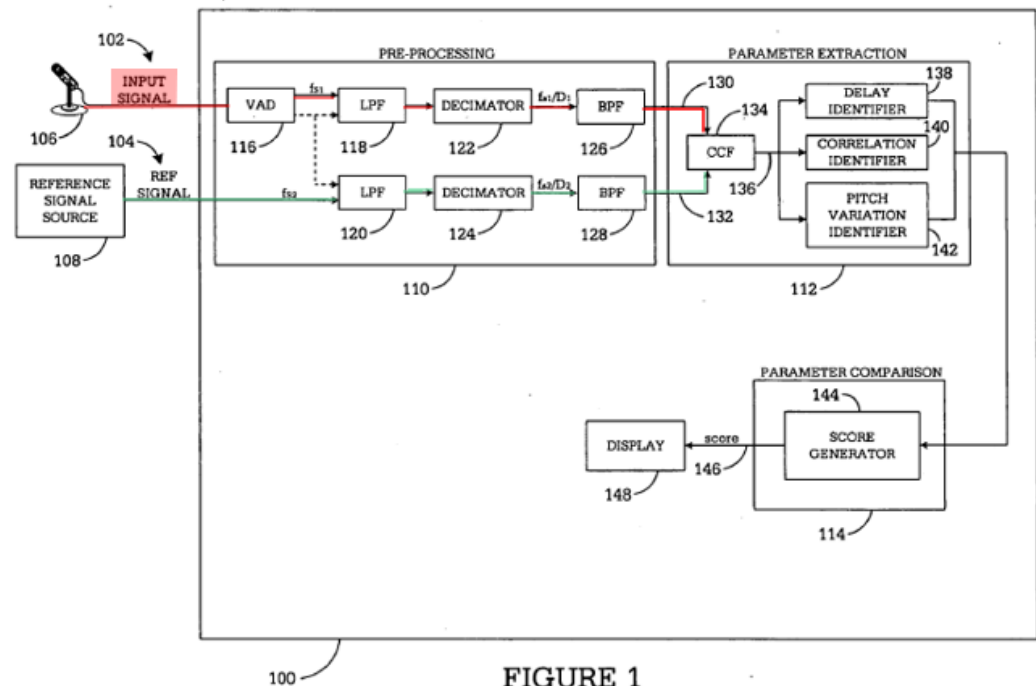


In the same way, '493 discloses "ECM 106 receives an acoustic signal present in ear canal 124 though ECM tube 110." '493, 5:9-11; Kyriakakis, ¶¶197-199.

	FIG 1
[7] The audio device according to claim 1, wherein the first signal is the test signal and the second signal is the first microphone signal.	See [1]. Epley discloses the first signal is the test signal (e.g., “known sound”) and the second signal is the first microphone signal (e.g. “acoustic response...picked up by the microphone”). <u>E.g., Epley:</u> Epley discloses a “comparison” of a “known sound” and an “acoustic response...picked up by the microphone” to “ensure proper sealing.” Kyriakakis, ¶¶200-202. • See [1.2.4] While Padhi teaches various modifications to the input audio signals before the cross-correlation is performed, Padhi’s modifications are consistent with the requirement that the microphone and test signals themselves be used because the value calculated as a result of cross-correlation is ultimately obtained “using” the original audio signals. Padhi, [0029]; Kyriakakis, ¶203. Even though <i>Padhi</i> illustrates cross-correlation function 134 is performed after passing through the pre-processing section 110, <i>Padhi</i> discloses using “cross-correlated signal 136 to identify characteristics associated with the input signal 102

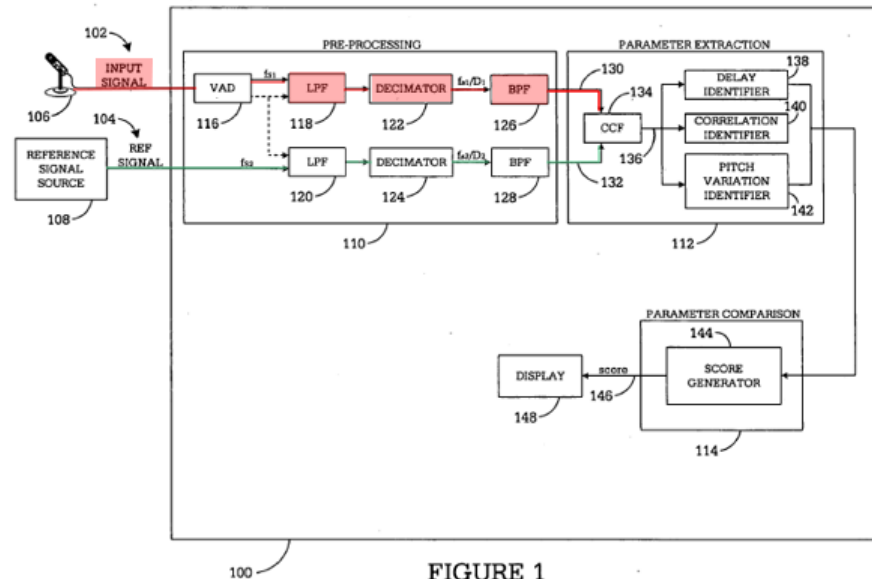
and/or the reference signal 104.” *Padhi*, [0029]. A POSITA would have understood that this is possible only because the cross-correlation calculation is performed using input signal 102. *Kyriakakis*, ¶¶203.

Regardless, to the extent the cross-correlation calculation must be directly performed on the test signal and first microphone signal without modification, it would have been a simple design choice to “omit[]” the pre-processing as it is not mandatory in *Padhi*. *Padhi*, [0035]; *Kyriakakis*, ¶¶204-205. There are no technical reasons why pre-processing must be performed, and making the substitution would have been routine and well within the skill level of a POSITA. *Kyriakakis*, ¶¶205-206. Moreover, a POSITA would have understood the advantages and tradeoffs of making the substitutions were predictable. *Kyriakakis*, ¶¶207-210. For example, omitting pre-processing would have the advantage of being more efficient/less computationally intensive, and any tradeoff would result in a straightforward design choice. *Arthrex, Inc. v. Smith & Nephew, Inc.*, 935 F.3d 1319, 1329 (Fed. Cir. 2019) (holding Board correctly found it “would have been an obvious design choice to a designer” to select between “two possible methods” disclosed in a reference) (quotations omitted). *Kyriakakis*, ¶¶203-211.



[8] The audio device of claim 1, wherein the first signal is the test signal and the second signal is a modified first microphone signal.	<i>See</i> [1]. Epley discloses the first signal is the test signal (<i>e.g.</i>, “known sound”) and the second signal is a first microphone signal (<i>e.g.</i>, “acoustic response...as picked up by the microphone”) <u>E.g., Epley:</u> Epley discloses a “comparison” of a “known sound” and an “acoustic response...picked up by the microphone” to “ensure proper sealing.” <i>See</i> [1.2.5]; <i>Kyriakakis</i>, ¶¶212-214. Padhi further teaches modifying (<i>e.g.</i>, via “filter 118,” “filter 126” and “decimator 122”) a microphone signal (“filtered signal,” [0045]). <u>E.g., Padhi:</u> Padhi discloses, when comparing a microphone signal with a reference signal, the microphone signal is modified by “filter 118,” “filter 126” and “decimator 122.” <i>Kyriakakis</i>, ¶215. As discussed in §IX.A.3, and [7], a POSITA would have been motivated to apply Padhi’s teachings of comparing audio signals through cross-correlation to Epley’s seal analyzer. <i>Kyriakakis</i>, ¶216. Moreover, Padhi describes the advantages of modifying a signal, including anti-aliasing of the signal, which would result in artifact-reduction. <i>Padhi</i>, [0023]-[0025]. <i>Kyriakakis</i>, ¶¶215-217. As discussed in [7], to the extent the cross-correlation calculation must be directly performed on the test signal without modification, it would have been a simple design choice to “omit[]” the pre-processing as it is not mandatory in Padhi. <i>See</i>, [7]. Moreover, a POSITA would have understood, while there are benefits to filtering and decimating the microphone signal because that signal is unpredictable, it would have been a simple design choice to generate the test signal (which would be a predictable signal) such that filtering and decimation are not required, and thus cross-correlation is performed directly on the unmodified test signal. <i>Kyriakakis</i>, ¶¶217-218. <u>E.g., Padhi:</u>
--	--

- See [7].
- Fig. 1



- [0023] (“In the pre-processing section 110, *the input signal 102 is supplied to a filter 118*, and the reference signal 104 is supplied to a filter 120... As a particular example, *the filters 118, 120 may represent anti-aliasing low pass filters*”)
- [0024] (“The *decimators 122, 124 decimate the input signal 102* and the reference signal 104, *which lowers the sampling frequency of the signals 102, 104.*”)
- [0025] (“*The filters 126, 128 filter the decimated input signal 102 and decimated reference signal 104.*”)

[10] The audio device of claim 1, wherein the first signal is a modified test signal

See [1].

Epley discloses the first signal is a test signal (e.g., “known sound”) and the second signal is the first microphone signal (e.g., “acoustic response”).

E.g., Epley:

and the second signal is the first microphone signal.

Moreover, **Epley** discloses a “comparison” of a “known sound” and an “acoustic response...picked up by the microphone” to “ensure proper sealing.” See [1.2.5]; *Kyriakakis*, ¶¶219-221.

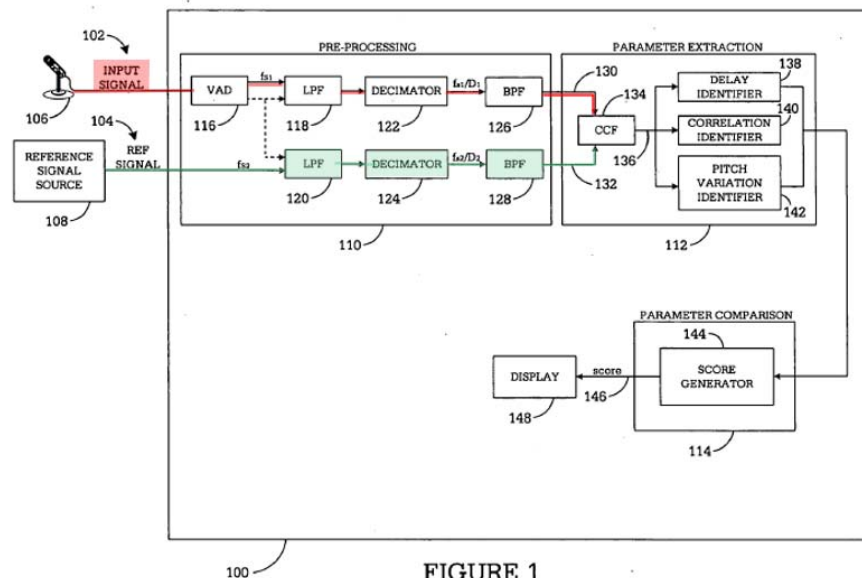
Padhi further teaches modifying (e.g., via “filter 120,” “filter 128” and “decimator 124”) a reference signal (“reference signal 104”).

E.g., Padhi:

Padhi discloses, when comparing a microphone signal with a reference signal, the microphone signal is modified by “filter 120,” “filter 128” and “decimator 124.” *Kyriakakis*, ¶¶222-224.

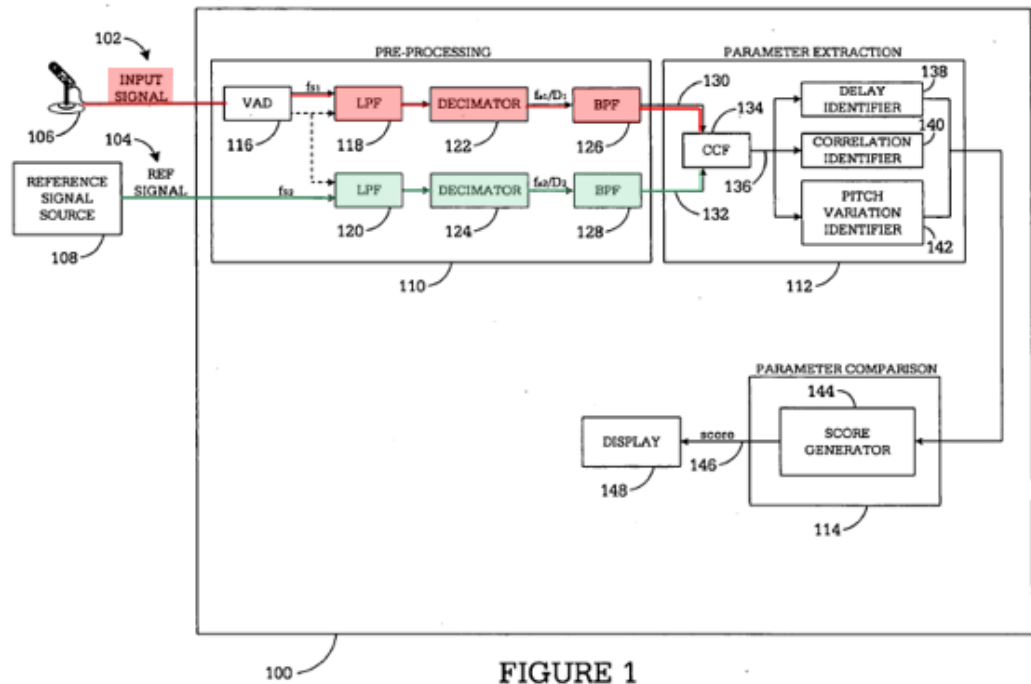
As discussed in [7]-[8], to the extent the cross-correlation calculation must be directly performed on the first microphone signal without modification, it would have been a simple design choice to “omit[]” the pre-processing, which is not mandatory in **Padhi**. See, [7]; *Kyriakakis*, ¶¶203-211.

- See [7], [8].
- Fig. 1



[11] The audio device according to claim 1, wherein the first signal is a modified test signal and the second signal is a modified first microphone signal.

See [1], [8] and [10]; Kyriakakis, ¶¶225-228.
See Padhi, Fig. 1.



[18] The audio device of claim 1, wherein the seal quality is good if the value is at or above the threshold value.

See [1]; Kyriakakis, ¶¶229-235.

Voix discloses wherein the seal quality is good (e.g., “presence of acoustic seal”) if the value is at or above the threshold value (e.g., attenuation value is “equal to or larger than a predetermined threshold value”).

E.g., Voix:

See [1.2.6]. Additionally, **Voix** discloses the “presence of acoustic seal” occurs when the attenuation is “equal to or larger than a predetermined threshold value.” [0039] As discussed in §IX.A.5, a POSITA would have been motivated to apply **Voix**’s known teachings of a threshold value in implementing **Epley**’s feedback mechanism. Moreover, this is consistent with the application of **Padhi**’s cross-correlation to **Epley**’s comparison of a test signal and the feedback from the microphone inside the ear canal. Cross-correlation is a measure of the similarity of two signals, and a POSITA would have understood that higher cross-correlation occurs when two signals are nearly identical. The test signal and microphone signal will be nearly

	identical when there is a good acoustic seal because little external sound enters the ear canal if the acoustic seal is good. <i>Kyriakakis</i>, ¶¶229-235. • [0039] (“Typically, step d) includes indicating <i>presence of acoustic seal</i> when attenuation between said first and second sound levels is <i>equal to or larger than a predetermined threshold value</i> within a predetermined frequency range.”) • [0147] (“The above detailed acoustic seal test ensures that the in-ear device 12 or earplug fits properly inside the ear canal 14 of the user, thereby providing <i>a good acoustic seal</i>.”) • See [1.2.6]
[19] The audio device of claim 1, wherein the sealing section is composed of at least one of rubber, silicone, a flexible polymer, or a combination thereof.	<i>See [1].</i> <i>Voix</i> discloses wherein the sealing section is composed of silicone (e.g., “silicones”). <u>E.g., Voix:</u> <i>Voix</i> discloses the in-ear device is “made out of” “silicones” because it is a “soft material[.]” As discussed in §IX.A.5, a POSITA would have been motivated to apply <i>Voix</i>’s teachings of making in-ear devices “out of soft materials such as silicones” in implementing <i>Epley</i>’s earpiece. <i>Kyriakakis</i>, ¶¶236-239. • [0099] (“<i>The in-ear device 12 or earplug, typically made out of generally soft materials such as silicones....</i>”)
[20] The audio device of claim 1, wherein the sealing section is an eartip.	<i>See [1].</i> <i>Epley</i> discloses the sealing section is an eartip (e.g., “ear-canal-easy cushion” “slipped over” “distal end” of “earpiece 70”) <u>E.g., Epley:</u>

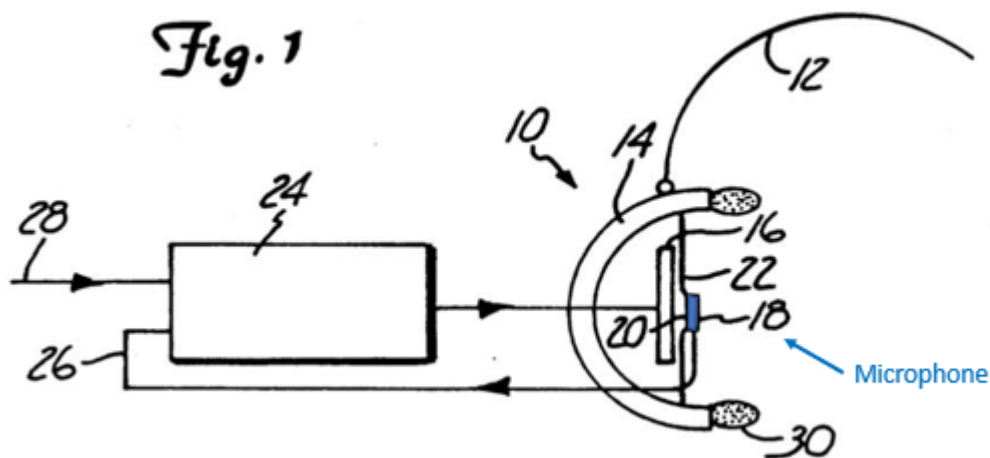
Epley discloses “earpiece 70 is configured to have an ear-canal-easy cushion” “slipped over its distal end for the comfort of a test subject.” See [1.2.3]; *Kyriakakis*, ¶¶240-244.

- [0065] (“*[E]arpiece 70 is configured to have an ear-canal-easy cushion, not shown, slipped over its distal end for the comfort of a test subject.*”)
- Fig. 3

B. Ground 2: Ground 1 in further view of *Bourk* (Claims 9 and 12)

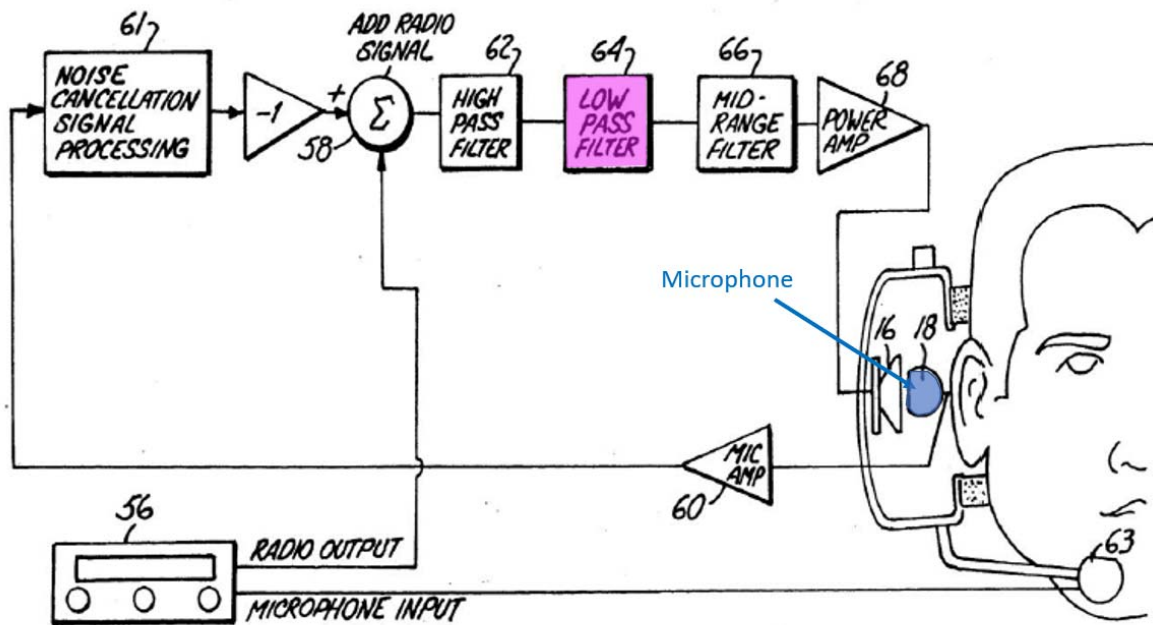
1. Overview of *Bourk*

Bourk is titled “noise cancellation headset.” Figures 1 and 4 illustrate headset 10, including **microphone 18** and **low pass filter 64**. *Bourk*, 3:55-4:10. *Kyriakakis*, ¶245.



Bourk, Figure 1.

Fig. 4



Bourk, Figure 4.

Bourk discloses summing an audio signal and anti-noise signal based on a signal from **microphone 18**, and sending the result to driver 16 (speaker). *Id.*, 4:7-16. When there is no audio signal, the modified signal includes only the anti-noise signal. *Id.*, 5:45-49, 6:12-17. *Kyriakakis*, ¶246.

The modified signal is filtered before entering driver 16. *Id.*, 4:23-27, 6:25-35. The filters include high pass filter 62 filtering components below a first frequency and **low pass filter 64 filtering components above a second frequency**, which ranges from 150 Hz to 8 kHz. *Id.*, 6:37-59. A POSITA would have understood **Bourk** to suggest choosing an upper cutoff frequency of 200 Hz,

which is the upper end of the range where “maximum noise reduction” occurs.

Bourk, 7:4-17; *Kyriakakis*, ¶¶247-248.

2. Motivation to apply *Bourk* to *Epley*, *Padhi* and *Voix*

Like **Epley**, **Padhi**, and **Voix**, **Bourk** is analogous art, in the same field as the '493, and reasonably pertinent to alleged problems addressed by the '493 in processing audio signals in acoustic devices. *E.g.*, '493, Abstract (“audio processing circuitry”), 5:17-22; 6:43-45, 10:26-29; *Epley*, [0070]; *Bourk*, 6:9-11 (“signal processing unit”); 2:65-3:3. And like the '493, **Bourk**’s device provides audio to a user. *See, e.g.*, '493, 13:58-62; *Bourk*, Abstract, 2:65-3:3. *Kyriakakis*, ¶249.

A POSITA would have been motivated to apply **Bourk**’s teachings of filtering out frequencies above 150Hz from a microphone signal to **Epley**, **Padhi**, and **Voix**’s teachings of a seal assessment device (and in particular, to filter **Epley**’s “acoustic response” from “microphone 76”) to “accentuate a desired frequency range.” *Bourk*, 6:29-44; *see also Bourk*, 4:23-27. A POSITA would have found this amounts to a simple substitution of known elements according to known techniques to yield predictable results (i.e., applying a low pass filter to the microphone signal—as already suggested in **Padhi**—with an upper cutoff frequency less than or equal to 200 Hz—as suggested in **Bourk**). *Kyriakakis*, ¶250.

3. Claim Chart – *Epley* in view of *Padhi*, *Voix*, and *Bourk*

Claim Elements	Ground 2: <i>Epley</i> in view of <i>Padhi</i> , <i>Voix</i> , and <i>Bourk</i>
[9] The audio device according to claim 8, wherein the modified first microphone signal is generated by applying a low pass filter to the first microphone signal, wherein the upper cutoff frequency is less than or equal to 200 Hz.	See [8] (§IX.A.6). Bourk discloses wherein the modified (e.g., “amplified”) first microphone signal (e.g., “microphone signal 18”) is generated by applying a low pass filter (e.g., “low pass filter”) to the first microphone signal (e.g., “microphone signal 18”), wherein the upper cutoff frequency (e.g., “frequency range”) is less than or equal to 200 Hz (e.g., “200 Hz”). <u>E.g. Bourk:</u> Bourk discloses “microphone signal 18 is amplified by mic amp 60 and provided to noise cancellation signal processing unit 61,” where it is “passed through” “filters designed to accentuate a desired frequency range.” <i>Kyriakakis</i>, ¶¶251-255. As discussed in §IX.B.2, a POSITA would have been motivated to apply Bourk’s disclosure of a “low pass filter” to the microphone signal wherein the upper cutoff is “200 Hz” in implementing Epley’s seal assessment (as modified by Padhi’s signal comparison). <i>Kyriakakis</i>, ¶¶256-258. • [6:9-11] (“The <i>electric signal from the microphone 18</i> is amplified by mic amp 60 and <i>provided to noise cancellation signal processing unit 61.</i>”) • [6:29-36] (“<i>The modified audio signal may be processed by its passage through a plurality of cascaded filters designed to accentuate a desired frequency range while minimizing undesirable phase characteristics....</i> As shown in FIG. 4, the series of cascaded filters may include...<i>a low pass filter 64 for filtering out those components of the modified audio signal having frequencies above a second frequency.</i>”)

	In the preferred embodiment...the second frequency is also in a range extending from 150 Hz to 8 kHz.") • 7:7-10 ("Maximum noise reduction will occur at frequencies from about 30 Hz to about 200 Hz at values of approximately 15 to 28 dB.") • Fig 4 (annotated) Fig. 4 See also, 4:7-27, 5:45-49, 6:12-17, 6:47-59, 7:4-17.
[12] The audio device according to claim 11, wherein the first microphone signal is generated by applying a low pass filter to the first microphone signal, wherein the upper cutoff frequency is less than or equal to 200 Hz.	See [11] (§IX.A.6). See [9]. Kyriakakis, ¶¶259-261.

C. Ground 3: Ground 1 in further view of *Hayashi* (Claim 2)

Hayashi discloses an “acoustic message” as required by claim 2, which recites “the message is an acoustic message.” **Hayashi** is titled “Leak tester of ear-mounted external sound processing device.” *Hayashi*, Abstract; *id.*, [0004]. *Hayashi*’s device functions by “measuring and displaying a leakage amount of an external sound.” *Id.* [0020]. *Hayashi* describes “a method may be used to notify the user of the leakage amount of the external sound by *a sound*, vibration, or the like.” *Id.* [0015]. *Kyriakakis*, ¶¶262-264.

A POSITA would have been motivated to apply **Hayashi**’s teachings of notifying the user of seal quality using sound in implementing **Epley**’s warning to the operator to better ensure the user notices the warning. Like **Epley**, **Padhi**, and **Voix**, **Hayashi** is analogous art, in the same field as the ’493, and reasonably pertinent to the alleged problems addressed by the ’493 of comparing signals for audio applications. *E.g.*, ’493, Abstract (“audio processing circuitry”), 5:17-22; 6:43-45, 10:26-29; *Hayashi*, Abstract, [0001], [0002], [0004], [0013], [0020]. And like the ’493, **Hayashi** is directed to a device designed to assess an audio device seal. *Id.* *Kyriakakis*, ¶265.

Hayashi teaches many different mechanisms can be used to notify a user of seal quality, including using “a display” or “a sound.” *Hayashi*, [0014] (“[A]

method may be used to *notify the user of the leakage amount of the external sound by a sound*, vibration, or the like.”). Moreover, **Epley** discloses its “display produc[ing] a warning to the operator” is part “of a desktop or portable laptop computer 40.” *Epley*, [0029]. A POSITA would have understood such a computer would provide audio warnings, in addition to or alternatively to the displayed warning. To the extent it is determined “seal quality” is non-binary, a POSITA would have been motivated to use a non-binary audio warning. See Ground 1, [1.7]. *Kyriakakis*, ¶266.

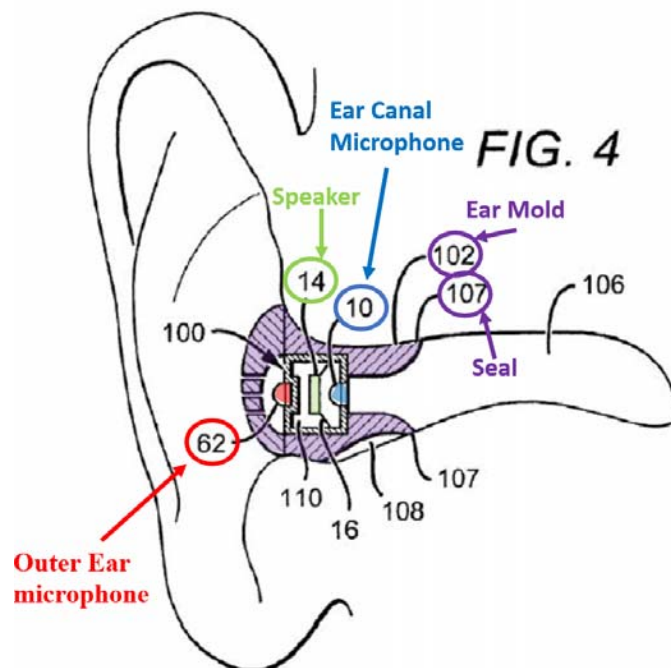
A POSITA would have had a reasonable expectation of success using **Hayashi’s** sound warning in implementing **Epley’s** device given the **Epley** device warns its user of seal quality. *Kyriakakis*, ¶¶267-268.

D. Ground 4: *Beard* in view of *Epley*, *Padhi*, and *Voix* (Claims 1, 4, 6, 13-14)

Claims 1, 4, 6, and 13-14 are rendered obvious by **Beard** in view of **Epley**, **Padhi**, and **Voix**. *Kyriakakis*, ¶269.

Beard describes a personal hearing device, such as a hearing aid, designed to provide audio to a user. *Beard*, Abstract, [0009], [0047]. **Beard’s** hearing aid includes “electroacoustic unit containing **speaker 14**, **ear canal microphone 10** and **outer ear microphone 62**.” *Id.*, [0052]. **Beard** describes an “**ear mold**” that “effectively seal[s] the ear canal.” *Id.*, [0053]. The “**custom ear mold 102**...fits

snugly in the concha of the ear...and seals at 107.” *Id.*, [0054], Fig. 4. **Beard** notes that “greater control over what a user hears is obtained when the system is arranged to seal the ear canals.” *Id.*, [0025]. “For this reason, a system which seals both ear canals and controls the sound delivered to both ears is preferred, and is assumed throughout the discussion below.” *Id.* *Kyriakakis*, ¶¶270-274.



Beard, Fig. 4 (annotated)

Beard further discloses “chirps, pseudorandom noise or swept sound signals can be used to determine the impulse transfer functions of the system.” *Beard*, [0044]. “Schemes of this type are typically implemented using one or more digital signal processors (DSPs).” *Id.* **Beard** explains “the digital signal processing electronics are preferably housed within **interface unit 50**” and “a behind-the-head

electronics module 140...preferably contains the electronics of the earphone unit,”
and is coupled to “electroacoustic modules 122 and 124.” *Beard*, [0059], [0052]-
[0053], Figs. 3, 5. *Kyriakakis*, ¶¶275-278.

ear canal microphone

speaker

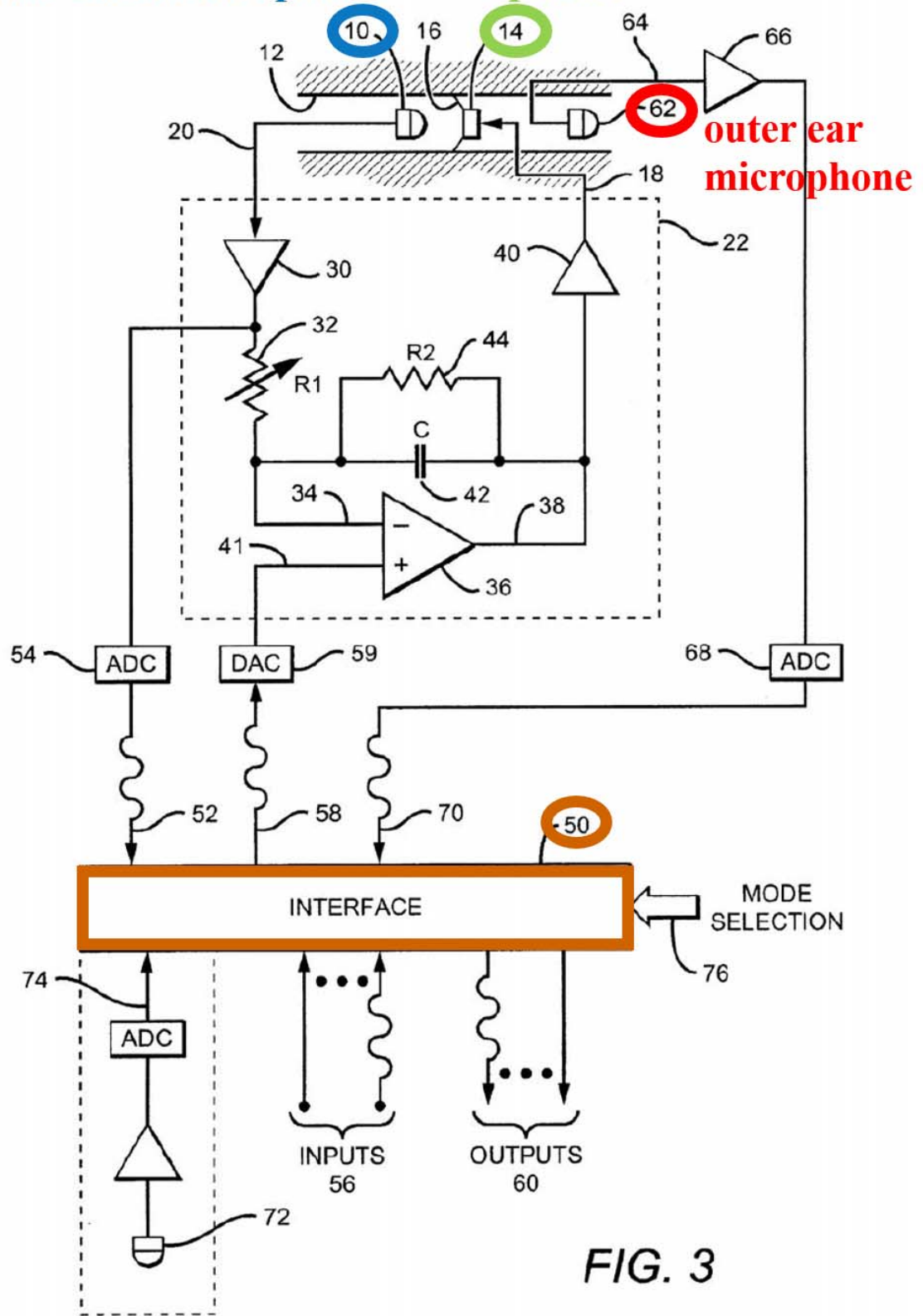
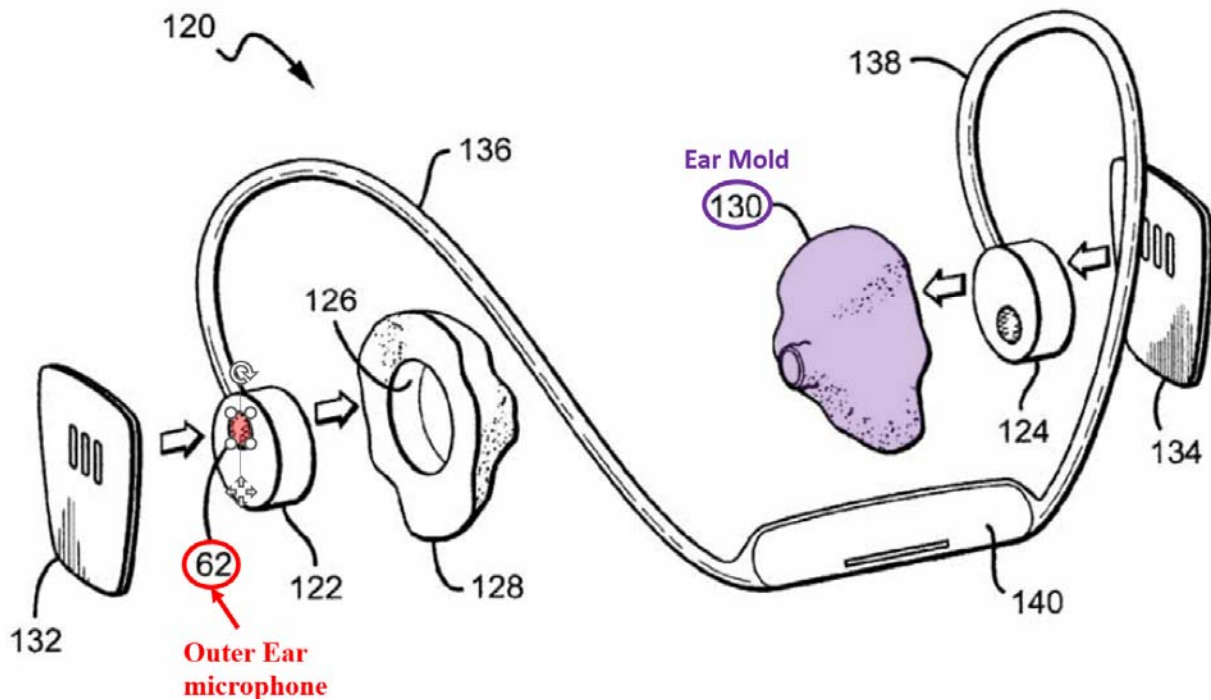


FIG. 3

FIG. 5



1. Motivation to Apply *Epley*, *Padhi*, and *Voix* to *Beard*

Like **Epley**, **Padhi**, and **Voix**, **Beard** is also analogous art, in the same field as the '493, and reasonably pertinent to the alleged problems addressed by the '493 of comparing signals for audio applications and/or audio sealing. *E.g.*, '493, Abstract (“audio processing circuitry”), 5:17-22; 6:43-45, 10:26-29; *Beard*, Abstract, [0013], [0039]; *Kyriakakis*, ¶¶279-281.

A POSITA would have been motivated to apply ***Epley***’s seal assessment teachings (using ***Voix***’s threshold and frequency range teachings and ***Padhi***’s cross-correlation teachings as explained in Ground 1), to **Beard**’s teachings of an interface unit connected to earphones with a “sealed ear canal” because, while

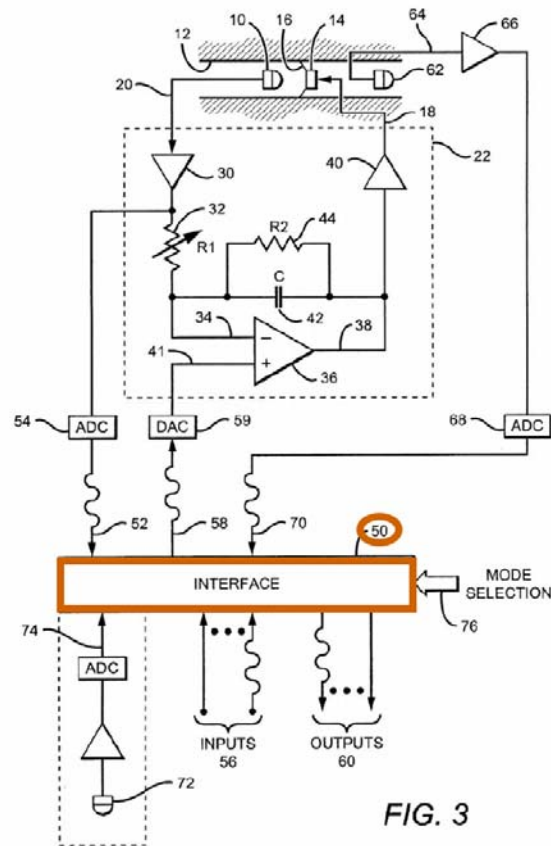
Beard discloses “a system which seals both ear canals...is assumed throughout the discussion,” **Beard** leaves it to a POSITA to decide how to determine whether a sufficient seal exists. *See, e.g., Beard*, [0025], [0042]; *Kyriakakis*, ¶¶282-283. A POSITA would have understood that a seal test is applicable to “in-ear devices,” including hearing aids, to determine whether a sufficient seal exists. *Voix*, [0005]. *Kyriakakis*, ¶284. For example, *Svean* discloses that “[i]deally...leakage should be detected and remedied prior to noise exposure” to avoid “harmful noise.” *Svean*, 3:60-64. **Epley**—as modified by **Padhi** and **Voix**—provides such a seal test. Thus, a POSITA would have been motivated to apply **Epley’s** seal test—including its transmission of a “warning” message to a “display” of a computer—to **Beard’s** interface unit 50 coupled to a “computer” to inform the user of “proper[] arrange[ment].” *Beard*, [0014], [0039]; *Kyriakakis*, ¶¶284-285.

A POSITA would have had a reasonable expectation of success applying the teachings of **Epley’s** seal assessment (using *Voix’s* threshold and frequency range and *Padhi’s* cross-correlation) in implementing **Beard’s** electronics module. *Kyriakakis*, ¶286. **Beard** teaches its “interface 50” is connected to the “electroacoustic modules” in a similar fashion to which **Epley’s** “feedback mechanism” is coupled to ear probes. *Beard*, [0059], Fig. 5; *Epley*, [0019]. Moreover, **Beard** teaches the DSP of its “interface 50” assesses the earphone functionality, including the “impulse transfer functions of the system.” *Beard*,

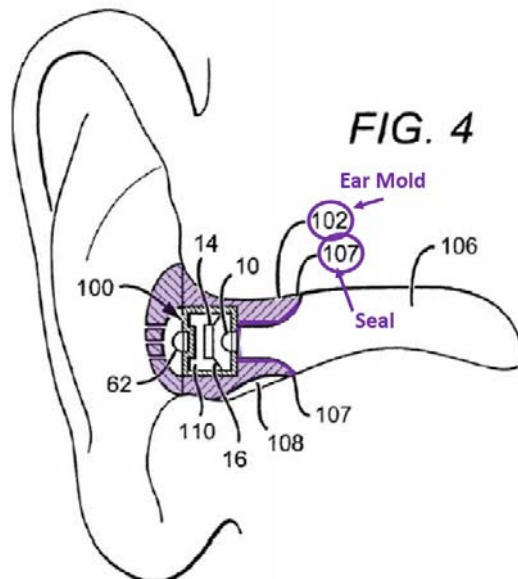
[0039], [0044]. And like **Epley**, **Beard** teaches both a speaker that can produce a known sound inside the ear canal and an ear canal microphone that detects sound inside the ear. *Beard*, [0012], [0026], [0052]. It would have been straightforward to implement the DSP of **Beard**'s interface 50 by applying the teachings of **Epley**'s sealing assessment software instructions (using the teachings of **Voix**'s threshold and frequency range and **Padhi**'s cross-correlation) to assess the seal quality of the earphones, and a POSITA would have known that such a combination (yielding the claimed limitations) would predictably work and provide the expected functionality. *Kyriakakis*, ¶¶286-288.

2. Claim Chart – *Beard* in view of *Epley*, *Padhi* and *Voix*

Claim Elements	Ground 4: <i>Beard</i> in view of <i>Epley</i> , <i>Padhi</i> and <i>Voix</i> .
[1.pre]: An audio device configured to test a seal of an earphone comprising	To the extent the preamble is limiting, <i>Beard</i> discloses an audio device (e.g., “interface unit 50”) and a seal of an earpiece (e.g., “seal 107” of “earphone”). <u>E.g., <i>Beard</i>:</u> <i>Beard</i> describes “interface unit 50” and an “earphone” with “[e]ar mold 102 extend[ing] into ear canal 106 and seals at 107.” <i>Beard</i>, [0012], [0054]; <i>Kyriakakis</i>, ¶¶289-292. • Fig. 3



- Fig. 4



- [0041] (“Interface unit 50 preferably includes multiple operating modes, with a means 76 provided with which a desired mode can be selected. The selected operating mode dictates which input signal is selected and how

	<i>the selected signal is processed before being coupled to speaker 14.”)</i> • [0042] (“<i>Interface unit 50</i> can also include a digital audio memory for <i>storing on board audio information</i> like music.”) • [0054] (“Ear canal mic 10, outer ear mic 62 and speaker 14 of <i>the earphone</i> element are contained in a shell 100. The shell is mounted inside a custom <i>ear mold 102 which fits snugly in the concha of the ear. Ear mold 102 extends into ear canal 106 and seals at 107.</i>”) To the extent the preamble is limiting, Epley discloses testing a seal of an earphone (see §IX.A.6, [1.pre]). As discussed in §IX.D.1, a POSITA would have been motivated to apply <i>Epley’s</i> seal assessment to <i>Beard’s</i> personal hearing system with a sealed ear canal. <i>Kyriakakis</i>, ¶293.
[1.1]: a memory that stores instructions; and	<i>Beard</i> discloses a memory that stores instructions (e.g., “digital audio memory” with processor for “modifying, storing, and sending digital audio information”). <u>E.g., Beard:</u> <i>Beard</i> discloses “interface 50” includes “digital audio memory” and “digital processing power that allows actively modifying, storing, and sending digital audio information.” [0042]. This allows the device to “operate in a wide range of modes selectable by the user.” [0042]. The “selected operating mode dictates...how the selected signal is processed.” [0041]. Moreover, the “DSP” implements “noise cancellation scheme.” [0044]. A POSITA would have understood (and at least found it obvious) that, for the processor to allow a user to select modes and manipulate audio information, the memory is associated with instructions. See [0041]; <i>Kyriakakis</i>, ¶¶294-297. • [0041] (“Interface unit 50 preferably includes multiple operating modes, with a means 76 provided with which

	<i>a desired mode can be selected. The selected operating mode dictates which input signal is selected and how the selected signal is processed</i> before being coupled to speaker 14....”) • [0042] (“Interface unit 50 can also include <i>a digital audio memory for storing on board audio information like music</i>. The interface can include <i>digital processing</i> power that <i>allows actively modifying, storing, and sending digital audio information</i> in various forms. With these features, the present system <i>can operate in a wide range of modes selectable by the user</i>.”) • [0044] (“A feedforward noise cancellation scheme of this sort works effectively at lower frequencies.... <i>Schemes of this type are typically implemented using one or more digital signal processors (DSPs)</i>.”)
[1.2]: a processor, wherein the processor is configured to execute the instructions to perform operations, the operations comprising:	Beard discloses a processor (e.g., “digital signal processor[] (DSP[])” of “interface unit 50”), wherein the processor is configured to execute (e.g., “implement”) the instructions to perform operations, (e.g., “schemes”). <u>E.g., Beard:</u> Beard discloses “interface 50” includes “digital signal processor[] (DSP[])” “implement[ing]” “schemes” like “noise cancellation.” Kyriakakis, ¶¶298-302. • [0044] (“<i>A feedforward noise cancellation scheme</i> of this sort works effectively at lower frequencies, and since it is a feed forward system, there are no stability issues. <i>Schemes</i> of this type are typically <i>implemented using one or more digital signal processors (DSPs)</i>.”) • [0043] (“This is accomplished by providing one or more filters <i>within interface 50 which process the audio signal</i> produced by outer ear microphone 62 such that a signal is coupled to speaker 14 <i>that cancels sound</i> that leaks from the outer ear to the inner ear side of the seal.”)

	• [0052] (“[T]he system’s digital signal processing electronics are preferably housed within interface unit 50....”) • <i>See also</i>, [0042], [0045]
[1.2.1]: generating a test signal,	Beard discloses instructions (e.g., “schemes,” see [1.2]) for generating an audio signal (e.g., “swept sound signals”). <u>E.g., Beard:</u> Beard discloses its DSP generates “swept sound signals” for calibrating feed forward cancellation. <i>Kyriakakis</i>, ¶¶303-307 • [0044] (“[S]wept sound signals can be used to determine the impulse transfer functions of the system....A feedforward noise cancellation scheme...of this type [is] <i>typically implemented using one or more digital signal processors (DSPs).</i>”) Epley discloses generating a test signal (see §IX.A.6, [1.2]). As discussed in §IX.D.1, a POSITA would have been motivated to apply Epley’s seal assessment teachings (including test signal generation) to Beard’s personal hearing system. <i>Kyriakakis</i>, ¶306.
[1.2.1.1]: wherein the test signal includes multiple frequency components, wherein at least one component lies between a range of 30 Hz and 200 Hz;	<i>See</i> §IX.A.6, [1.2.1.1]. As discussed in §IX.A.5, a POSITA would have been motivated to apply Voix’s teachings of a test signal range to Epley’s seal assessment. As discussed in §IX.D.1, a POSITA would have been motivated to apply Epley’s seal assessment teachings (including test signal generation) to Beard’s personal hearing system. <i>Kyriakakis</i>, ¶¶308-309.

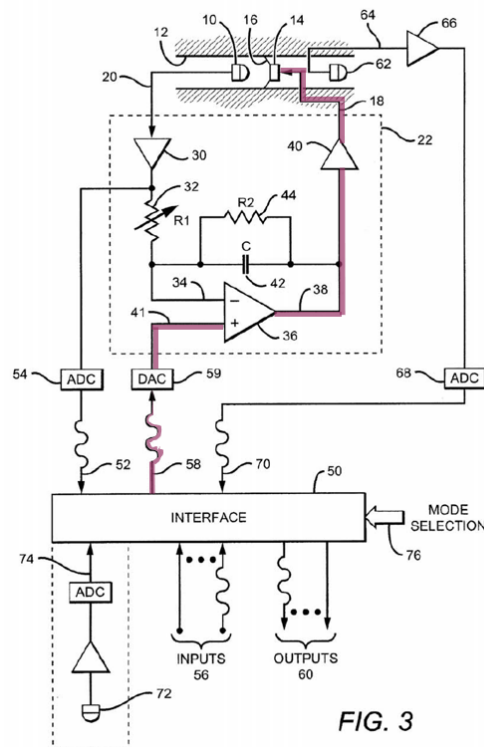
[1.2.2]: sending the test signal to a speaker of an earphone,

Beard discloses instructions (e.g., “schemes,” see [1.2]) **for sending an audio signal** (e.g., “swept sound signals”) **to a speaker** (e.g., “speaker 14”) **of an earphone** (e.g., “earphone”).

E.g., Beard:

Beard discloses “swept sound signals” from “digital processing” of “interface 50” for “feedforward noise cancellation,” which a POSITA would have understood to involve transmission to “speaker 14” of “earphones.”
Kyriakakis, ¶¶310-320.

- Fig. 3



- Fig. 4

	• [0054] (“Ear canal mic 10, outer ear mic 62 and <i>speaker 14 of the earphone</i> element are contained in a shell 100.”) • [0026] (“[A] <i>speaker 14</i> having a diaphragm 16 is arranged to <i>direct sound into the user’s ear canal in response to a driving signal 18.</i>”) • [0042] (“The interface can include <i>digital processing power that allows actively</i> modifying, storing, and <i>sending digital audio information</i> in various forms.”) • See also, [0039]. Epley discloses sending the test signal to a speaker of an earphone (see §IX.A.6, [1.2.2]). Kyriakakis, ¶315. As discussed in §IX.D.1 a POSITA would have been motivated to apply <i>Epley’s</i> seal assessment teachings (including sending test signal to speaker) to <i>Beard’s</i> personal hearing system. Kyriakakis, ¶¶316-320.
[1.2.3]: wherein the earphone includes a first microphone,	Beard discloses the earphone includes a first microphone (e.g., “outer ear microphone 62”), the speaker (e.g., “speaker 14”), and a sealing section (e.g., “custom ear mold 102”), and wherein the sealing section is configured to form an acoustic barrier between a first side of the earphone (e.g.,

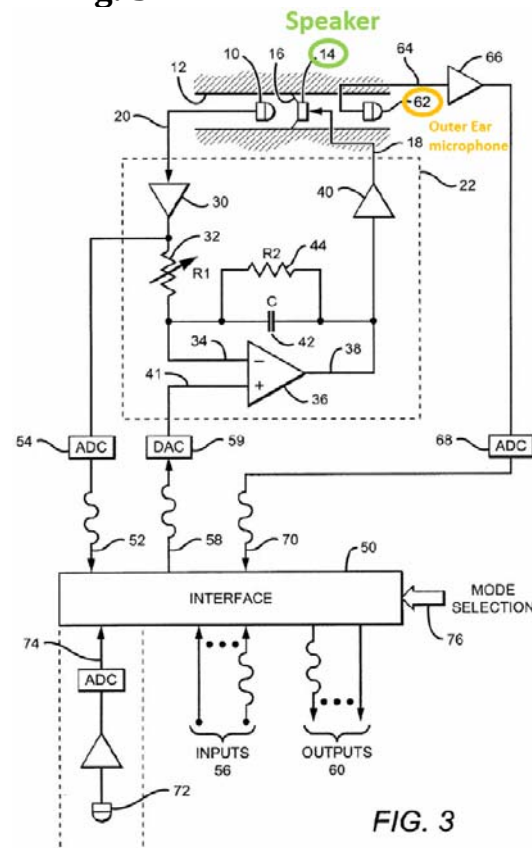
the speaker, and a sealing section, and wherein the sealing section is configured to form an acoustic barrier between a first side of the earphone and a second side of the earphone when the earphone is worn by a user

“inner ear side of the seal”) **and a second side of the earphone** (e.g., “outer ear side of the ear canal”) **when the earphone is worn by a user** (e.g., “fits snugly in the concha of the ear” and “extends into ear canal 106” to form a seal that “blocks leakage of outside sound”).

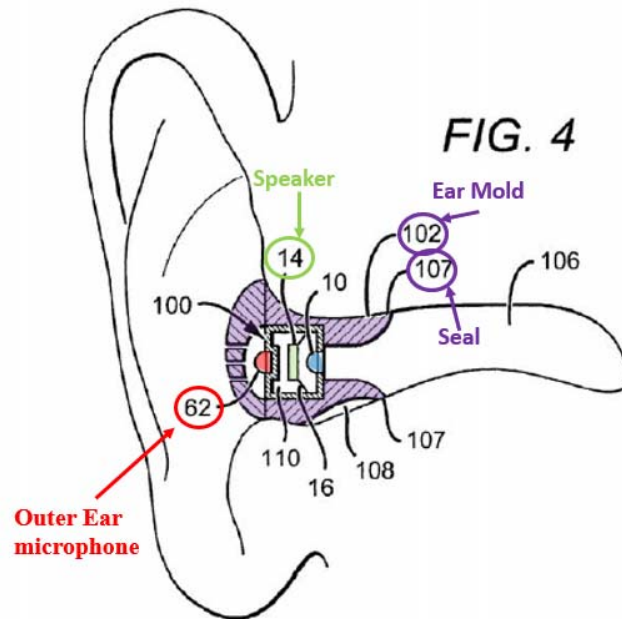
E.g., Beard:

Beard discloses its earphone includes “outer ear microphone,” a “speaker 14,” and “snug-fitting” “ear mold 102” that “fits snugly in the concha of the ear” and “extends into ear canal 106 and seals at 107” to block leakage of outside sound. *Kyriakakis*, ¶¶310-320.

• **Fig. 3**

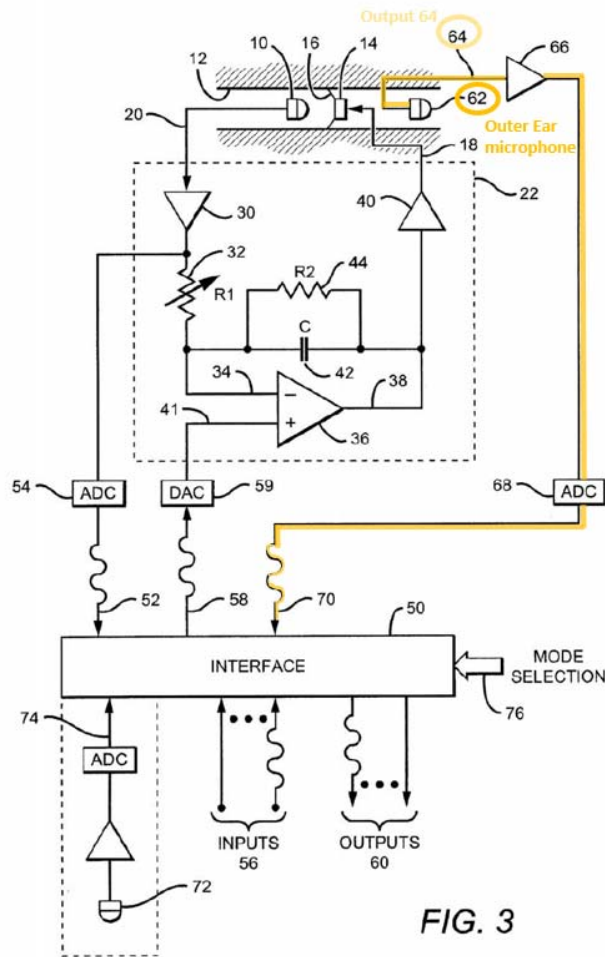


• **Fig. 4**



- [0012] (“[T]he personal hearing control system is *fitted to seal the user's ear canal*, with the speaker and ear canal microphone located on the *inner ear side of the seal*.”)
- [0026] (“An ‘ear canal microphone’ 10 is located within a user’s ear canal 12, and a *speaker 14* having a diaphragm 16 is arranged to direct sound into the user's ear canal in response to a driving signal 18.”)
- [0040] (“[T]he personal hearing control system also includes *a microphone 62 suitable for placement on the outer ear side of the ear canal*.”)
- [0054] (“The shell is mounted inside a *custom ear mold 102 which fits snugly in the concha of the ear. Ear mold 102 extends into ear canal 106 and seals at 107. This seal blocks leakage of outside sound* and provides for good low frequency response of the system.”)
- See also [0052], [0053]

[1.2.4] receiving a first microphone signal from the first microphone;	Beard discloses instructions (<i>e.g.</i>, “schemes,” <i>see</i> [1.2]) for receiving a first microphone signal (<i>e.g.</i>, “output 64”) from the first microphone (<i>e.g.</i>, “outer ear microphone 62”). <u>E.g., Beard:</u> Beard discloses a “noise cancellation scheme” “implemented” using a “DSP[]” ([0044]) where “output 64” ([0040]) is “received from outer ear microphone 62.” ([0051]). In the same way, the ’493 discloses “ASM 120 provides the measured ambient signal to processor.” ’493, 9:3-4. <i>Kyriakakis</i>, ¶¶321-324. • Fig. 3
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- [0040] (“In a preferred embodiment, the personal hearing control system also includes a *microphone 62* suitable for placement on the *outer ear side of the ear canal*. The *output 64 of this microphone* is preferably buffered...”)
- [0044] (“A feedforward *noise cancellation scheme* of this sort...*typically implemented using one or more digital signal processors (DSPs)*.”)
- [0051] (“The audio received from *outer ear microphone 62* may be equalized...”)

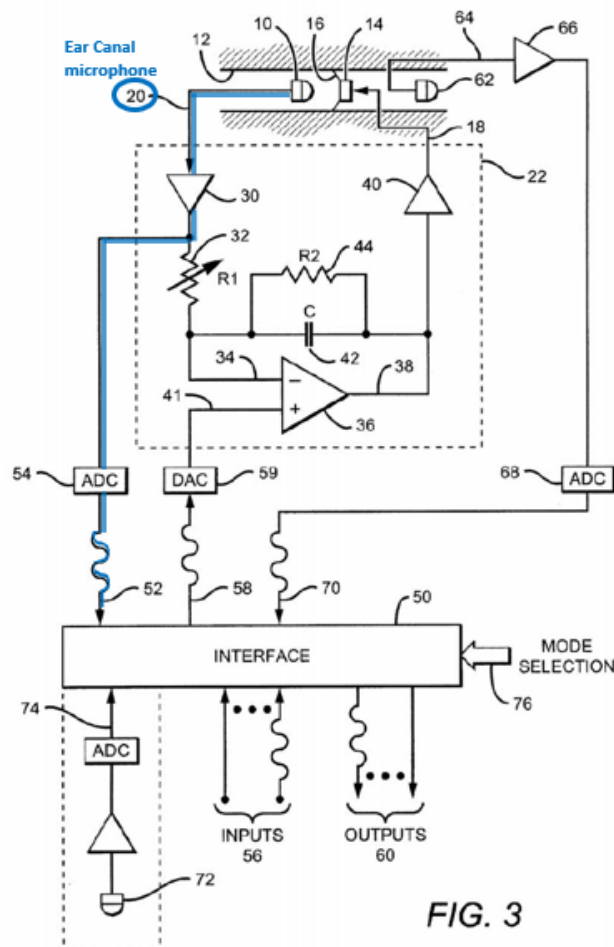
[1.2.5]
calculating a value, using a first signal and a second signal, wherein the value is the result of a non phase calculation of at least one of a coherence, a correlation, a cross-correlation, a difference, or a combination;⁵

Beard discloses a first signal (e.g., “output signal 20” of “ear canal microphone 10”).

E.g., Beard:

Beard discloses DSP of “interface 50” receiving an “output signal 20” from “ear canal microphone 10” via “input 52.” *Kyriakakis*, ¶¶325-330.

- Fig. 3



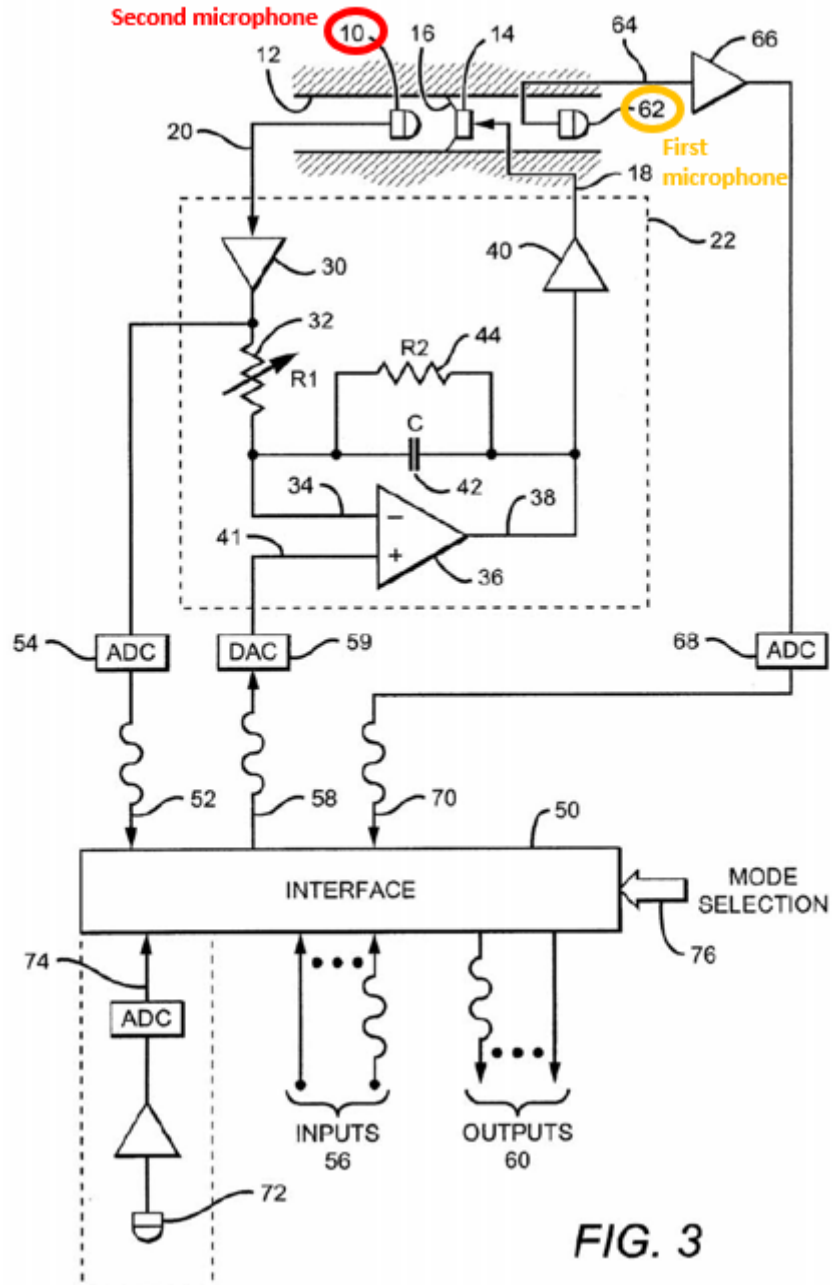
- [0011] (“The present system includes a microphone suitable for placement within a user's ear canal (*the ‘ear*

⁵ Note: Element [1.2.5] does not require the first or second signal to include the “first microphone signal from the first microphone” of Element [1.2.4].

	<i>canal microphone’)</i> which produces an output signal...) • [0026] (“Ear canal microphone 10 produces an output signal 20 which varies with the instantaneous pressure in the ear canal.”) • See also, [0043]. As discussed in §IX.D.6, [1.2.5], Epley’s seal assessment (using Padhi’s cross-correlation) calculates a value, using a first signal and a second signal, wherein the value is the result of a non phase calculation of at least one of a cross-correlation. As discussed in §IX.D.1, a POSITA would have been motivated to apply the teachings of Epley’s seal assessment (using Voix’s threshold and Padhi’s cross-correlation) to Beard’s personal hearing system. In doing so, a POSITA would have used a test signal (as taught by Epley) and Beard’s “output signal 20” received from “ear canal microphone 10” to perform the cross-correlation calculation. <i>Kyriakakis</i>, ¶¶329-330.
[1.2.6] – [1.2.7]:	See §IX.A.6 ([1.2.6] – [1.2.7]) As discussed in §IX.D.1, a POSITA would have been motivated to apply the teachings of Epley’s seal assessment (using Voix’s threshold and Padhi’s cross-correlation) to Beard’s personal hearing system, and in doing so, Beard’s electronics module would send a warning to a display of its “computer.” <i>Kyriakakis</i>, ¶¶331-333.
[4]: The audio device according to claim 1, wherein the speaker plays the test signal from the first side.	See [1] (§IX.D.2). Beard discloses the speaker (e.g., “speaker”) plays a signal (e.g., “driving signal 18”) from the first side (e.g., “inner ear side of the seal”). <u>E.g., Beard:</u> Beard discloses a “speaker” that plays “driving signal 18” from the “inner ear side of the seal.” See [1] (§IX.D.2); <i>Kyriakakis</i>, ¶¶334-336.

	• [0012] (“In a preferred embodiment, the personal hearing control system is fitted to seal the user's ear canal, with the <i>speaker</i> and ear canal microphone located on the <i>inner ear side of the seal.</i>”) • See [1.2.1] As discussed in §IX.D.1, a POSITA would have been motivated to apply the teachings of Epley’s seal assessment (including its test signal) to Beard’s personal hearing system. <i>Kyriakakis</i>, ¶¶337-338.
[6]: The audio device according to claim 4, wherein the first microphone measures sound from the second side.	See [4] (§IX.D.2). Beard discloses the first microphone (e.g., “outer ear microphone 62”) measures sound from the second side (e.g., “picks up outside sound at the ear”). <u>E.g., Beard:</u> Beard discloses “outer ear microphone 62” “picks up outside sound at the ear.” <i>Kyriakakis</i>, ¶¶339-342. • [0040] (“[T]he personal hearing control system also includes a <i>microphone 62</i> suitable for placement <i>on the outer ear side of the ear canal....</i> Microphone 62 is preferably a high quality, low noise microphone which <i>picks up outside sound at the ear.</i>”) • [0043] (“Further attenuation of outside sound can be achieved by using the signal from <i>outer ear microphone 62....</i>”)
[13]: The audio device according to claim 1, wherein the earphone includes a second microphone.	See [1] (§IX.D.2). Beard discloses the earphone includes a second microphone (e.g., “ear canal microphone 10”). <u>E.g., Beard:</u> Beard discloses “[a]n ‘ear canal microphone’ 10 is located within a user's ear canal 12....” <i>Kyriakakis</i>, ¶¶343-346.

- [0026] (“An ‘ear canal microphone’ 10 is located within a user’s ear canal 12....”)
- Fig. 3.

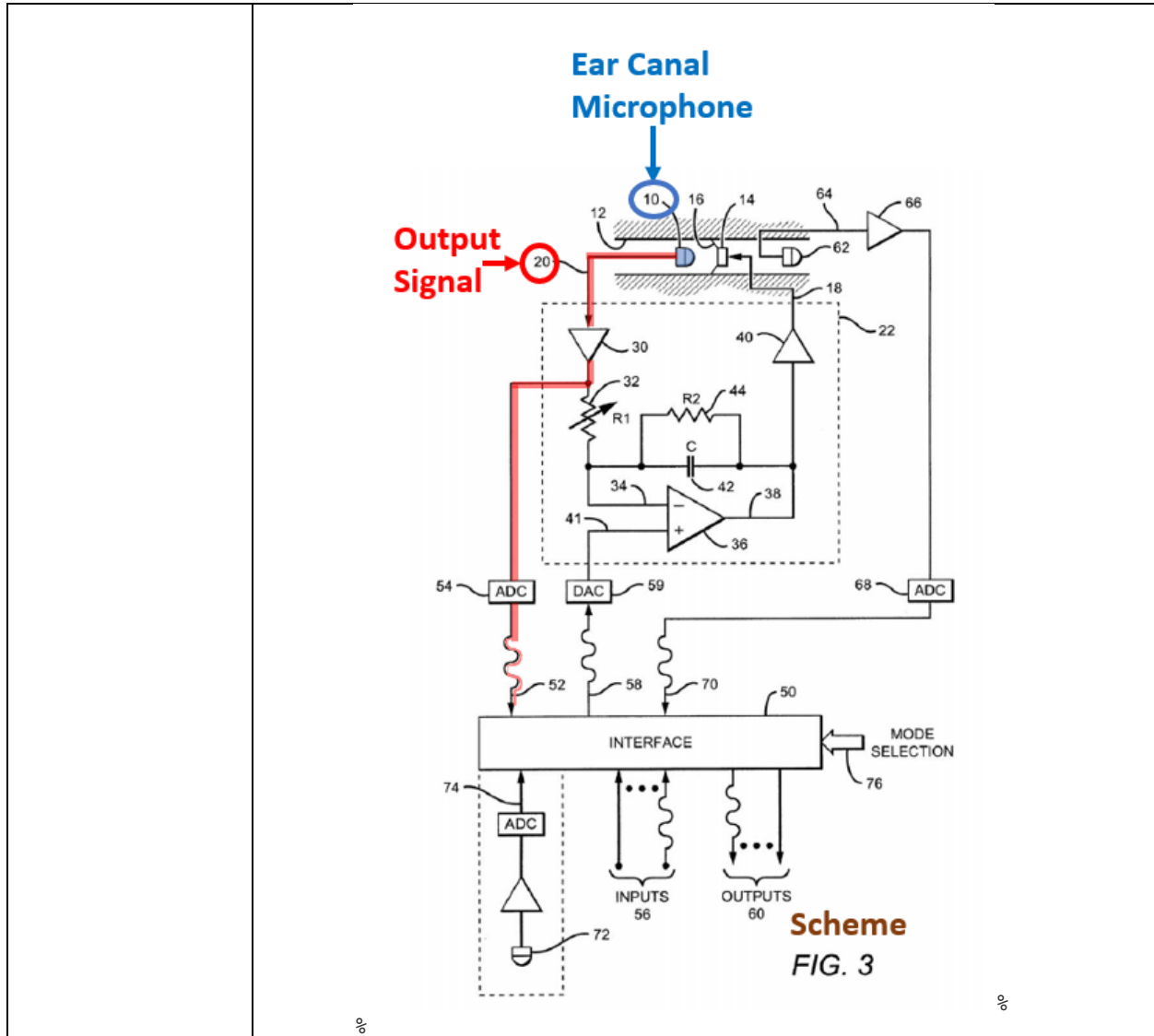


- See Ground 4, [1.2.3]

[14]: The audio device according to

See [13] (§IX.D.2).

claim 13, wherein the operations further comprise: receiving a second microphone signal from the second microphone.	Beard discloses instructions (<i>e.g.</i>, “schemes,” “implemented” using “DSP,” see [1.2]) for receiving a second microphone signal (<i>e.g.</i>, “output signal 20”) from the second microphone (<i>e.g.</i>, “ear canal microphone 10”). <u>E.g., Beard:</u> Beard discloses DSP of “interface 50” receiving an “output signal 20” from “ear canal microphone 10” via “input 52.” See [1.2.5] (§IX.D.2). In the same way, the ’493 algorithm step 308 requires “acquir[ing] internal acoustic field with...ECM,” and the processor receives the signal from the ECM. ’493, 8:58-60, Fig. 3. <i>Kyriakakis</i>, ¶¶347-352. • Fig. 3%
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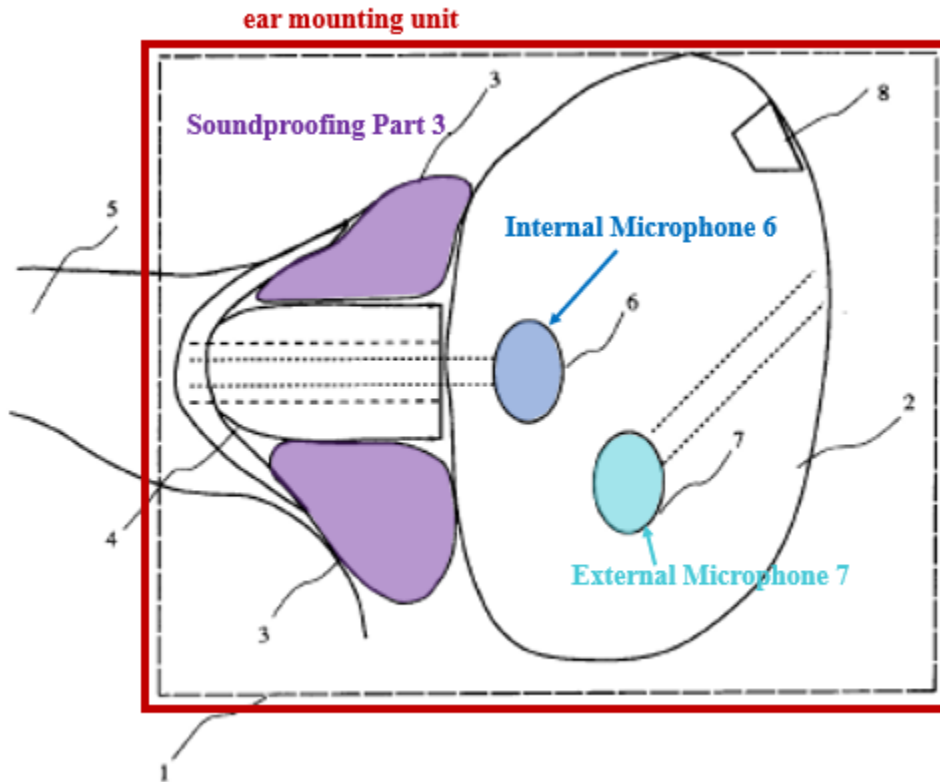
E. Ground 5: Ground 4 in further view of *Hayashi* (Claims 15-17)

Claims 15-17 are rendered obvious by **Beard** in view of **Epley, Padhi, Voix, and Hayashi**. *Kyriakakis*, ¶353.

Hayashi discloses determining similarity between two microphone signals to evaluate the seal of an in-ear device. *E.g.*, *Hayashi*, [0005]-[0006], [0012]-[0016]. In Figure 2, **Hayashi** discloses **ear mounting unit 1** with **external**

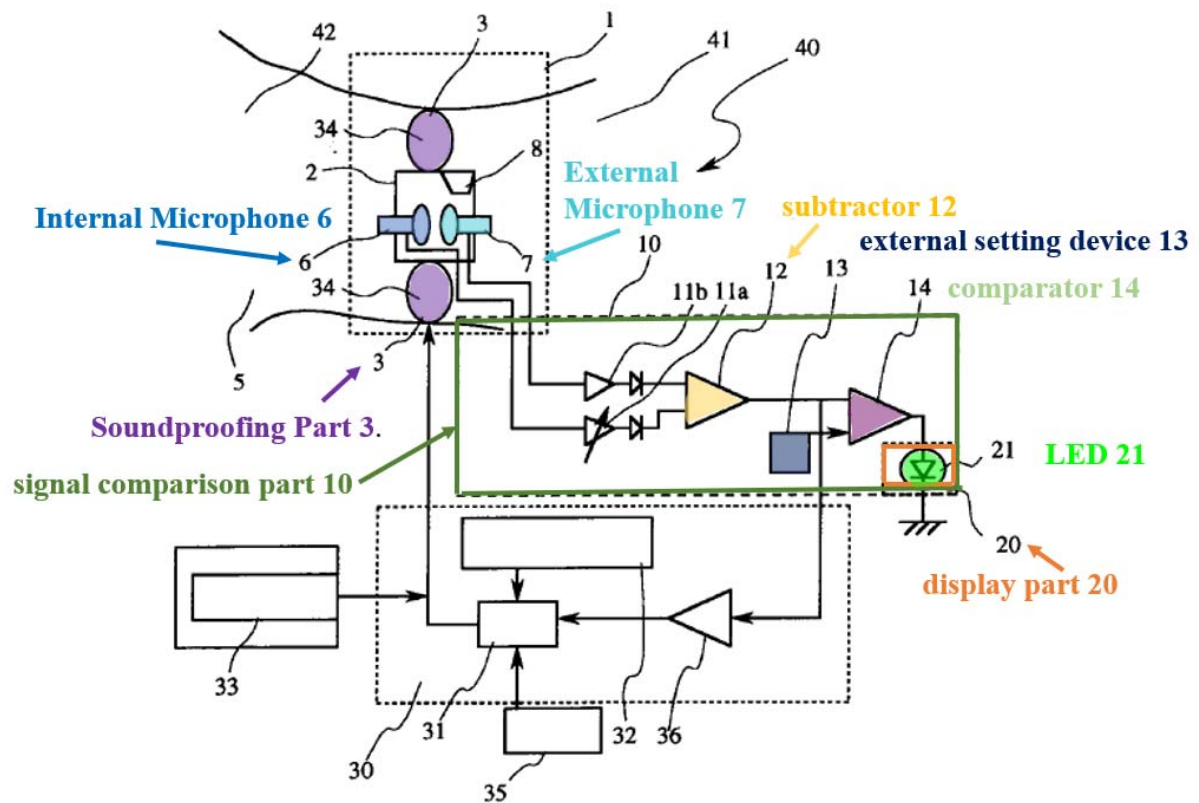
microphone 7 and internal microphone 6, and soundproofing part 3.

Kyriakakis, ¶354.



Hayashi, Figure 2.

Hayashi discloses an algorithm for calculating a value with the signals generated by the internal and external microphones to evaluate the seal. *See, e.g., Hayashi, [0012]-[0016].* **Hayashi's** Figure 1 is reproduced below. *Kyriakakis, ¶355.*



Hayashi, Figure 1.

Hayashi discloses **signal comparison part 10** supplies received input signals from **internal microphone 6** and **external microphone 7** to **subtractor 12**. *Hayashi*, [0013]. **Hayashi's** **subtractor 12** subtracts signals from **internal microphone 6** and **external microphone 7**, and **comparator 14** compares the output of the subtractor to a reference voltage threshold from **external setting device 13**. *Hayashi*, [0013]. If the input to **comparator 14** is less than the threshold, **comparator 14** outputs 0 volts. *Hayashi*, [0013]. Otherwise, **comparator 14's** output lights up **LED 21** in **display part 20** to indicate sound

leakage through **soundproofing part 3**. *Hayashi*, [0013]-[0014]. *Kyriakakis*, ¶¶356-357.

Thus, **Hayashi** discloses two microphone signals measuring sound from opposite sides of a sealing section (soundproofing part 3) in an ear mounted unit are utilized in a calculation to determine seal quality. *Kyriakakis*, ¶358.

In applying **Hayashi's** teaching of using two microphone signals to **Beard** (using **Epley's** seal assessment, **Voix's** threshold and **Padhi's** cross-correlation), for element [1.2.4], **Beard's** speaker 24 would play a test signal, and **Beard's** ear canal microphone 10 and outer ear microphone 62 would provide inputs to a signal comparison according to **Padhi's** teachings. The analysis of limitations [1.2.5] and [1.2.6] remains the same, except a POSITA would have recognized where two microphone signals are used, a lower cross-correlation value would correspond to higher seal quality, and would adjust the threshold comparison step accordingly before generating and sending a message. *Kyriakakis*, ¶¶359-360.

The seal analysis of claims 15-17 is the same for this ground as it is for ground 1 (see §IX.A.6), except that **Beard's** signal 20 of ear canal microphone 10 and output 64 of outer ear microphone 62 respectively replace **Epley's** microphone and test signals of ground 1. *Kyriakakis*, ¶¶361-362.

A POSITA would have been motivated to apply **Hayashi's** teachings of two microphone signals in implementing **Beard** in view of **Epley**, **Padhi**, **Voix**, and

Hayashi instead of using a test signal and an inner ear microphone. As **Hayashi** teaches, using two microphone signals for a seal test makes it “possible to enhance a measuring accuracy of a pressure difference of sound.” *Hayashi* [0006]. And because **Beard** teaches two microphones, application of **Hayashi**’s teachings of two microphone signals for a seal test would have been straightforward. And consistent with the explanation above for claims 7, 8, 10 and 11 in Ground 1, the microphone signals would be modified as needed for claims 15-17 in the current ground. *Kyriakakis*, ¶¶361-362.

X. SECONDARY CONSIDERATIONS

There is no evidence in the ’493’s prosecution history or elsewhere supporting secondary considerations, or evidence of nexus. *See generally* ’493FH; *Kyriakakis*, ¶363. Petitioners reserve the right to address any such evidence if PO raises it.

XI. CONCLUSION

Substantial, new, and noncumulative technical teachings have been presented for ’493 Claims 1-20, which are obvious for the reasons set forth above. §§I-X, *Kyriakakis*, ¶¶364-367. There is a reasonable likelihood that Petitioners will prevail as to the Claims. *Inter partes* review of Claims 1-20 is accordingly requested.

Date: July 1, 2024

Respectfully submitted,

/James L. Davis, Jr./

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Counsel for Petitioners

CERTIFICATE OF COMPLIANCE

The undersigned hereby certifies that the foregoing Petition for *Inter Partes* Review contains 13,988 words, excluding those portions identified in 37 C.F.R. §42.24(a), as measured by the word-processing system used to prepare this paper.

/James L. Davis, Jr./
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Lead Counsel

CERTIFICATE OF SERVICE

I certify that on July 1, 2024, I caused a true and correct copy of the foregoing Petition for *Inter Partes* Review of U.S. Patent No. 11,665,493 and supporting exhibits to be served via overnight delivery on the Patent Owner at the following correspondence address of record as listed on Patent Center:

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