

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

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

Petitioners

v.

STATON TECHIYA, LLC,

Patent Owner

Case IPR2024-01032

U.S. Patent No. 11,683,643

**DECLARATION OF NATAHANIEL POLISH, PH.D. IN SUPPORT
OF PETITION FOR INTER PARTES REVIEW
OF U.S. PATENT NO. 11,683,643**

Samsung et al. v. Techiya IPR2024-01032 Exhibit 1002
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I, Nathaniel Polish declare that:

I. ASSIGNMENT

1. I have been retained on behalf of Samsung Electronics Co., Ltd. and Samsung Electronics America, Inc. (together “Samsung”) to offer technical opinions related to U.S. Patent No. 11,683,643 (“the ’643 patent”) (EX1001¹). I understand that Samsung is requesting that the Patent Trial and Appeal Board (“PTAB” or “Board”) institute an *inter partes* review (“IPR”) proceeding of the ’643 patent.

2. I have been asked to provide my independent analysis of the ’643 patent based on the prior art publications cited in this declaration.

3. I am not and never have been, an employee of Samsung or Harman. I received no compensation for this declaration beyond my normal hourly compensation based on my time actually spent analyzing the ’643 patent, the prior art publications cited below, and issues related thereto, and I will not receive any added compensation based on the outcome of any IPR or other proceeding involving the ’643 patent.

¹ Where appropriate, I refer to exhibits I understand will be attached to the petition for inter partes review of the ’643 patent (the “Petition”).

II. QUALIFICATIONS

4. I am over the age of 18 and am competent to write this declaration. I have personal knowledge, or have developed knowledge, of these technologies based upon education, training, or experience of the matters set forth herein.

5. I am an independent consultant. All of my opinions stated in this declaration are based on my own personal knowledge and professional judgment. In forming my opinions, I have relied on my knowledge and experience in acoustics, signal processing, design of headsets and sound production equipment, and representations of acoustic sounds.

6. A copy of my current curriculum vitae, which details my education and professional and academic experience, is included as Ex. 1003 in this proceeding. The following provides an overview of some of my experience that is relevant to the matters set forth in this declaration.

7. I have a Ph.D. in Computer Science from Columbia University. In fact, I hold the following four degrees from Columbia, spanning the years 1980 to 1993:

- Ph.D. in Computer Science, May 1993, Thesis: Mixed Distance Measures for the Optimization of Concatenative Vocabularies in Speech Synthesis;
- M.Phil. in Computer Science, December 1989;
- M.S. in Computer Science, December 1987; and

- B.A. in Physics, Columbia College, May 1984.

8. For over thirty years, I have run a computer technology development firm that I co-founded, called Daedalus Technology Group. My primary business activity is the development of computer-related products. This activity involves understanding the business objectives of customers, designing products to suit their needs, and supervising the building, testing, and deployment of these products. I develop hardware and software as well as supervise others who do so.

9. Also, from time to time I found other companies in order to pursue particular product opportunities. I develop and ultimately sell these companies. Most of my business activity, however, is as a consulting product developer. From time to time I have also served as an expert witness on computer and software related cases. I am a named inventor on eight United States patents and am a member of several professional societies, including the IEEE and ACM.

10. I have extensive experience in several areas relevant to this case. My doctoral work was in the area of computer speech. As part of that work I developed signal processing systems and algorithms to filter and manipulate sound, especially speech. That work gave me strong practical insight into such topics as voice activity detection, digital mixing of audio and speech, as well as the general problems of digital filtering of speech signals.

11. Much of my professional work over the past thirty years has been as a computer technology product developer. Several of those products involved technologies closely related to the topics in the patent at issue in the current matter, including digital audio systems and associated signal processing. One product in particular was for a company called HeadGear in the later 1990s. That product involved developing a set of headphones that mixed ambient music from an outdoor concert with wirelessly delivered audio content. Under my supervision, the firm developed prototype versions of this product.

12. In addition to this work for HeadGear, the firm also designed and developed, under my supervision, a number of products or systems for delivering digital audio and performing associated signal processing. Between 1982-1991, the firm designed and built, under my supervision, all parts of four generations of interactive voice editing systems for The Dun & Bradstreet Corporation. These editing systems produced output used in an extensive, high quality speech synthesis system that was part of a larger information delivery system. The systems were built on networks of computers in a variety of programming languages and systems. The systems involved interactive user interfaces, screen windows, signal processing, and voice file systems.

13. Between 1995-1997, the firm also designed and developed, under my supervision, a series of products to deliver digital video and audio materials

over wide-area internet using consumer grade computers. These products were developed for Instant Video Technologies, Inc. and designed to fit within their existing patent portfolio. There were also new aspects of the technology that resulted in a new patent for the company.

14. In 2000, I also supervised the development, design, and deployment of an industrial strength interactive voice response (IVR) system that allows users to access streaming media via their cell phones. This system supported up to 96 streams on a single chassis and was designed for a company called Savos. Under my supervision, the firm developed for this system the web-based content management system and interface for customizable user preferences.

15. In addition to the products and systems described above, I have also developed many other systems that utilize various signal processing techniques, including both speech recognition and speech synthesis. In the late 1990s, I started a company named Soliloquy to commercialize my technology in the area of speech access to databases. That work resulted in a patent. I have also developed a number of systems that use speech recognition to control system functions. One of the more amusing systems that I developed for a client was a talking golf club.

16. Through these and other experiences, I am very familiar with the technologies at issue in this matter.

III. SUMMARY OF CONCLUSIONS FORMED

17. This Declaration explains the conclusions that I have formed based on my analysis. To summarize those conclusions:

- Ground 1A: *Svean, Andrea, and Beasley* render obvious claims 1-11
- Ground 1B: *Svean, Andrea, Beasley, and Berg* render obvious claims 1-11
- Ground 2: *Asada and Usher* render obvious claims 1-11

IV. LEVEL OF ORDINARY SKILL IN THE ART

18. I have been informed by Petitioners' counsel that a person having ordinary skill in the art ("POSITA") is a hypothetical person who is presumed to have the skill and experience of an ordinary worker in the field at the time of the priority date of the challenged patent. With respect to Grounds 1A-1B, I have been asked to assume that the priority date is May 4, 2007. With respect to Ground 2, I have been asked to assume that the priority date is no earlier than March 29, 2021. In my opinion, the level of ordinary skill in the art is the same whether the priority date is May 4, 2007, or March 29, 2021.

19. Based on my knowledge and experience in the field and my review of the '643 patent and file history, I believe that a person having ordinary skill in the art in this matter would have had a Bachelor's of Science degree (or equivalent) in electrical engineering, computer science, or a similar field and two years of experience in the design of digital audio systems and associated signal

processing such as voice and or speech processing and/or acoustic pattern recognition. A person having ordinary skill in the art could have also obtained similar knowledge and experience through other means.

20. Based on my experiences, I have at least the skills of a person having ordinary skill in the art as well as a good understanding of the capabilities of a person having ordinary skill in the art. To be clear, all of my opinions in this declaration are from the perspective of one of ordinary skill in the art as I have defined it here during the relevant timeframe.

V. LEGAL PRINCIPLES

21. I am not an attorney and offer no legal opinions, but in the course of my work, I have had experience studying and analyzing patents and patent claims from the perspective of a person skilled in the art.

22. For the purposes of this declaration, I have been informed about certain aspects of the law that are relevant to forming my opinions. My understanding of the law is as follows.

23. Petitioners' counsel has informed me that for the prior art to inherently disclose a claimed limitation, the prior art need not expressly disclose the limitation, so long as the claimed limitation necessarily flows from a disclosure in the prior art. I also understand that it is acceptable to examine evidence outside the prior art reference (extrinsic evidence) in determining

whether a feature, while not expressly discussed in the reference, is necessarily present in that reference.

24. Petitioners' counsel has informed me that a patent claim can be considered to have been obvious to a person having ordinary skill in the art at the time the application was filed. I am informed that this means that, even if all of the requirements of a claim are not found in a single prior art reference, the claim is not patentable if the differences between the subject matter in the prior art and the subject matter in the claim would have been obvious to a person having ordinary skill in the art at the time of the invention.

25. I have been informed by Petitioners' counsel that a determination of whether a claim would have been obvious should be based upon several factors, including, among others:

- the level of ordinary skill in the art at the time the application was filed;
- the scope and content of the prior art; and
- what differences, if any, existed between the claimed invention and the prior art.

26. I have been informed by Petitioners' counsel that a single reference can render a patent claim obvious if any differences between that reference and the claims would have been obvious to a person having ordinary skill in the art.

Alternatively, I understand that the teachings of two or more references may be

combined in the same way as disclosed in the claims, if such a combination would have been obvious to one having ordinary skill in the art. In determining whether a combination based on either a single reference or multiple references would have been obvious, it is appropriate to consider, among other factors:

- whether the teachings of the prior art references disclose known concepts combined in familiar ways, and when combined, would yield predictable results;
- whether a person having ordinary skill in the art could implement a predictable variation, and would see the benefit of doing so;
- whether the claimed elements represent one of a limited number of known design choices, and would have a reasonable expectation of success by those skilled in the art;
- whether a person having ordinary skill would have recognized a reason to combine known elements in the manner described in the claim;
- whether there is some teaching or suggestion in the prior art to make the modification or combination of elements claimed in the patent; and
- whether the innovation applies a known technique that had been used to improve a similar device or method in a similar way.

27. I have been informed by Petitioners' counsel that one of ordinary skill in the art has ordinary creativity and is not an automaton. Petitioners'

counsel has also informed me that in considering obviousness, obviousness may not be determined using the benefit of hindsight, including hindsight derived from the patent being considered.

28. I further understand that a hypothetical person having ordinary skill in the art is assumed to know and to have all relevant prior art in the field of endeavor covered by the patent at issue. I have been informed that there are two criteria for determining whether prior art is analogous and thus can be considered prior art: (1) whether the art is from the same field of endeavor, regardless of the problem addressed, and (2) if the reference is not within the field of the patentee's endeavor, whether the reference still is reasonably pertinent to the particular problem with which the patentee is involved. I have also been informed that the field of endeavor of a patent is not limited to the specific point of novelty, the narrowest possible conception of the field, or the particular focus within a given field. I have also been informed that a reference is reasonably pertinent if, even though it may be in a different field from that of the patentee's endeavor, it is one which, because of the matter with which it deals, logically would have commended itself to a patentee's attention in considering their problem.

29. I further understand that, in making a determination as to whether the claimed invention would have been obvious to a person having ordinary

skill, the Board may consider certain objective factors if they are present, such as: commercial success of products practicing the claimed invention; long-felt but unsolved need; teaching away; unexpected results; copying; and praise by others in the field. These factors are generally referred to as “secondary considerations” or “objective indicia” of nonobviousness. I understand, however, that for such objective evidence to be relevant to the obviousness of a claim, there must be a causal relationship (called a “nexus”) between the claim and the evidence and that this nexus must be based on a novel element of the claim rather than something in the prior art. I also understand that even when they are present, secondary considerations may be unable to overcome primary evidence of obviousness (such as motivation to combine with predictable results) that is sufficiently strong.

30. I have been informed by Petitioners’ counsel that for a patent claim in a later-filed application to be entitled to the priority date of an earlier-filed application, the specification of the earlier-filed application must adequately support the patent claim of the later-filed application. This means that the specification of the earlier-filed application must provide an adequate written description of the invention claimed in the later-filed application.

31. I have been informed by Petitioners’ counsel that the written description requirement is met if the applicant conveys in the specification with

reasonable clarity to those skilled in the art that he or she possessed the claimed invention as of the filing date of the application. An applicant shows that one is “in possession” of the invention by describing the invention, with all its claimed limitations, not merely that which makes it obvious. A description that merely renders the later-filed claim obvious is not sufficient. One may satisfy the written description requirement with words, structures, figures, diagrams, and/or formulas that fully set forth the claimed invention. Although the exact terms of the claim need not be recited verbatim in the specification, the specification must contain an equivalent description of the claimed subject matter.

32. I am also informed that the failure to include in the written description aspects of the claimed invention that would be routinely known and understood by one of ordinary skill in the art when the application was filed will not be fatal to the validity of the claim if such aspects are inherent to what was disclosed. To be inherent, the missing descriptive matter must necessarily be present in the specification such that one skilled in the art would recognize such a disclosure.

VI. MATERIALS CONSIDERED

33. My analysis and conclusions set forth in this declaration are based on my educational background and experiences in the field (see Section II).

Based on my knowledge and experience, I believe that I am considered to be an

expert in the field. Also, based on my knowledge and experience, I understand and know of the capabilities of persons of ordinary skill in the field since the 1990s, and I mentored, participated in organizations, and worked closely with many such persons in the field during that time frame.

34. As part of my independent analysis for this declaration, I have considered the following: the background knowledge/technologies that were commonly known to persons of ordinary skill in this art during the time before the earliest claimed priority date for the '643 patent; my own knowledge and experiences gained from my work experience in the field of the '643 patent and related disciplines; and my experience in working with others involved in this field and related disciplines.

35. In addition, I have analyzed the following publications and materials:

- U.S. Patent 11,683,643 (“’643pat.”) (EX1001)
- File History of U.S. Patent 11,683,643 (EX1004)
- U.S. Provisional Application 60/916,271 (EX1005)
- U.S. Application 12/115,349 (EX1006)
- U.S. Application 12/170,171 (EX1007)
- U.S. Application 13/956,767 (EX1008)
- U.S. Application 16/247,186 (EX1009)

- U.S. Patent 6,754,359 (“*Svean*”) (EX1015)
- U.S. Publication 2006/0153394A1 (“*Beasley*”) (EX1016)
- U.S. Patent 5,251,263 (“*Andrea*”) (EX1017)
- U.S. Publication 2006/0140416 (“*Berg*”) (EX1018)
- U.S. Publication 2018/0115818A1 (“*Asada*”) (EX1019)
- U.S. Publication 2014/0270200A1 (“*Usher*”) (EX1020)
- U.S. Publication 2001/0046304A1 (“*Rast*”) (EX1021)
- U.S. Publication 2018/0160211A1 (“*Kirsch*”) (EX1022)
- EP1594344 (“*Stirnemann*”) (EX1023)
- U.S. Publication 2007/0009122A1 (“*Hamacher*”) (EX1024)
- U.S. 5,862,065 (“*Muthusamy*”) (EX1025)
- U.S. Publication 2002/0141599A1 (“*Trajkovic*”) (EX1026)
- U.S. Publication 2003/0147544A1 (“*Lichtblau*”) (EX1027)
- U.S. Patent 7,209,568 (“*Arndt-568*”) (EX1028)
- U.S. Patent 6,826,286 (“*Arndt-286*”) (EX1029)
- U.S. Publication 2020/0380945A1 (“*Woodruff*”) (EX1030)
- U.S. Patent 6,415,034 (“*Hietanen*”) (EX1031)
- EP 1385324 (“*Pedersen*”) (EX1032)
- U.S. Publication 2005/0168824 (“*Travers*”) (EX1033)
- U.S. Publication 2006/0135085 (“*Chen*”) (EX1034)

- Excerpt from COMPUTER DICTIONARY (2d ed. 1994) (“*Computer Dictionary*”) (EX1035)
- Kuo, et al., “Active Noise Control: A Tutorial Review,” In Proc. IEEE 87(6) (June 1999) (“*Kuo*”) (EX1036)
- U.S. Publication 2007/0223717A1 (“*Boersma*”) (EX1037)
- U.S. Patent 5,636,351 (“*Lee*”) (EX1038)

and any other materials I refer to in this declaration in support of my opinions.

36. My analysis and conclusions set forth in this declaration are based on the perspective of a person having ordinary skill in the art.

VII. INTERPRETATION OF THE '643 PATENT CLAIMS

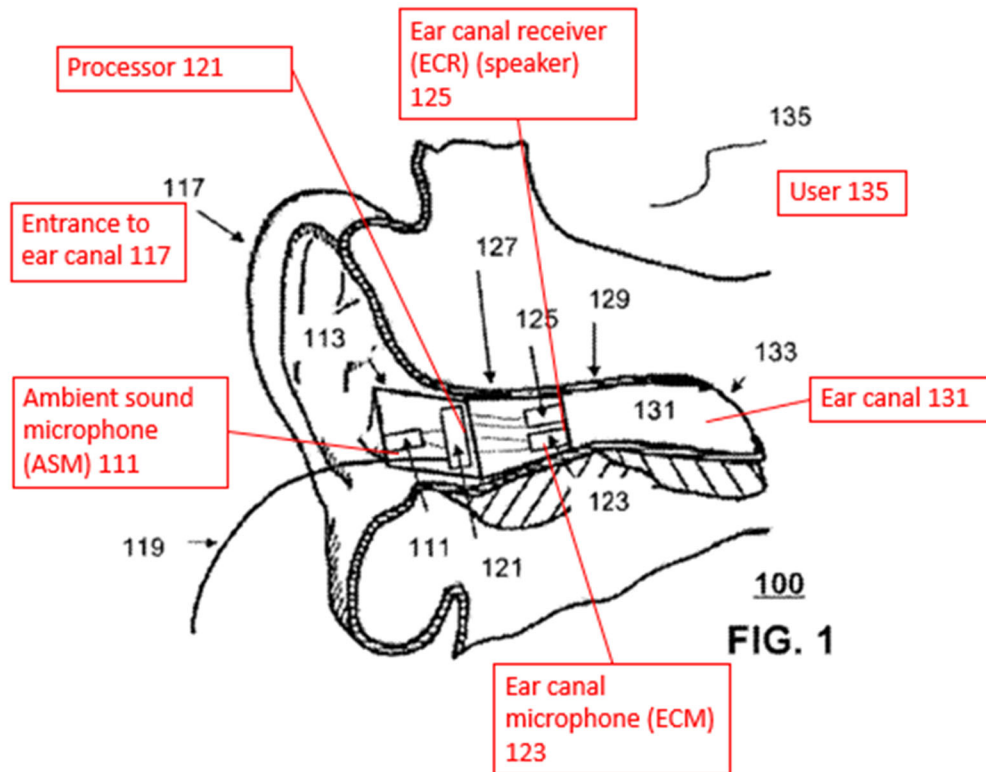
37. I have given all the claim terms their plain and ordinary meaning, as would have been understood by a person having ordinary skill in the art, at the time of the alleged invention, having taken into consideration the language of the claims, the specification, and the prosecution history of record.

VIII. OVERVIEW OF THE '643 PATENT

A. THE SPECIFICATION

38. The '643 patent is directed to “a method and device for suppressing echo in an ear-canal when capturing a user’s voice when using an ambient sound microphone and an ear canal microphone.” ’643*pat.*, 1:22-30. Figure 1 is a diagram of an earpiece including an ambient sound microphone (ASM), ear

canal receiver (ECR/speaker) 125, and an ear canal microphone (ECM) 123. *Id.*, 6:16-20, 6:30-32.



'643pat., FIG. 1 (annotated)²

39. In sum, the earpiece processor measures a background noise signal and a voice activity level based on signals captured by the ASM and ECM. The ASM signal and the ECM signal may be mixed in a ratio that depends on those measurements, and then the mixed signal is looped back to the user through the speaker. For example, at *low* background noise levels and *low* voice activity

² I have added all emphases/color/annotations added unless noted otherwise

levels, the ASM signal can be amplified relative to the ECM signal in producing the mixed signal. *Id.*, 2:40-43. At **high** background noise levels and **high** voice activity levels, the ECM signal (which is less susceptible to background noise) can be amplified relative to the ASM signal in producing the mixed signal. *Id.*, 2:46-49.

40. Figure 6 is a schematic of an operational unit 600 of the acoustic management module for in-ear canal echo suppression. *Id.*, 10:46-48. “During operation, the echo suppressor 610 monitors the mixed signal 323 delivered to the ECR 125 and produces an echo estimate $\tilde{y}(n)$ of an echo $y(n)$ 609.” *Id.*, 11:7-10. The echo suppressor 610 then “subtracts the echo estimate $\tilde{y}(n)$ from the electronic internal signal 410 to produce the modified electronic internal signal $e(n)$ 412.” *Id.*, 11:14-16.

sending a signal including ambient sound to the speaker, and the applicant argued that *Hietanen* is not designed to introduce ambient sound into the auditory tube 10. *Id.*, at 549, 554. As another example, the amended claims require a single earpiece including two ambient microphones, an ear canal microphone, a processor, and a memory, and the applicant argued that the cited art fails to disclose such an earpiece. *Id.*, at 555. In particular, the applicant explained that the claimed combination is important “since two ambient sound microphones allow more functionality, for example that can be used for beam sampling to detect voices.” *Id.*, at 556.

43. Following another applicant amendment to the preamble, the Office mailed a Notice of Allowance on April 27, 2023. *Id.*, at 16.

C. THE CLAIMS

44. The table below includes identifiers for the '643 patent claims and limitations, which are referenced throughout.

Claim 1	
1.pre	A device, comprising:
1.1	a first ambient microphone configured to generate a first ambient signal, wherein the first ambient microphone is part of an earpiece;
1.2	a second ambient microphone configured to generate a second ambient signal, wherein the second ambient microphone is part of the earpiece;
1.3	an ear canal microphone configured to generate an ear canal signal, wherein the ear canal microphone is part of the earpiece;
1.4	a speaker, wherein the speaker is part of the earpiece;

1.5	an eartip, configured to seal the earpiece between a first side and a second side of the earpiece;
1.6	a memory that stores instructions; and
1.7	a processor, wherein the processor is part of the earpiece, wherein the processor is operatively connected to the first ambient microphone, wherein the processor is operatively connected to the second ambient microphone, wherein the processor is operatively connected to the ear canal microphone, wherein the processor is operatively connected to the speaker, wherein the processor is operatively connected to the memory, wherein the processor is configured to execute the instructions to perform operations, the operations comprising:
1.8	receiving a first microphone signal, wherein the first microphone signal is at least one of the first ambient signal or a modified first ambient signal;
1.9	receiving a second microphone signal, wherein the second microphone signal is at least one of the ear canal signal or a modified ear canal signal;
1.10	receiving a third microphone signal, wherein the third microphone signal is at least one of the second ambient signal or a modified second ambient signal;
1.11	generating a background noise reduction signal using either the first and second microphone signals or the second and third microphone signals;
1.12	mixing an audio content signal and the background noise reduction signal generating a mixed signal; and
1.13	sending a modified mixed signal to the speaker.
Claim 2	
2	The device according to claim 1, wherein the operations further comprise: generating an ambient signal from at least one of the first ambient signal or the second ambient signal or a combination of both.
Claim 3	
3	The device according to claim 2, wherein the operations further comprise: sending a modified ambient signal to the speaker.

Claim 4	
4	The device according to claim 3, where the modified ambient signal is the ambient signal.
Claim 5	
5	The device according to claim 3, wherein the operations further comprise: generating the modified ambient signal by filtering an ambient signal, wherein the ambient signal is generated from at least the first ambient sound signal or the second ambient sound signal.
Claim 6	
6	The device according to claim 3, wherein the operations further comprise: generating a modified ambient signal by filtering the ambient signal and modifying an amplitude of at least one frequency of the ambient signal.
Claim 7	
7	The device according to claim 1, wherein the modified mixed signal is the mixed signal.
Claim 8	
8	The device according to claim 1, wherein the operations further comprise: generating the modified mixed signal by mixing the mixed signal with an ambient signal, wherein the ambient signal is generated from at least one of the first ambient signal, the second ambient signal or a combination of both.
Claim 9	
9	The device according to claim 8, wherein the operations further comprise: analyzing at least one of the ambient signal or the ear canal signal or a combination of both, to detect a user's voice.
Claim 10	
10	The device according to claim 9, wherein the operations further comprise: reducing the audio content signal prior to generating the mixed signal if the user's voice is detected.

Claim 11	
11	The device according to claim 9, wherein the operations further comprise: reducing the ambient signal prior to generating the mixed signal if the user's voice is not detected.

IX. THE CLAIMS OF THE '643 PATENT ARE NOT ENTITLED TO A PRIORITY DATE EARLIER THAN MARCH 29, 2021

45. The '643 patent issued from U.S. application number 17/215,804 ("804App."), and claims priority as a continuation-in-part of U.S. application number 16/247,186 ("186App.") filed on January 14, 2019. As explained below, the '186App. does not include a written description from which a POSITA would have concluded that the applicant was in possession of the '643 patent claimed invention as of January 14, 2019. The '186App. incorporates by reference U.S. Application Nos. 13/956,767 ("767App."); 12/170,171 ("171App."); 12/115,349 ("349App."), and Provisional Application No. 60/916,271 ("271PROV.") (together, the "Priority Applications"). '186App ¶[0001]. For purposes of this analysis, I consider the disclosures of the Priority Applications as part of the disclosure of the '186App.

A. No support for a single earpiece including a "first" and "second" "ambient microphone."

46. Claim 1 requires "a first ambient microphone" that is "part of an earpiece" and a "second ambient microphone" that is "part of the earpiece." '643pat., 16:30-35. Patent Owner added this limitation to the claim by

amendment during prosecution, and Patent Owner distinguished the prior art on the basis of this limitation, explaining that it provides “more functionality” such as “beam sampling.” EX1004, 544, 555-556.

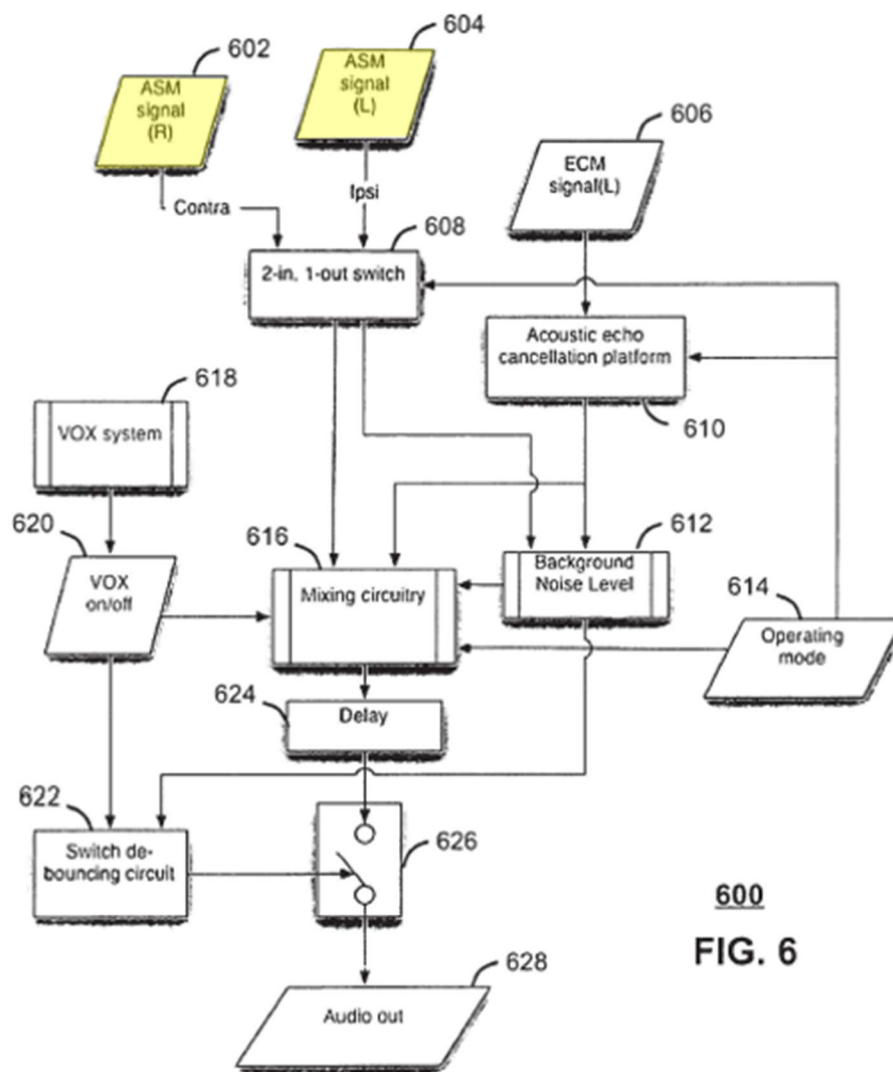
47. In my opinion, the ’186App. does not disclose this feature. The ’186App. discloses at most one ambient sound microphone in a single earpiece. *See* ’186App. ¶[0031] (“Earpiece 100 includes an Ambient Sound Microphone (ASM) 111 to capture ambient sound.”).

48. Patent Owner may argue that the disclosures in paragraphs [0006] and [0010] of the ’186App.—which describe “a method for in-ear canal echo suppression control” including a step of capturing an ambient signal “from at least one Ambient Sound Microphone (ASM)” —discloses a single earpiece with two ASMs. But those disclosures are insufficient because a POSITA would have understood that the ’186App. only disclosed the structure of a single earpiece with a single ASM, and that the disclosed method involved capturing ambient sound signals at an ASM in each of two earpieces. *See* ’349App. ¶¶[0053]-[0054] (describing a “right earpiece ASM signal” and a “left earpiece ASM signal”), FIG. 6. More particularly, that the ’186App. discloses a “method” including the step of capturing an ambient signal “from at least one Ambient Sound Microphone (ASM)” **does not** disclose a single earpiece with two ASMs because that description is a reference to a **method** that involves capturing an

ambient sound signal from a single ASM in each of left and right earpieces. The '349App., which is incorporated by references into the '186App. ('186App. ¶[0001]), discloses the method with reference to Figure 6 of the '349App.

[0053] **FIG. 6** is a block diagram of a method for an audio mixing system to mix an external microphone signal with an internal microphone signal based on a background noise level and voice activity level in accordance with an exemplary

[0054] As illustrated the mixing circuitry 616 (shown in center) receives an estimate of the background noise level 612 for mixing either or both the *right earpiece ASM signal 602 and the left earpiece ASM signal 604* with the left earpiece ECM signal 606. (The right earpiece ECM signal can be used similarly.) An operating mode 614 selects a switching (e.g., 2-in, 1-out) between *the left earpiece ASM signal 604 and the right earpiece ASM signal 602*. As indicated earlier, the ASM signals and ECM signals can be first amplified with a gain system and then filtered with a filter system (the filtering may be accomplished using either analog or digital electronics). The audio input signals 602, 604, 606 are therefore taken after this gain and filtering process.



600
FIG. 6

'349App, FIG. 6 (annotated)

49. The applicant stated that support for the claim amendment introducing this limitation would be found in “paragraphs [0005], [0006], [0011], [0013], [0044], [0049], and [0050].” EX1004, 548. The table below shows the correspondence between the paragraphs identified by the applicant in the '804App. and the parent '186App. None of the paragraphs identified by the applicant disclose a single earpiece with two ASMs.

'804App.	Parent '186App.
[0005]	The statement “Embodiments in accordance with the present invention provide a method and device for background noise control, ambient sound mixing and other audio control methods associated with an earphone” <u>is not present in any Priority Application.</u> The remainder of the paragraph is analogous to paragraph [0001] of the '186App.
[0006]	[0006]
[0011]	[0011]
[0013]	[0013]
[0044]	[0039]
[0049]	[0044]
[0050]	[0050]

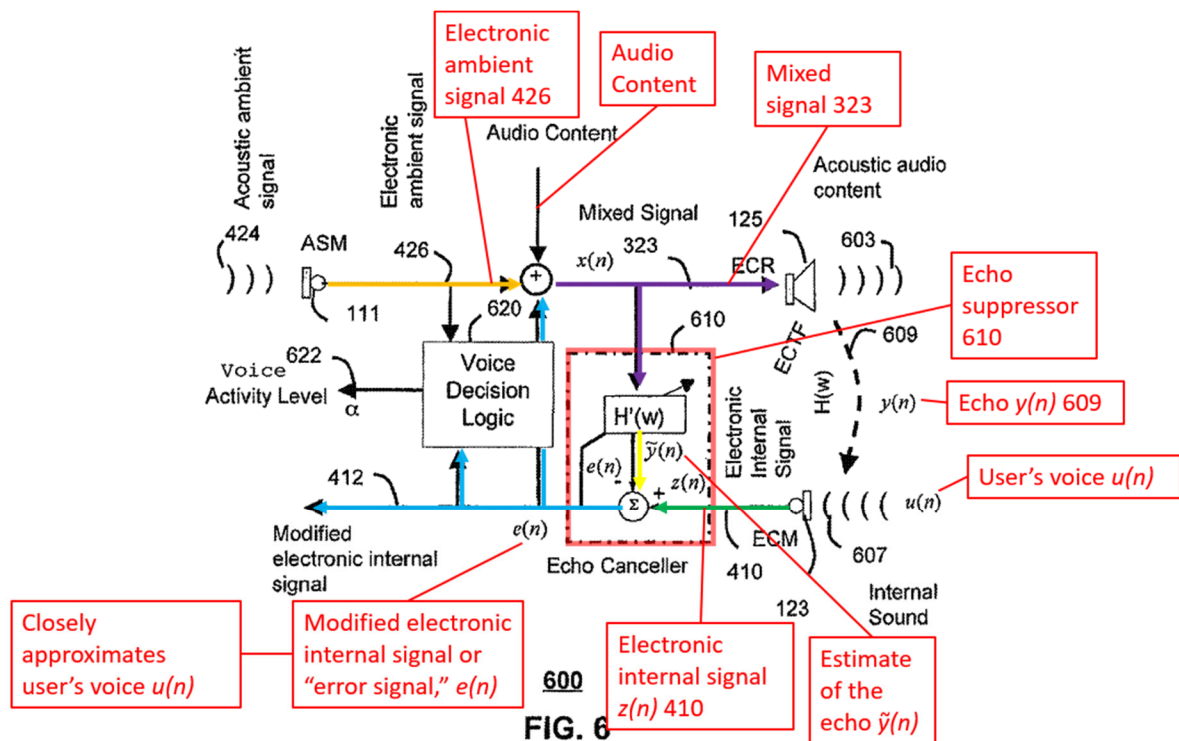
B. No support for “mixing an audio content signal and the background noise reduction signal generating a mixed signal”

50. Claim 1 requires “mixing an audio content signal and the background noise reduction signal generating a mixed signal.” Patent Owner

added this limitation to the claim by amendment during prosecution. EX1004 at 545.

51. In my opinion, the '186App. does not disclose this feature. First, I note that the '186App. does not disclose a “background noise reduction signal.” Patent Owner may argue that the echo estimate signal $\tilde{y}(n)$ discloses a “background noise reduction signal,” but even if true, the '186App. does not disclose mixing the echo estimate signal $\tilde{y}(n)$ with the audio content signal.

52. As illustrated for example in Figures 4 and 6, the '186App. discloses that the audio content signal is mixed with an ambient signal and the internal signal (or “error signal”) $e(n)$, not the echo estimate signal $\tilde{y}(n)$.



'643 Patent, FIG. 6 (annotated)

53. Patent Owner may also argue that a POSITA would have understood the error signal $e(n)$ to be a “background noise reduction signal,” but that would be unreasonable because the error signal $e(n)$ is either of low or no magnitude (when the user is not speaking) or approximates the users voice (when the user is speaking). See ’186App. ¶¶[0055]-[0056], [0061]-[0064]). In this regard, the ’186App refers separately to both “spoken voice” as $u(n)$ and “background noise (if present, for instance due to improper sealing)” as $v(n)$. 186App. ¶¶[0055]-[0056]. This is consistent with the fact that a POSITA would have understood spoken voice and background noise to be two different things.

54. Moreover, the error signal $e(n)$ is used to affirmatively check for the presence of voice in the voice activity detector (VAD). 186App. ¶¶[0048], [0058], [0062]. Thus, a POSITA would have understood the error signal $e(n)$ to be the actual voice that is detected. As a result, when the error signal $e(n)$ is added to the audio content and electronic ambient signal 426, the voice would be added to those signals, not removed. Thus, even if voice were considered noise, the error signal $e(n)$ is not used to reduce noise.

55. Thus, a POSITA would have understood that the error signal could not have the effect of reducing background noise when mixed with the ambient signal and the audio content signal.

56. That the '186App. does not disclose this feature is reinforced by the fact that the '186App. accomplishes noise reduction by filtering the ambient signal and internal signal prior to mixing them with the audio content signal. *See '186App.* ¶¶[0045] (“The acoustic management module 201 filters the electronic ambient signal 426 and the electronic internal 410 signal based on a characteristic of the background noise signal using filter coefficients stored in memory or filter coefficients generated algorithmically.”), [0059] (“The acoustic management module 201 can additionally apply frequency specific filters based on the characteristics of the background noise.”); '349App. ¶¶[0065]-[0066], FIG. 8. In other words, a POSITA would have understood that the '186App. does not disclose mixing a “background noise reduction signal” with an “audio content signal” because the '186App. affirmatively discloses reducing noise by implementing a filtering technique, not by generating and mixing a “background noise reduction signal” with an audio content signal.

C. No support for dependent claim 8

57. Independent claim 1 recites “sending a modified mixed signal to the speaker,” and dependent claim 8 recites “generating the modified mixed signal by mixing the mixed signal with an ambient signal.” '643 patent, 18:1-7. A POSITA would have understood claim 8 to require two-step mixing. That is, “generating a mixed signal” as required by claim 1, and then mixing *the mixed*

signal with an “ambient signal”—i.e., two-step mixing. There is no disclosure of this feature in the ’186App. Even if the ’186App. discloses the claimed “mixed signal” (it does not for the reasons discussed in §IX.B), the ’186App. does not disclose mixing any “ambient signal” with an already mixed signal.

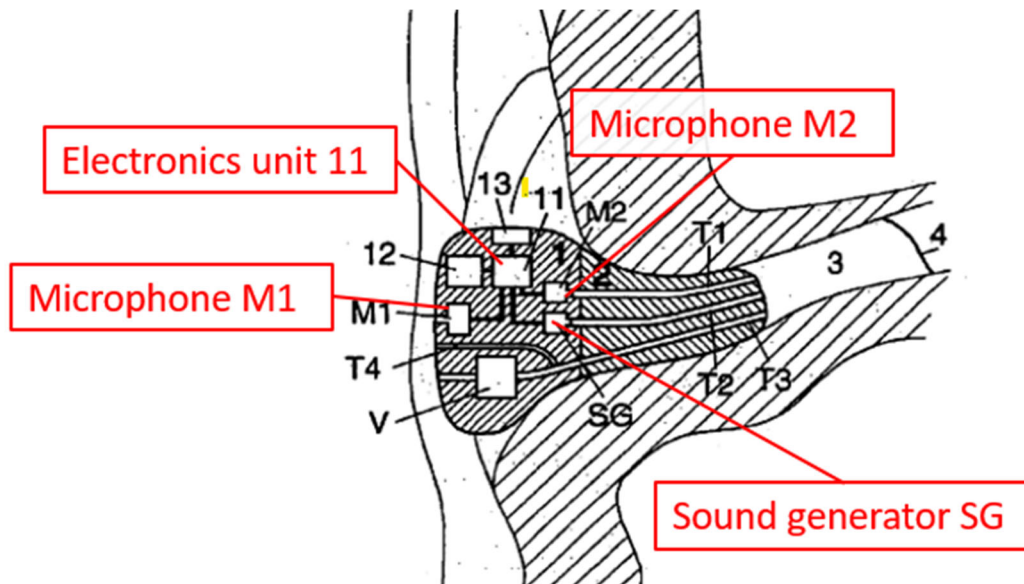
X. SPECIFIC GROUNDS FOR CHALLENGE

A. GROUND 1A: *SVEAN* IN COMBINATION WITH *BEASLEY* AND *ANDREA* RENDERS CLAIMS 1-11 OBVIOUS

1. Overview of *Svean-Beasley-Andrea*

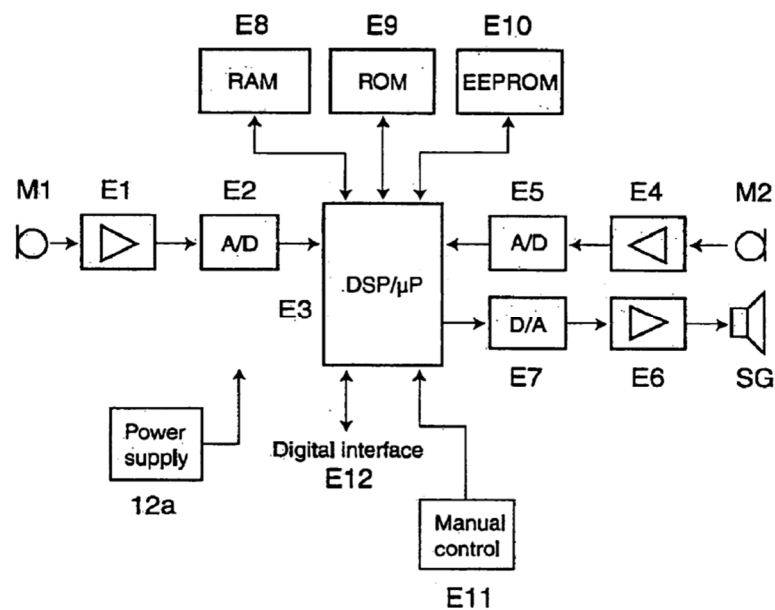
58. The ’643 patent claims are an obvious combination of *Beasley*’s audio bypass feature and *Andrea*’s noise-cancelling technique in *Svean*’s ear terminal. *Svean*, *Andrea*, and *Beasley* are analogous to the ’643 patent because they are within the same field of endeavor of the ’643 patent and/or reasonably pertinent to one or more problems addressed by the ’643 patent.

59. *Svean* discloses an ear terminal that acts as a hearing protector and has wireless communication capabilities. *Svean*, 1:24-27. The ear terminal includes an outer microphone M1, an inner microphone M2, a sound generator (speaker), and an electronics unit 11. *Id.*, 5:29-51, 5:57-61.



Svean, FIG. 1 (cropped and annotated)

60. The electronics unit in *Svean*'s ear terminal includes a digital signal processor and memory for storing programs. *Id.*, 6:33-58. A digital interface E12 exchanges digital audio signals to and from the ear terminal from other devices, including communication signals. *Id.*, 6:59-7:13.



Svean, FIG. 2

61. *Svean* discloses that its ear terminal can perform “active noise cancelling by feedback of acoustic signals” from “microphones (M1, M2) through[] the sound generator (SG),” but notes that the “algoritmes [*sic*] for noise control are per se known and will not be described in any detail.” *Id.*, 4:45-50. *Svean* further explains that “[r]estoration of ***desired*** sounds (***external sounds and signals from [a] communication system***) ... is achieved by using the same microphones M1, M2 and loudspeaker SG and the electronics unit 11” but, again, explains that the “algoritmes [*sic*] for obtaining this are per se known and will not be described in any detail here.” *Id.*, 4:51-62.

62. To the extent a POSITA required additional details for implementing active (1) noise cancellation and (2) restoration of desired sounds in *Svean*’s ear terminal, a POSITA would have readily identified *Beasley* and *Andrea*. With respect to restoring desired sounds in a noise cancelling ear terminal, a POSITA would have readily identified *Beasley*, which discloses a headset with various features related to providing ambient pass-through and audio signals (i.e., restoring desired sounds) in a noise-cancelling headset. As discussed below, a POSITA would have been motivated to implement these related features in *Svean*’s ear terminal.

63. *Beasley* discloses improving active noise-reducing headsets by providing an ambient sound passthrough feature. *Beasley* ¶[0006]-[0009]. More

particularly, *Beasley* discloses an “audio bypass module 306 ... implemented to allow background sounds originating outside the headset to more readily be heard by the user of an audio headset.” *Id.* ¶[0033].

64. *Beasley* discloses implementing its solution in “headset applications where it may be useful or desirable for a user to allow outside audio information such as, for example, a conversation to pass through the headset so this information can be heard by the user.” *Id.* ¶[0027]. And it may be “implemented utilizing hardware, firmware, software, or a combination thereof, as may be desirable based on the given application.” *Id.* ¶[0033].

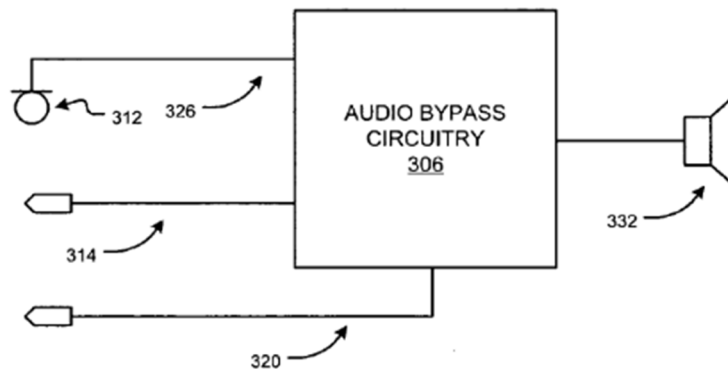
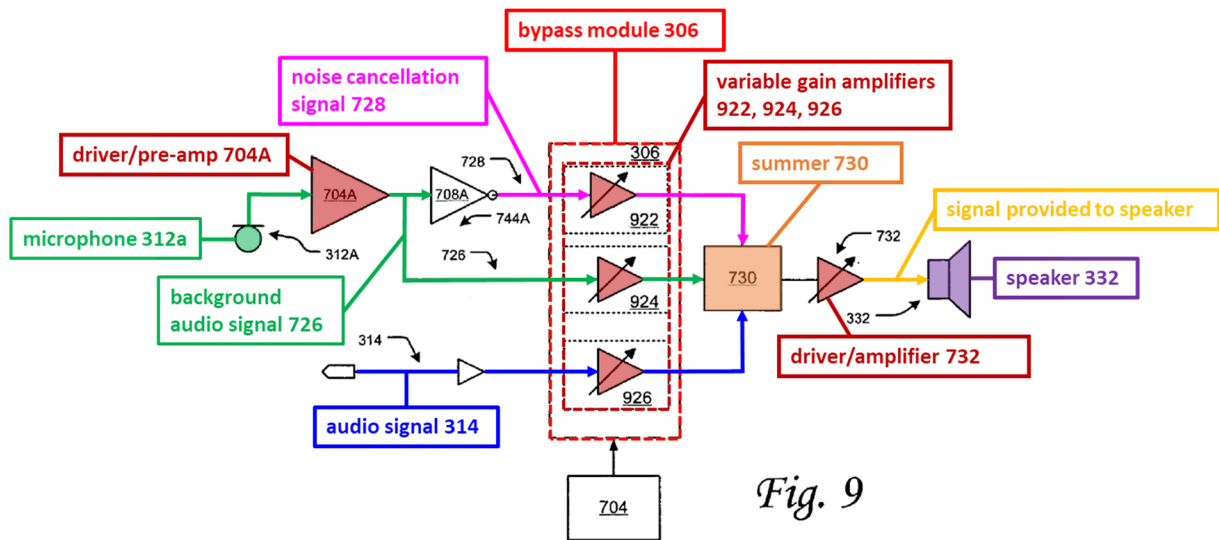


Fig. 3

Beasley, FIG. 3

65. With reference to Figure 9, *Beasley* discloses a bypass module 306 with amplifiers that variably adjust the gain of a noise-cancellation signal 728, a background audio signal 726, and an audio signal 314. The signals are then mixed in summer 730 and amplified by driver/amplifier 732 to generate a signal

that is provided to the speaker 332. *Id.* ¶[0053]. The output of summer 730 is variably amplified by driver/amplifier 732 prior to output from the speaker 332. *Id.* ¶[0051].



Beasley, Fig. 9 (annotated)

66. “[W]hen the audio bypass mode is initiated, the gain of variable gain amplifiers 922 and 926 is attenuated such that noise cancellation signal 728 and audio signal 314 are attenuated and the gain of variable gain amplifier 924 is increased such that the background audio signal 726 is amplified and readily heard by the user through speaker 332.” *Id.* ¶[0053]. “Conversely, when the bypass mode is terminated, the gain of variable gain amplifier 924 is turned down such that the background audio signal 726 is no longer amplified (or is attenuated to some extent). Additionally, the gain of variable gain amplifier 926 is increased such that audio signal 314 is amplified and can be readily heard by the user via speaker 332.” *Id.* ¶[0053].

67. A POSITA would have been motivated to implement *Beasley*'s teachings related to implementing its audio bypass feature into *Svean*'s ear terminal and would have had a reasonable expectation of success. A POSITA would have considered the combination obvious because it amounted to applying a known technique (*Beasley*'s audio bypass feature) to a known device (the *Svean* ear terminal) ready for improvement (*Svean* already discloses a noise cancelling headset that can restore desired sounds for the user) to yield predictable results (a noise cancelling ear terminal that has *Beasley*'s passthrough feature)

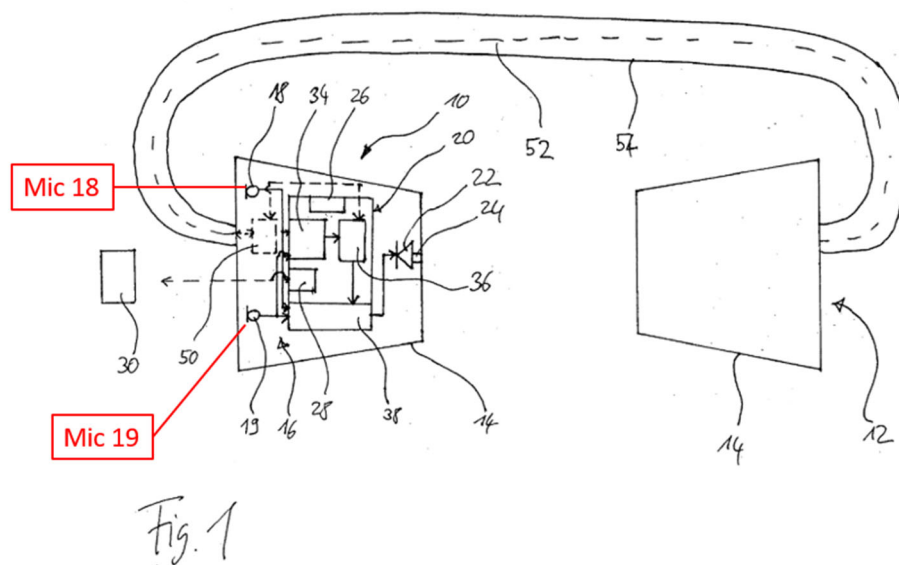
68. *Svean* does not expressly disclose implementing two outer microphones in its ear terminal. Nevertheless, a POSITA would have considered that obvious because there were multiple known motivations for adding a second ambient microphone to *Svean*'s ear terminal. For example, *Beasley* discloses that instead of using a single microphone for generating both the noise-cancellation signal and the background audio signal, one or more additional and separate microphones may be provided. *Beasley* ¶[0056]. "One advantage [of adding an additional microphone], depending on the alternative placement, is that it may allow the microphone(s) 312 to be directed toward the source of the background audio for better pickup." *Id.* Thus, a POSITA would have understood *Beasley* to

expressly suggest a second microphone oriented toward the desired background audio for better pickup.

69. Moreover, a POSITA would have been aware of earpieces similar in form factor and processing capabilities to *Svean*'s ear terminal that implement multiple ambient microphones. This is corroborated, for example, by *Berg*, *Hamacher*, *Trajkovic*, *Stirnemann*, *Lichtblau*, and *Arndt-586*.³

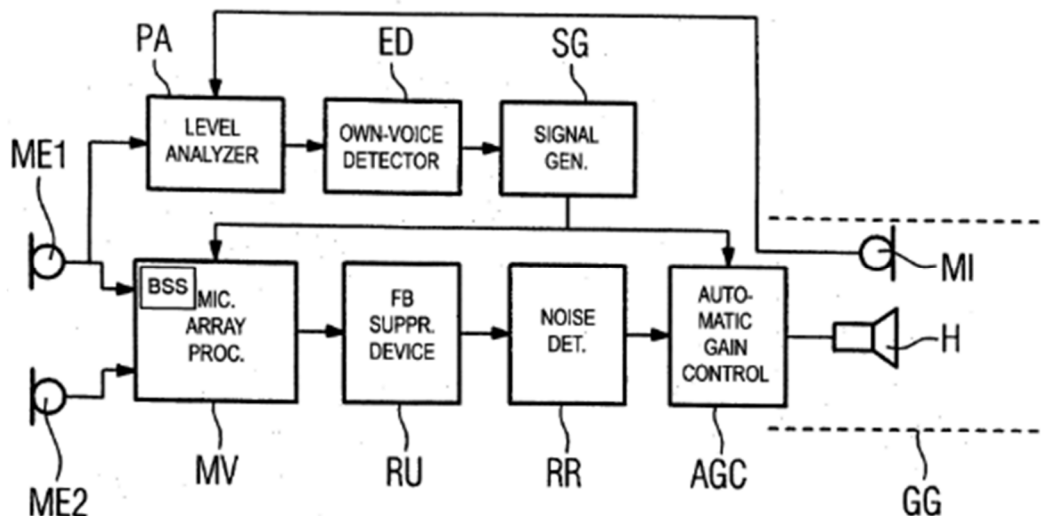
70. As shown in Figure 1 below, *Berg* discloses an earpiece similar to *Svean*'s earpiece with two ambient sound microphones. *Berg* relates to a hearing protection system. *Berg* at Abstract. *Berg* discloses filtering ambient microphone signals according to various modes depending on the level of ambient noise and the detection of speech close to the user. *Id.* ¶[0028]. The use of a second microphone in the earpiece enables *Berg*'s judgement module to “assign angular directions to the input audio signals by analyzing phases of the input audio signals, i.e. by determining the phase difference of the input audio signal provided by the microphone 18 and the input audio signal provided by the microphone 19.” *Id.* ¶[0034].

³ To be clear, I am relying on *Berg*, *Hamacher*, *Trajkovic*, *Stirnemann*, *Lichtblau*, and *Arndt-586* as evidence of the knowledge of a person having ordinary skill in the art and they are not part of the unpatentability ground 1A.



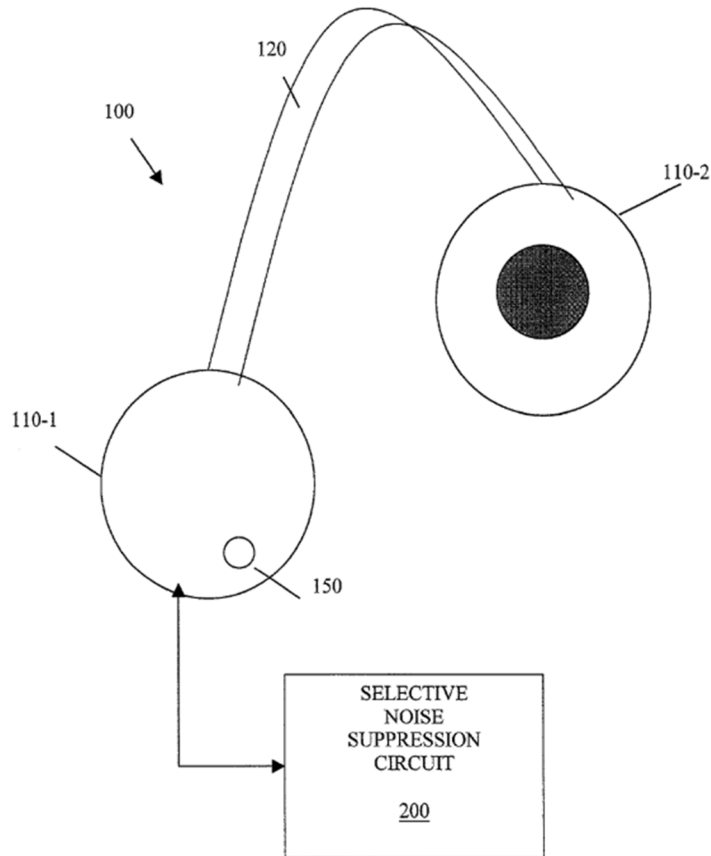
Berg, FIG. 1 (annotated)

71. *Hamacher* discloses a hearing aid earpiece with two external microphones ME1 and ME2 for implementing an adaptive directional microphone. *Hamacher* ¶[0024].



Hamacher FIGURE

72. Trajkovic discloses “a selective noise canceling headset” with “one or more microphones 150 mounted on the earpieces 110 to monitor the external sound at the user's ear.” *Trajkovic* ¶[0017].



Trajkovic, FIG. 1

73. *Stirnemann* confirms that “[m]ost hearing instruments nowadays comprise at least two input microphones (‘outer microphones’ in this text) in order to enable beamforming.” *Stirnemann* ¶[0028]. *Lichtblau* itself discloses a hearing aid that “employs two microphones 820, 821 that form a directional microphone by processing the signals from the two microphones using a suitable signal processor 823, as known in the art.” *Lichtblau* ¶[0064]. *Arndt-568* is yet

another example, disclosing a hearing aid with “at least two microphones” to enable a directional response. *Arndt-568*, 1:43-2:17, 2:33-36.

74. Thus, a POSITA would have found it obvious to add a second ambient microphone as taught by *Beasley* to *Svean* because it amounted to the use of a known technique (*Beasley*’s additional ambient sound microphone) to a known device (*Svean*’s ear terminal) ready for improvement (*Svean*’s ear terminal can accept a second ambient microphone) to yield predictable results (*Svean*’s ear terminal with two outer microphones).

75. A POSITA also would have been motivated to incorporate *Beasley*’s teaching related to providing variable amplification of the output of *Beasley*’s summer in *Svean*. A POSITA would have understood that *Beasley*’s driver/amplifier 732 provides the ability to control the output volume of the summed (i.e., mixed) signal. A POSITA would have recognized that providing variable amplification of the output signal is a common feature of audio systems because users desire control over the volume at which audio is output from the system. This is corroborated, for example, by *Arndt-286*, which explains that “[a]udio amplification devices, such as hearing aids are typically manufactured with volume controls to provide users with the ability to adjust the sound level (i.e. loudness) of output from the devices. Many users of hearing aids appreciate the flexibility provided by a volume control. For example, the volume control

allows users to turn down the hearing aid volume when exposed to loud sounds, or to turn up the hearing aid volume when they want to hear very quiet sounds. Users may also use the volume control to compensate for auditory fatigue, which may occur in the course of a day.” *Arndt-286*, 1:13-23; *see also Boersma ¶[0063]* (“The volume switch 72, also preferably a rheostat in this embodiment, functions to adjust the gain of the amplifier 84. Accordingly, the user may control the gain of the amplifier 84 which amplifies the combined audio and ambient sound signals. As a result, the user may control the overall volume of the sound reproduced by the headset.”).⁴

76. Thus, a POSITA would have found it obvious to further modify the *Svean-Beasley* combination to include variable amplification of the mixed signal because it amounted to applying a known technique (variable amplification of a signal prior to output) to a known device (the *Svean-Beasley* combination) ready for improvement to yield predictable results (the *Svean-Beasley* combination with variable amplification of the mixed signal prior to output).

⁴ To be clear, I am relying on *Arndt-286* and *Boersma* as evidence of the knowledge of a person having ordinary skill in the art and they are not part of the unpatentability ground 1A.

77. With respect to additional details for implementing noise-cancellation in *Svean*'s ear terminal, a POSITA would have readily identified *Andrea*. As an initial note, *Beasley*'s audio bypass feature is not limited to a particular technique for generating a noise-cancellation signal. *See Beasley* ¶[0032] ("Cancellation signal 208 can be generated using an inverter 206, a compensation filter, a DSP, or other circuitry, devices or techniques to create a signal that when provided to speaker 218 cancels all or part of the background noise transduced by microphone 136. The example application illustrated in FIG. 2 shows the use of an inverter 206. However, it will become apparent to one of ordinary skill in the art after reading this discussion how alternative techniques such as those provided in the foregoing examples can be implemented.").

78. *Andrea* discloses a known technique for using external and internal microphones similar to *Svean* to implement noise cancellation and speech enhancement. *Andrea*, 1:26-56. In particular, *Andrea* discloses an in-ear headset unit 40 including a speaker 50, a reference microphone 60 to detect external background signals, and a feedback microphone 70 in the ear canal. *Andrea*, 6:45-51.

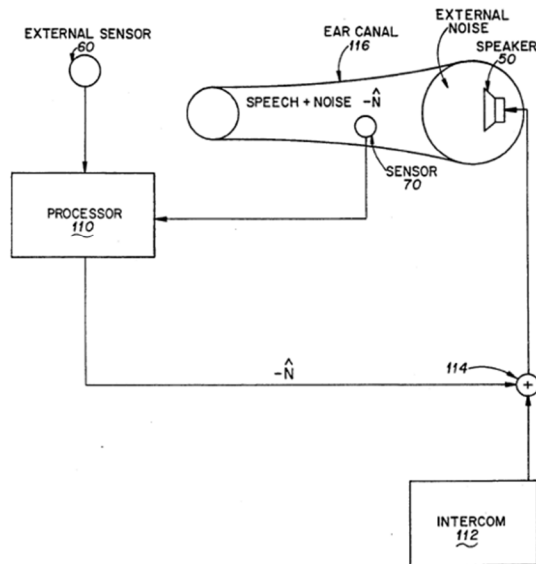


Fig. 5

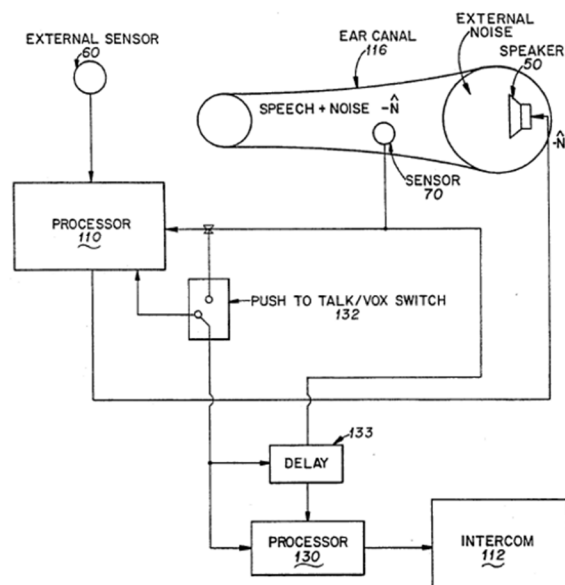


Fig. 6

Andrea, FIGs. 5, 6

79. Andrea discloses the headset operates in two modes—a receive mode (Figure 5) and a transmit mode (Figure 6). *Id.*, 7:8-9. In receive mode, the microphone 60 picks up background sound (e.g., crowd noises) and supplies them to processor 110 along with a feedback or error signal from the microphone 70. *Id.*, 7:10-15. The processor 110 processes the signal and outputs an “anti-noise” signal to a combining circuit 114 along with a signal from an intercom 112. *Id.*, 7:15-25. The combined signal is supplied to the speaker 50 to be heard by the user. *Id.*, 7:25-34.

80. The transmit mode operates when the user wants to speak. *Id.*, 7:35-40. When the user speaks, the system either uses a push-to-talk switch or a

voice-operated switch (VOX switch), which causes the internal feedback microphone signal to no longer be supplied to the processor 110 for generation of the anti-noise signal (because it is currently a voice signal, not an error signal). *Id.*, 7:40-8:2.

81. A POSITA would have been motivated to implement *Andrea's* teachings regarding generating an anti-noise signal into *Svean* and would have had a reasonable expectation of success. *Polish ¶*. A POSITA would have found it obvious to incorporate *Andrea's* teachings regarding noise cancellation into *Svean* because it amounted to the application of a known technique (*Andrea's* noise cancellation technique) to a known device (*Svean's* ear terminal with internal and external microphones and a processor) ready for improvement (*Svean* already discloses active noise cancellation using microphones M1, M2) to yield predictable results (*Svean's* ear terminal implementing a known algorithm for implementing active noise cancellation).

82. As explained further below, the *Svean-Beasley-Andrea* combination discloses or suggests each limitation of the Challenged Claims.

2. Claim 1

a. [1.pre]: A device, comprising:

83. I have been asked to assume the preamble is limiting. *Svean* discloses an “ear terminal.” *Svean*, Abstract. A POSITA would have understood an ear terminal to be a “device.”

84. Accordingly, in my opinion, a POSITA would have understood *Svean* to disclose or suggest an ear terminal (“[a] device”).

b. [1.1]: a first ambient microphone configured to generate a first ambient signal, wherein the first ambient microphone is part of an earpiece;

85. In my opinion, *Svean* discloses or suggests “a first ambient microphone configured to generate a first ambient signal, wherein the first ambient microphone is part of an earpiece.”

86. *Svean*’s “ear terminal” is consistent with how the ’643 patent describes an “earpiece.” ’643 patent, 6:9-15 (“The earpiece 100 can be an in the ear earpiece, behind the ear earpiece, receiver in the ear, open-fit device, or any other suitable earpiece type. The earpiece 100 can be partially or fully occluded in the ear canal, and is suitable for use with users having healthy or abnormal auditory functioning.”). *Svean* discloses that the ear terminal includes an outer microphone M1 that picks up ambient sound. *Svean*, 5:40-42, 6:35-44. *Svean* further explains that “signal[s] from the microphone M1” are amplified, digitized, and fed to processing unit E3. *Id.*, 6:33-37; *see also id.*, FIG. 2.

87. Accordingly, in my opinion, a POSITA would have understood *Svean* to disclose or suggest an outer microphone that picks up ambient sound (“a first ambient microphone”) and outputs a signal corresponding to that ambient sound (“configured to generate a first ambient signal”), where the outer microphone is included in the ear terminal (“wherein the first ambient microphone is part of an earpiece”).

c. [1.2]: a second ambient microphone configured to generate a second ambient signal, wherein the second ambient microphone is part of the earpiece;

88. In my opinion, *Svean* in combination with *Beasley* discloses or suggests “a second ambient microphone configured to generate a second microphone signal.”

89. As discussed in §X.A.1, per *Beasley*’s suggestion, it would have been obvious to implement a second ambient microphone in *Svean*’s ear terminal. Moreover, it would have been obvious to implement the second ambient microphone to operate in the same manner as *Svean*’s outer microphone M1—that is, to pick up ambient sound and output a corresponding signal.

90. Accordingly, in my opinion, a POSITA would have understood the *Svean-Beasley* combination to disclose or suggest a second ambient microphone (“a second ambient microphone”) that outputs a signal corresponding to that ambient sound (“configured to generate a second ambient signal”) wherein the

second ambient microphone is included in the ear terminal (“wherein the second ambient microphone is part of the earpiece”).

d. [1.3]: an ear canal microphone configured to generate an ear canal signal, wherein the ear canal microphone is part of the earpiece;

91. In my opinion, *Svean* in combination with *Beasley* discloses or suggests “an ear canal microphone configured to generate an ear canal signal, wherein the ear canal microphone is part of the earpiece.”

92. *Svean* discloses that the ear terminal includes an inner microphone M2 that picks up the sound in the meatus 3 between the isolating section 2 and the tympanum 4. *Svean*, 5:42-43, 6:39-44. This is consistent with how the ’643 patent describes an “ear canal microphone” that is part of the earpiece. ’643 patent, 6:16-20 (“Earpiece 100 includes ... an Ear Canal Microphone (ECM) 123 to assess a sound exposure level within the ear canal 131.”).

93. *Svean* further explains that “[a] signal 51 from microphone M2, ... is amplified in the amplifier E4 and sampled and digitised [*sic*] in the analogue to digital converter E5 and fed to the processing unit E3.” *Id.*, 6:39-44. A POSITA would have understood that, because *Svean* describes amplifying, digitizing, and processing “signal 51 from microphone M2” and that microphone M2 picks up the sound present in the meatus, just outside the eardrum, *Svean*’s

microphone M2 captures sound in the ear canal and is configured to generate an ear canal signal.

94. Accordingly, in my opinion, a POSITA would have understood the *Svean-Beasley* combination to disclose or suggest an inner microphone that picks up sound present in the meatus just outside the eardrum (“an ear canal microphone”) and generates a signal corresponding to that sound (“configured to generate an ear canal signal”), where the inner microphone is included in the ear terminal (“wherein the ear canal microphone is part of the earpiece”)

e. [1.4]: a speaker, wherein the speaker is part of the earpiece;

95. In my opinion, *Svean* in combination with *Beasley* discloses or suggests “a speaker, wherein the speaker is part of the earpiece.”

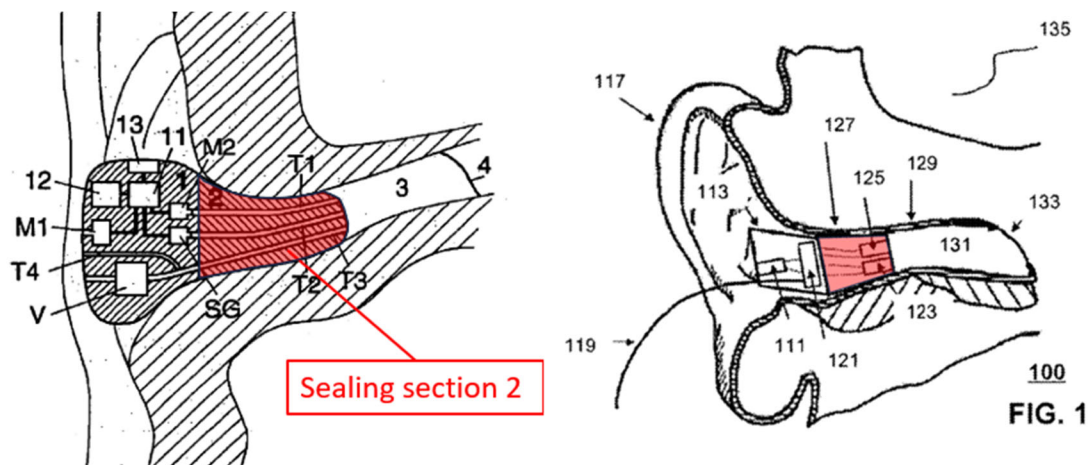
96. *Svean* discloses that the ear terminal includes “a sound generator SG.” *Svean*, 5:30-31; *see also id.*, 6:45-51.

97. Accordingly, a POSITA would have understood the *Svean-Beasley* combination to disclose or suggest an ear terminal (“an earpiece”) including a sound generator or loudspeaker (“a speaker, wherein the speaker is part of the earpiece”).

- f. [1.5]: an eartip, configured to seal the earpiece between a first side and a second side of the earpiece;

98. In my opinion, *Svean* in combination with *Beasley* discloses or suggests “an eartip, configured to seal the earpiece between a first side and a second side of the earpiece.”

99. *Svean* discloses that the ear terminal includes a “sealing section 2” that is attached to the main section 1 of the ear terminal. *Svean*, 4:29-33. *Svean* further explains that “[t]he sealing section may be an integral part of the earplug, or it may be interchangeable.” *Id.*, 5:38-40. A POSITA would have understood that Figure 1 of the '643 patent illustrates an eartip and that it is consistent with *Svean*'s sealing section 2.



Left: *Svean* FIG. 1 (excerpted and annotated); Right: '643 patent, Fig.1
(annotated)

100. Accordingly, in my opinion, a POSITA would have understood the *Svean-Beasley* combination to disclose or suggest an ear terminal (“an earpiece”) where the ear terminal includes a sealing section 2 (“an eartip”) that is configured to seal off the inner portion of the meatus just outside the eardrum when the earplug is inserted into the wearer’s ear (“configured to seal the earpiece between a first side and a second side of the earpiece”).

- g. **[1.6.] and [1.7]: a memory that stores instructions; and a processor, wherein the processor is part of the earpiece, wherein the processor is operatively connected to the first ambient microphone, wherein the processor is operatively connected to the second ambient microphone, wherein the processor is operatively connected to the ear canal microphone, wherein the processor is operatively connected to the speaker, wherein the processor is operatively connected to the memory, wherein the processor is configured to execute the instructions to perform operations, the operations comprising;**

101. In my opinion, *Svean* in combination with *Beasley* discloses or suggests “a memory that stores instructions; and a processor, wherein the processor is part of the earpiece, wherein the processor is operatively connected to the first ambient microphone, wherein the processor is operatively connected to the second ambient microphone, wherein the processor is operatively connected to the ear canal microphone, wherein the processor is operatively connected to the speaker, wherein the processor is operatively connected to the

memory, wherein the processor is configured to execute the instructions to perform operations.”

102. *Svean* discloses that the ear terminal includes an electronics unit 11 to which the microphones are connected. *Svean*, Abstract, 5:57-61.

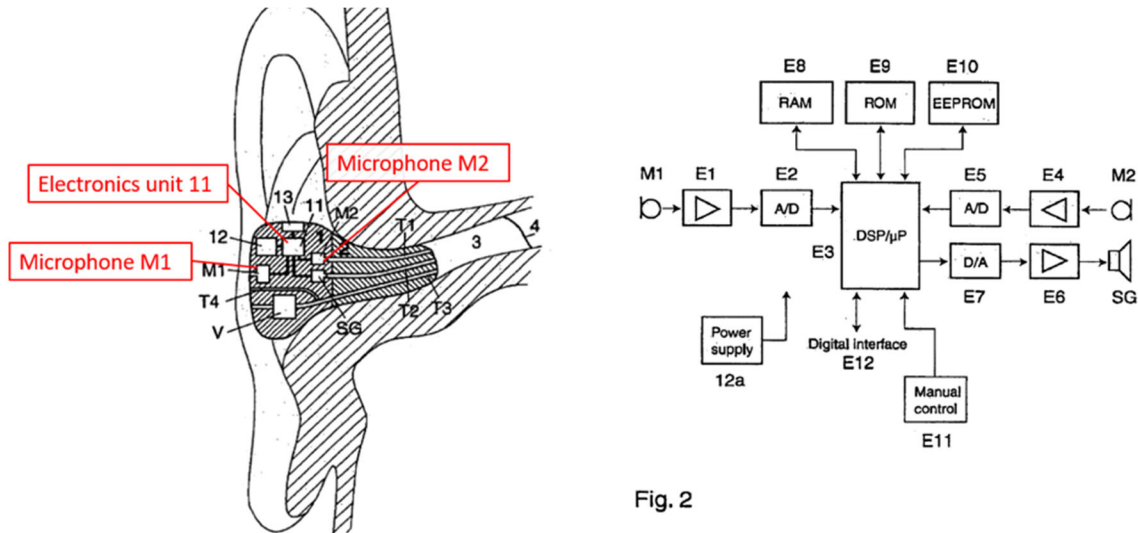


Fig. 2

Svean, FIGs. 1, 2 (annotated)

103. The electronics unit includes a processing unit E3 such as a digital signal processor and memory. *Id.*, 6:33-58. Memories E8, E9, and E10 are used for storing, among other things, “computer programs.” *Id.*, 6:52-58. A POSITA would have understood that computer programs are composed of software instructions.

104. As explained in §§X.A.1 and X.A.2.c, a POSITA would have been motivated to modify *Svean*’s earplug to include two ambient microphones. A POSITA would have understood that in the *Svean-Beasley* combination, the

second ambient microphone would be operatively connected to the electronics unit.

105. Accordingly, a POSITA would have understood the *Svean-Beasley* combination to disclose or suggest an ear terminal (“an earpiece”) including a processing unit (“a processor, wherein the processor is part of the earpiece”) that is operatively connected to two ambient microphones (“wherein the processor is operatively connected to the first ambient microphone, wherein the processor is operatively connected to the second ambient microphone”), connected to an inner microphone (“wherein the processor is operatively connected to the ear canal microphone”), connected to a sound generator (“wherein the processor is operatively connected to the speaker”), and connected to memory that stores computer programs executed by the processing unit (“wherein the processor is operatively connected to the memory, wherein the processor is configured to execute the instructions to perform operations”).

- h. [1.8], [1.9], [1.0]: receiving a first microphone signal, wherein the first microphone signal is at least one of the first ambient signal or a modified first ambient signal; receiving a second microphone signal, wherein the second microphone signal is at least one of the ear canal signal or a modified ear canal signal; receiving a third microphone signal, wherein the third microphone signal is at least one of the second ambient signal or a modified second ambient signal;

106. In my opinion, *Svean* in combination with *Beasley* discloses or suggests “receiving a first microphone signal, wherein the first microphone signal is at least one of the first ambient signal or a modified first ambient signal; receiving a second microphone signal, wherein the second microphone signal is at least one of the ear canal signal or a modified ear canal signal.”

107. *Svean* explains that “[a] **signal from the microphone M1** is amplified in E1 and sampled and digitised [*sic*] in an analogue to digital converter[] E2 and **fed to a processing unit E3** that may be a digital signal processor (DSP), a microprocessor (μP) or a combination of both.” *Id.*, 6:33-37; *see also id.*, FIG. 2. *Svean* similarly explains that “**signal 51 from microphone M2** ... is amplified in the amplifier [E4] and sampled and digitised [*sic*] in the analogue to digital converter E5 and **fed to the processing unit E3.**” *Id.*, 6:37-42; *see also id.*, 7:45-49, FIG. 2.

108. As explained in §§X.A.1 and X.A.2.c, a POSITA would have been motivated to modify *Svean*’s ear terminal to include two outer microphones. A

POSITA would have understood that in the *Svean- Beasley* combination, processing unit E3 would receive a signal from both ambient microphones.

109. Accordingly, in my opinion, a POSITA would have understood the *Svean-Beasley* combination to disclose or suggest *Svean*'s processing unit E3 executing instructions to receive a signal from an outer microphone that picks up ambient sound ("receiving a first microphone signal, wherein the first microphone signal is at least one of the first ambient signal or a modified first ambient signal"); an inner microphone ("receiving a second microphone signal, wherein the second microphone signal is at least one of the ear canal signal or a modified ear canal signal"); and a second outer microphone ("receiving a third microphone signal, wherein the third microphone signal is at least one of the second ambient signal or a modified second ambient signal").

- i. **[1.11]: generating a background noise reduction signal using either the first and second microphone signals or the second and third microphone signals;**

110. In my opinion, the *Svean* in combination with *Beasley* and *Andrea* discloses or suggests "generating a background noise reduction signal using either the first and second microphone signals or the second and third microphone signals."

111. As discussed in §X.A.1, *Svean* discloses that its ear terminal can perform “active noise cancelling,” and *Andrea* discloses an “anti-noise signal” that is generated by using the signals from microphone 60 and microphone 70.

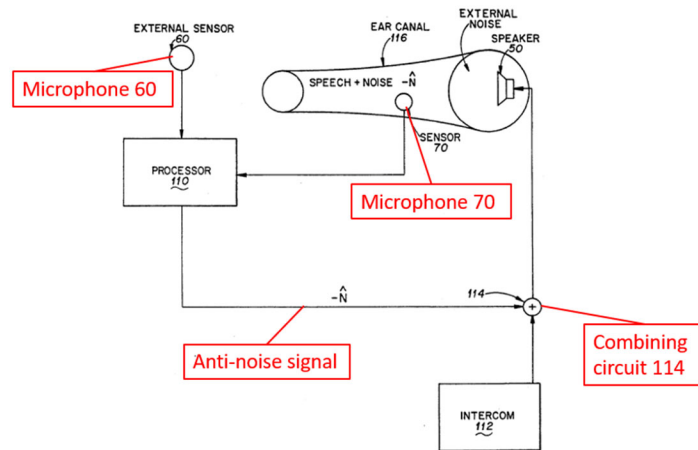


Fig. 5

Andrea, FIG. 5 (annotated)

112. A POSITA would have understood that microphone 60 is analogous to *Svean*’s outer microphone and that microphone 70 is analogous to *Svean*’s inner microphone because the microphone 60 is an “external sensor” for sensing “ambient noise” similar to *Svean*’s outer microphone, and microphone 70 is for picking up the sound in the ear canal. *Andrea*, 14:17-25, 14:35-39. A POSITA would have understood that *Andrea*’s “anti-noise signal” is a “background noise reduction signal” because it reduces ambient noise. *Andrea*, 7:31-34. This is corroborated, for example, by *Kuo*, which explains that “Active noise control (ANC) is achieved by introducing a canceling ‘anti[-]noise’ wave through an

appropriate array of secondary sources.” *Kuo* at Abstract; *see also* Introduction (“Active noise control (ANC) [3]–[6] involves an electroacoustic or electromechanical system that cancels the primary (unwanted) noise based on the principle of superposition; specifically, an anti[-]noise of equal amplitude and opposite phase is generated and combined with the primary noise, thus resulting in the cancellation of both noises.”)

113. A POSITA would have been motivated to combine *Svean* and *Andrea* for the reasons discussed in §X.A.1.

114. Accordingly, in my opinion, a POSITA would have understood the *Svean-Beasley-Andrea* combination to disclose or suggest *Svean*’s processing unit executing instructions to generate an anti-noise signal (“a background noise reduction signal”) using a signal from one of the two outer microphones (“a first microphone signal” and “a third microphone signal,” respectively) and a signal from an inner microphone (“the second microphone signal”) (“using either the first and second microphone signals or the second and third microphone signals”).

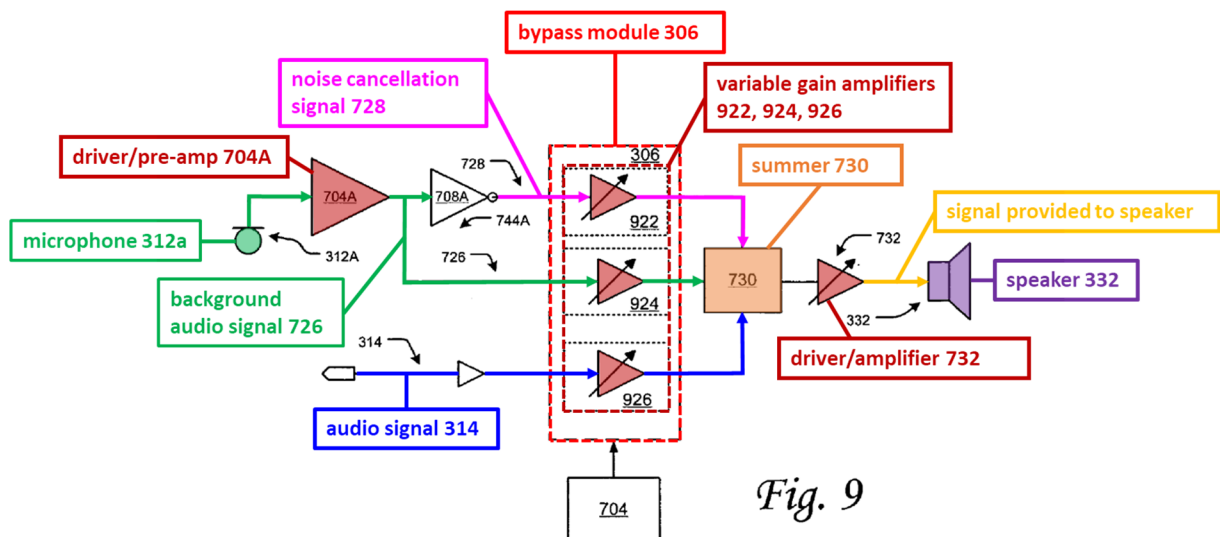
- j. **[1.12] and [1.13] mixing an audio content signal and the background noise reduction signal generating a mixed signal; and sending a modified mixed signal to the speaker.**

115. In my opinion, the *Svean* in combination with *Andrea* and *Beasley* discloses or suggests “mixing an audio content signal and the background noise

reduction signal generating a mixed signal; and sending a modified mixed signal to the speaker.”

116. As discussed in §X.A.1, *Svean* discloses that its ear terminal can perform “active noise cancelling” and restore *desired* sounds for the user, including “external sounds *and* signals from [a] communication system,” and a POSITA would have been motivated to combine *Beasley*’s teachings related its audio bypass mode into *Svean* to implement that feature.

117. *Beasley* discloses mixing the noise-cancellation signal with an audio signal when the audio bypass mode is off. *Beasley* ¶¶[0006], [0050]-[0051]. A POSITA would have understood that *Beasley*’s noise-cancellation signal 728 is analogous to the *Andrea* “anti-noise” signal. As explained in §X.A.2.i, *Andrea*’s “anti-noise” signal is a “background noise reduction signal.”



Beasley, FIG. 9

118. A POSITA would have recognized that *Beasley*'s audio signal is analogous to *Svean*'s signal from a communication system. A POSITA would have understood that *Svean*'s signal from a communication system is consistent with how the '643 patent describes an "audio content signal." '643 patent, 7:55-65.

119. *Beasley* discloses that the functionality of its audio bypass feature may be implemented with software. *Beasley* ¶[0033] ("Audio bypass module 306 in this and the other embodiments described herein can be implemented utilizing hardware, firmware, software, or a combination thereof, as may be desirable based on the given application."); *see also id.* ¶[0064] ("Furthermore, the schematic diagrams are provided to illustrate example implementations of various embodiments of the functionality of the audio bypass feature, and one of ordinary skill in the art after reading this description will understand how to implement these features and functions utilizing alternative configurations of hardware, software, firmware or combinations thereof."). A POSITA would have understood that software is executed by a processor, and that *Svean* discloses that its processor is capable of executing programs stored in memory. *Svean*, 6:52-58, 7:3.

120. Thus, the *Svean-Beasley-Andrea* combination discloses or suggests *Svean*'s processing unit mixing *Andrea*'s anti-noise signal ("background noise

reduction signal”) with *Svean*’s signal from a communication device (“audio content signal”) to implement noise cancellation while outputting desired sounds from the communication system and the audio bypass mode is off.

121. As explained in §X.A.1, the *Svean-Beasley* combination discloses or suggests variably amplifying the mixed signal before it is output from the speaker. A POSITA would have understood that variably amplifying the mixed signal modifies it.

122. Accordingly, a POSITA would have understood the *Svean-Beasley-Andrea* combination to disclose or suggest *Svean*’s processing unit executing instructions to sum (“mixing”) signals from a communication system (“an audio content signal”), and an anti-noise signal (“the background noise reduction signal”) to produce a summed signal (“generating a mixed signal”) and amplifying the mixed signal before outputting to the speaker (“sending a modified mixed signal to the speaker”).

3. Claim 2: The device according to claim 1, wherein the operations further comprise: generating an ambient signal from at least one of the first ambient signal or the second ambient signal or a combination of both

123. In my opinion, the *Svean-Beasley-Andrea* combination discloses or suggests this claim.

124. *Svean* discloses that its ear terminal can restore desired external sounds and that doing so “may include amplification of chosen frequencies

converted by said the [sic] microphone (M1) and generating a corresponding acoustic signal through said sound generator (SG).” *Svean*, 4:49-67. A POSITA would have understood that “amplification of chosen frequencies” to comprise filtering the signal because that is how certain frequencies are amplified relative to others. This is corroborated by *Beasley*, which discloses a similar functionality and expressly discloses using a bandpass filter “to allow frequency components within the range of human speech” to be passed through. *Beasley* ¶[0052]. A POSITA would have considered that *Svean*’s filtering process “generat[es] an ambient signal” from at least one of the two ambient microphones in the *Svean-Beasley-Andrea* combination. I note that neither the claims nor the specification specify how the claimed “ambient signal” must be generated—only that it is generated “from at least one of the first ambient signal or the second ambient signal or a combination of both.”

125. Accordingly, a POSITA would have understood the *Svean-Beasley-Andrea* combination to disclose or suggest *Svean*’s processing unit executing instructions to filter a signal from at least one of the two outer microphones (“generating an ambient signal from at least one of the first ambient signal or the second ambient signal or a combination of both”).

4. **Claims 3-6: Claim 3 (“The device according to claim 2, wherein the operations further comprise: sending a modified ambient signal to the speaker.”) Claim 4 (“The device according to claim 3, where the modified ambient signal is the ambient signal.”) Claim 5 (“The device according to claim 3, wherein the operations further comprise: generating the modified ambient signal by filtering an ambient signal, wherein the ambient signal is generated from at least the first ambient sound signal or the second ambient sound signal.”) Claim 6 (“The device according to claim 3, wherein the operations further comprise: generating a modified ambient signal by filtering the ambient signal and modifying an amplitude of at least one frequency of the ambient signal.”)**

126. In my opinion, the *Svean-Beasley-Andrea* combination discloses or suggests these claims.

127. As explained in §X.A.1, a POSITA would have found it obvious to implement *Beasley*’s teachings regarding audio bypass mode into *Svean*. *Beasley* discloses that when audio bypass mode is initiated, the gain of variable gain amplifier 924 is increased such that the background audio signal 726 is amplified and readily heard by the user through speaker 332.” *Beasley*, ¶[0053].

128. As discussed in §X.A.3, *Svean* discloses amplifying certain frequencies of the outer microphone signal, i.e., filtering the signal (“generating an ambient sound signal”). A POSITA would have understood that in the combination, *Svean*’s filtered signal (“ambient sound signal”) from one of the outer microphones would be variably amplified in the same manner as *Beasley*’s background audio signal 726 when audio bypass mode is initiated. A POSITA

would have understood that amplifying *Svean*'s filtered outer microphone signal as taught by *Beasley* modifies the signal.

129. Thus, a POSITA would have understood that the *Svean-Beasley-Andrea* combination discloses or suggests that when bypass mode is initiated, *Svean*'s processing unit variably amplifies *Svean*'s filtered outer microphone signal before mixing it with the anti-noise signal and audio signal (thereby generating a "modified ambient sound signal") and sending it to the speaker. Therefore, the *Svean-Beasley-Andrea* combination discloses or suggests "generating a modified ambient signal" including the steps of amplifying certain frequencies of the outer microphone signal (i.e., filtering) an ambient signal, variably amplifying the signal per *Beasley*'s audio bypass feature, and then mixing it with the anti-noise signal and communication signal.

130. A POSITA would have further understood that if *Beasley*'s variable gain amplifier 924 did not amplify the signal, for example, while audio bypass mode was off, then the "modified ambient signal" would just be the "ambient signal" itself.

131. Accordingly, with respect to claim 3, a POSITA would have understood the *Svean-Beasley-Andrea* combination to disclose or suggest *Svean*'s processing unit executing instructions to generate a filtered signal from

one of *Svean*'s outer microphones, variably amplify it, and then mix it before sending it to the speaker ("sending a modified ambient signal to the speaker").

132. With respect to claims 5 and 6, a POSITA would have further understood the *Svean-Beasley-Andrea* combination to disclose or suggest a processing unit executing instructions to generate a filtered signal from one of *Svean*'s outer microphones and variably amplifying it, which meets both "generating the modified ambient signal by filtering an ambient signal, wherein the ambient signal is generated from at least the first ambient sound signal or the second ambient sound signal" (as required by claim 5) and "generating a modified ambient signal by filtering the ambient signal and modifying an amplitude of at least one frequency of the ambient signal" (as required by claim 6).

133. And with respect to claim 4, a POSITA would have further understood the *Svean-Beasley-Andrea* combination to disclose or suggest a processing unit executing instructions to generate a filtered signal from one of *Svean*'s outer microphones and not amplifying it (e.g., when audio bypass mode is off) ("where the modified ambient signal is the ambient signal.")

5. Claim 7: The device according to claim 1, wherein the modified mixed signal is the mixed signal.

134. In my opinion, the *Svean-Beasley-Andrea* combination discloses or suggests this claim.

135. As explained in §§X.A.1 and X.A.2.j, the *Svean-Beasley-Andrea* combination discloses or suggests modifying the mixed signal by variably amplifying it prior to output from the speaker. A POSITA would have understood that if the mixed signal was not amplified, then the mixed signal would not be modified.

136. Accordingly, the *Svean-Beasley-Andrea* combination discloses or suggests *Svean*'s processing unit executing instructions to not amplify the mixed signal ("wherein the modified mixed signal is the mixed signal").

6. Claim 8: The device according to claim 1, wherein the operations further comprise: generating the modified mixed signal by mixing the mixed signal with an ambient signal, wherein the ambient signal is generated from at least one of the first ambient signal, the second ambient signal or a combination of both.

137. In my opinion, the *Svean-Beasley-Andrea* combination discloses or suggests this claim.

138. As explained in §X.A.2.j, *Beasley* discloses when the audio bypass feature is turned on, the background audio signal is amplified, and the noise-cancelling signal and audio signal are attenuated, and then all three are mixed together.

139. As discussed in §IX.C, a POSITA would have understood this claim to require generating the "mixed signal" and then mixing the "ambient sound signal" with "the mixed signal." The *Svean-Beasley-Andrea* combination,

in further combination with the knowledge of a POSITA, renders obvious this two-step mixing process.

140. *Beasley* does not disclose how its summer 730 sums three signals, instead illustrating a black box. A POSITA would have understood that first generating a “mixed audio signal” by mixing a noise cancellation signal and an audio signal and then mixing the resulting “mixed audio signal” with an “ambient sound signal” would have amounted to choosing from a finite number of predictable solutions, with a reasonable expectation of success.

141. In particular, a POSITA would have recognized that when processors mix signals, they mix two signals at a time. This is because processors have an arithmetic logic unit (ALU)—the component of a processor that performs arithmetic operations such as addition—which performs operations on two operands at a time. This is corroborated, for example, by *Lee* and *Muthusamy*. *Lee* explains that “[i]n general, single processor systems sequentially perform operations on two operands. ... Thus an integer “add” instruction, in a 64-bit computer, adds two 64-bit integer operands to produce a 64-bit integer result.” *Lee*, 1:12-20; *see also Muthusamy*, 1:59-2:26 (“Many mathematical operations performed by the ALU proceed from the least significant bits of the operands to the most bits. For example, a typical ADD operation executed by a ripple-carry adder will add the least significant bit of a

first operand to the least significant bit of a second operand to produce a least significant bit of result and a first carry bit.”)).

142. Thus, a POSITA would have recognized that there are three possible implementations of the summing unit in the *Svean-Beasley-Andrea* combination: (1) mixing the anti-noise and audio signals followed by mixing the filtered ambient signal, (2) mixing the filtered ambient signal and audio signal followed by mixing the anti-noise signal, and (3) mixing the anti-noise and filtered ambient signal first, followed by mixing the audio signal.

143. A POSITA would have recognized that each of these approaches is a design choice with the same predictable result—i.e., a “modified audio signal” that includes a mix of the anti-noise signal, filtered ambient signal, and the audio signal and desirably provides ambient sound passthrough. Indeed, *Beasley* expressly contemplates that “alternative configurations” may be used. *Beasley* ¶[0064]. Further, a POSITA would have had a reasonable expectation of success in mixing the anti-noise signal with the audio signal and then mixing the resulting signal with the filtered ambient signal because this would involve performing conventional operations (amplifying and mixing signals) known to a POSITA.

144. At the very least, a POSITA would have recognized that *Beasley* does not specify how to add the three signals, and adding the noise reduction

signal and audio signal first and then adding the ambient sound signal to the result was a known technique applicable to the summation in *Beasley*, with predictable results.

145. Accordingly, a POSITA would have understood the *Svean-Beasley-Andrea* combination to disclose or suggest the processor of the ear terminal executing instructions to mix the anti-noise signal and communications signal, then further mixing in the filtered ambient signal (“generating the modified mixed signal by mixing the mixed signal with an ambient signal, wherein the ambient signal is generated from at least one of the first ambient signal, the second ambient signal or a combination of both”).

146. Alternatively, to the extent Patent Owner argues that claim 8 does not require two-step mixing as discussed in §IX.C, the *Svean-Beasley-Andrea* combination renders this limitation obvious because it discloses or suggests mixing all three signals together.

7. **Claims 9-11: Claim 9 (“The device according to claim 8, wherein the operations further comprise: analyzing at least one of the ambient signal or the ear canal signal or a combination of both, to detect a user’s voice.”); Claim 10 (“The device according to claim 9, wherein the operations further comprise: reducing the audio content signal prior to generating the mixed signal if the user’s voice is detected.”); Claim 11 (“The device according to claim 9, wherein the operations further comprise: reducing the ambient signal prior to generating the mixed signal if the user’s voice is not detected.”)**

147. In my opinion, the *Svean-Beasley-Andrea* combination discloses or suggests this claim.

148. *Beasley* discloses when audio bypass mode is on, the gain of the audio signal is reduced before being mixed, and the gain of the background audio signal is increased before being mixed. *Beasley* ¶ [0053] (“Preferably, when the audio bypass mode is initiated, the gain of variable gain amplifiers 922 and 926 is attenuated such that noise cancellation signal 728 and audio signal 314 are attenuated and the gain of variable gain amplifier 924 is increased such that the background audio signal 726 is amplified and readily heard by the user through speaker 332. Conversely, when the bypass mode is terminated, the gain of variable gain amplifier 924 is turned down such that the background audio signal 726 is no longer amplified (or is attenuated to some extent).”).

149. *Beasley* discloses using “voice or speech recognition” to enter audio bypass mode “in response to a command that is spoken by the user” or when the

device “senses that the user has spoken” using the headset’s microphone configured to pick up background noise. *Beasley*, ¶¶[0035], [0037], [0040], [0060]-[0061]. *Beasley* further discloses implementing a “timeout feature” which “allow[s] the device to automatically terminate the audio bypass mode upon the passage of a specified amount of time.” *Beasley* ¶[0062]. *Beasley* states that the feature can be preprogrammed or user selected and controlled, depending on the implementation.” *Id.* A POSITA would have considered it obvious to implement the timeout feature such that the bypass mode would terminate after a time without detecting the user’s speech. *Beasley* explains that the purpose of the bypass feature is to facilitate conversations, and a POSITA would have understood that conversations do not have a fixed duration. Thus, a POSITA would have understood that the timeout feature should be based at least in part on a period of time without detecting the user’s speech.

150. A POSITA would have been motivated to implement the foregoing functionality in the *Svean-Beasley-Andrea* combination because a POSITA would have understood that it would have provided control over the reproduction of both sound captured by the outer microphones and signals from the communication system. Thus, a POSITA would have found it obvious to implement *Beasley*’s voice or speech-activated bypass mode into *Svean*’s ear terminal because it amounted to the use of a known technique (using voice or

speech recognition to control bypass mode) to improve similar devices (the *Svean-Beasley-Andrea* noise-cancelling ear terminal) in the same way (to provide voice or speech-based control over when bypass mode is turned on or off).

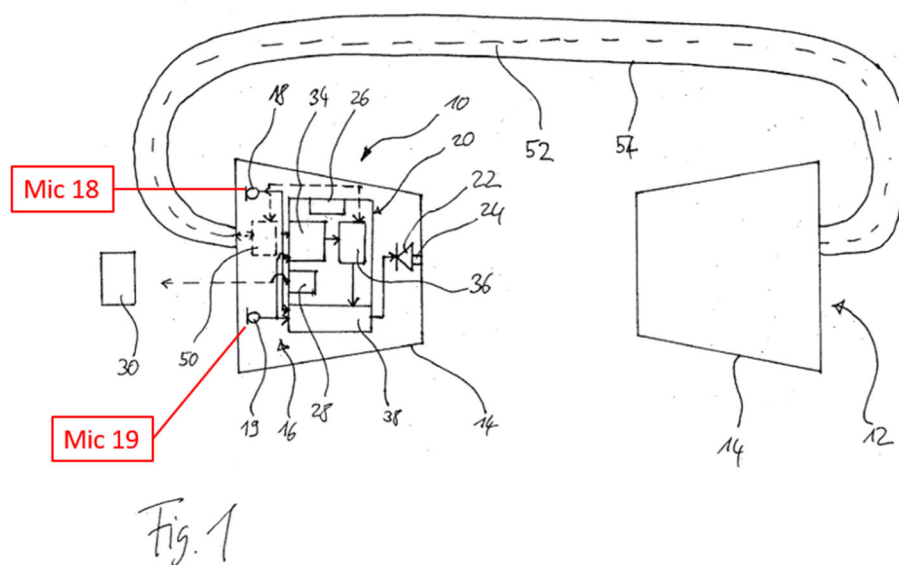
151. Accordingly, in my opinion, a POSITA would have understood the *Svean-Beasley-Andrea* combination to disclose or suggest a processing unit executing instructions to analyze the inner microphone signal and outer microphone signal to detect when the user is speaking (“analyzing at least one of the ambient signal or the ear canal signal or a combination of both, to detect a user’s voice”) and attenuating the audio signal when the user’s voice is detected and bypass mode is entered (“reducing the audio content signal prior to generating the mixed signal if the user’s voice is detected”), and attenuating *Svean*’s filtered and amplified microphone signal before mixing it after expiration of *Beasley*’s timeout feature and bypass mode is exited (“reducing the ambient signal prior to generating the mixed signal if the user’s voice is not detected.”).

B. GROUND 1B: *SVEAN, BEASLEY, ANDREA, AND BERG* RENDER OBVIOUS CLAIMS 1-11

152. If Patent Owner argues, or the Board finds, that the *Svean-Beasley-Andrea* combination does not itself render obvious implementing two ambient sound microphones in *Svean*’s ear terminal, a POSITA nevertheless would have

considered it obvious to do so. By May 2007, it was common to implement hearing aids with two ambient sound microphones so as to enable beamforming or other directional processing. *See Stirnemann ¶[0028]* (“Most hearing instruments nowadays comprise at least two input microphones (‘outer microphones’ in this text) in order to enable beamforming.”); *Hamacher ¶[0024]*). *Berg* is exemplary of such devices. *Berg* is analogous to the ’643 patent because it is within the same field of endeavor of the ’643 patent and/or reasonably pertinent to one or more problems addressed by the ’643 patent.

153. *Berg* relates to a hearing-protection system. *Berg*, Abstract. As shown in Figure 1 below, *Berg* discloses an earpiece similar to *Svean*’s earpiece with two ambient sound microphones. *Berg* discloses filtering ambient microphone signals according to various modes depending on the level of ambient noise and the detection of speech close to the user. *Berg* ¶[0028]. The use of a second microphone in the earpiece enables *Berg*’s judgement module to “assign angular directions to the input audio signals by analyzing phases of the input audio signals, i.e. by determining the phase difference of the input audio signal provided by the microphone 18 and the input audio signal provided by the microphone 19.” *Berg* ¶[0034].



Berg FIG. 1 (annotated)

154. *Svean* is concerned with restoring speech in the environment for the user. See *Svean*, 4:51-62. A POSITA would have recognized that implementing *Berg*'s teachings related to adjusting the filtering of the ambient microphone signals based on the detection of close speech would improve the adaptability of the *Svean- Beasley-Andrea* combination.

155. A POSITA would have found it obvious to incorporate a second ambient microphone in *Svean*'s ear terminal as taught by *Berg* because it amounted to the use of known technique (implementing two ambient sound microphones in an earpiece) to improve similar devices (*Berg* and *Svean* are both directed to hearing protection devices) in the same way (to enable adjusting audio output based on directional processing).

156. Accordingly, a POSITA would have understood that the *Svean-Beasley-Andrea-Berg* combination discloses or suggests *Svean*'s ear terminal implemented with a second ambient microphone ("a second ambient microphone configured to generate a second ambient signal, wherein the second ambient microphone is part of the earpiece.").

157. The *Svean-Beasley-Andrea-Berg* combination otherwise renders the claims obvious for the same reasons discussed in §§X.A.2-X.A.7.

C. GROUND 2: ASADA AND USHER RENDER OBVIOUS CLAIMS 1-11

1. Overview of *Asada-Usher*

158. *Asada* and *Usher* are analogous to the '643 patent because they are within the same field of endeavor of the '643 patent and/or reasonably pertinent to one or more problems addressed by the '643 patent.

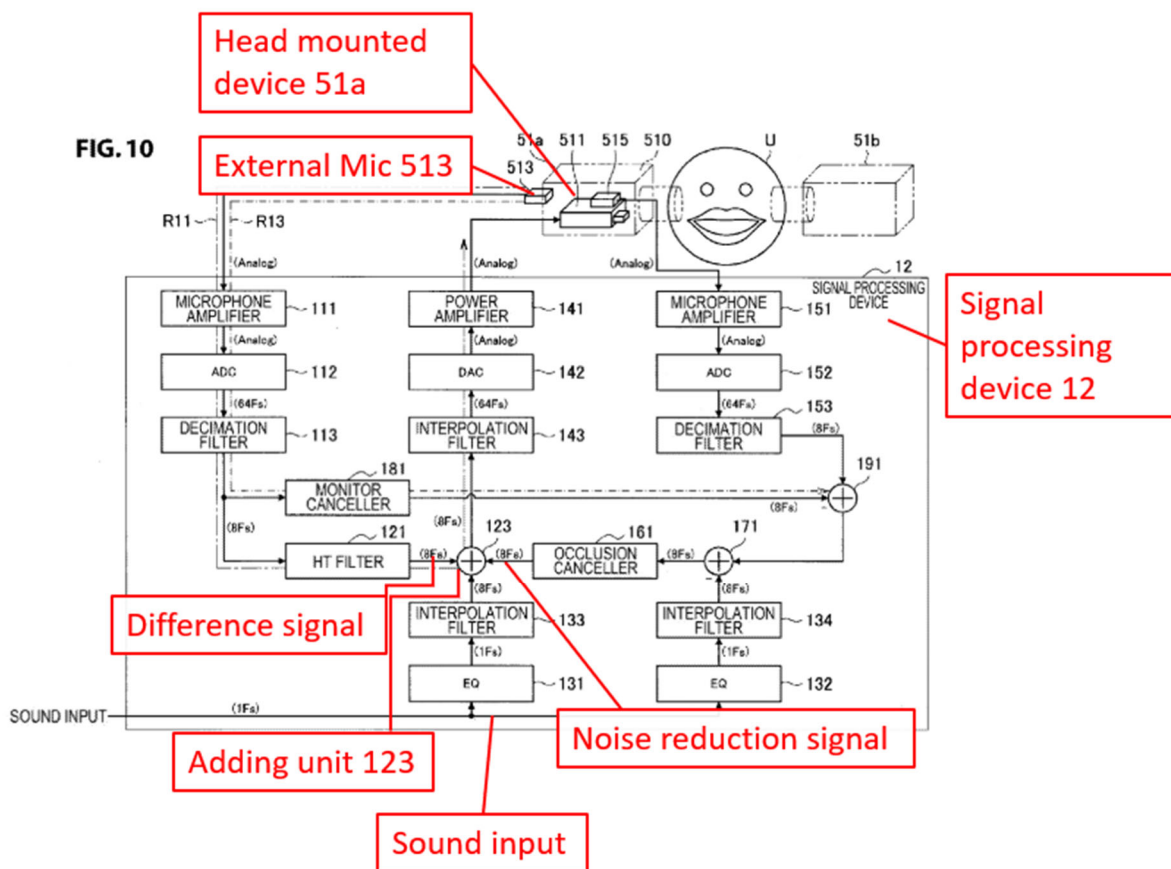
159. *Asada* explains that it is desirable for the user to be able to hear so-called ambient sounds in addition to audio content while constantly wearing a head-mounted acoustic device. *Asada* ¶[0039]. This is called the "hear-through state" or "hear-through effect." *Id.* ¶[0040]. *Asada* explains that this is important for head-mounted devices with "high hermeticity ... such as a so-called canal type earphone." *Id.* ¶[0042]. Thus, *Asada* discloses a technique for implementing the hear-through state in an ear canal type earphone. *Id.* ¶[0044].

160. *Asada* discloses several embodiments. My analysis focuses on the embodiment of Figure 10, but *Asada*'s embodiments build on each other, and *Asada* does not repeat the entire description of each component that is common to prior embodiments. *Asada* first describes a "basic functional configuration of the signal processing device for implementing the hear-through effect" in Figure 5. *Asada* ¶[0061]. Then, in Figure 7, *Asada* discloses a first embodiment of a "signal processing device 11" which differs from Figure 5 in certain specific respects, for example by addition of the subtracting unit 171, occlusion canceller 161, and EQ 132. *Id.* ¶[0084]. Figure 8 shows an example configuration of the signal processing device 11, and explains that it can be installed in the mounting unit 510 of the head-mounted acoustic device. *Asada* ¶[0099]. Figures 9 and 10 further build on Figure 7 and disclose a "signal processing device 12." *Id.* ¶¶[0105]-[0106], [0128]-[0129]. Thus, for example, my analysis cites some description of the embodiments in Figures 7-9 for the purpose of explaining *Asada*'s disclosure regarding those components in the embodiment of Figure 10.

161. In Figure 10, *Asada* discloses a head-mounted device that includes an external microphone 513, and internal microphone 515, and a signal processing device 12. *Asada* ¶¶[0105]-[0119]. The signal processing device 12 may be implemented within the head-mounted device. *Id.* ¶¶[0099], [0105]-[0106], FIG. 8. To note, although *Asada* paragraph [0099] describes "signal

processing device 11” being implemented in the head-mounted device, it is clear from the context that *Asada* discloses implementing signal processing devices 11-14 within the head-mounted device. *Asada* generally describes the differences between the different signal processing devices 11-14 (*Asada* ¶¶[0084], [106], [161]), and *Asada* never mentions any differences between the devices with respect to whether they can be implemented within the head-mounted device or not. Thus, a POSITA would have understood that each of *Asada*’s signal processing devices 11-14 may be implemented within the head-mounted acoustic device.

162. The adding unit 123 of the signal processing device adds three signals together: a “difference signal output from the HT filter 121,” a “sound input,” and a “noise reduction signal output from the occlusion canceller 161.” *Id.* ¶[0096].



Asada FIG. 10 (annotated)

163. **“Difference signal.”** The signal from the external microphone 513 is amplified by microphone amplifier 111 and processed through decimation filter 113 and an HT filter 121, which generates the “difference signal.” *Asada* ¶¶[0069]-[0071], [0132]-[0133]. *Asada* explains that the “difference signal” is a signal that when output in the user’s ear, simulates the “hear-through effect,” i.e., “the ambient sound in a case in which the user directly hears it is simulated.” *Id.* ¶[0071].

164. **“Sound input” signal.** Sound input is “audio content or a received signal in a voice call” that is processed through EQ 131 which performs an equalizing process and the interpolation filter 133. *Asada ¶¶[0071], [0136].*

165. **“Noise reduction signal.”** The signal from the internal microphone 515 is first amplified by microphone amplifier 151. *Asada ¶[0088]. Asada* explains that the signal from the internal microphone 515 includes three component sounds: (1) the output from the speaker, (2) a component of the ambient sound that propagates into the ear canal; and (3) a component of the user’s voice propagating into the ear canal. *Asada ¶[0087].* The subtraction unit 191, together with the monitor canceller 181, are “configured to suppress a component corresponding to the difference signal among components” of the signal from the internal microphone. *Id. ¶[0107].*

166. The “subtracting unit 171 subtracts the sound input” from the output of the subtracting unit 191. *Id. ¶¶[0090], [0116], [0117].* Then the output of the subtracting unit 191 is input into the occlusion canceller 161 which is “an acoustic signal in which the component corresponding to a difference signal and the component corresponding to the sound input ... are suppressed.” *Id. ¶[0117].* Then the occlusion canceller 161 “generates the noise reduction signal.” *Id. ¶[0118].*

167. As discussed above, *Asada* notes that one of the problems with known earphones with high hermeticity was that they made the user less aware of their surroundings. It was also known that such earphones made it difficult to engage in conversations with others. This is corroborated, for example, by *Melanson* and *DiCenso*.⁵

168. *Melanson* explains that “it has become increasingly difficult to get the attention of a personal audio device user in order to converse with them, and conversation between persons using personal audio devices tends to be mutually exclusive of such use. For instance, a person generally must turn off or extremely attenuate their program material in order to conduct a conversation, or must remove one or both headphone elements from their ears.” *Melanson*, 1:28-35.

169. *DiCenso* similarly explains that “using headphones may reduce a user’s ability to hear and communicate with those around the user, isolating the user from the surrounding environment. Moreover, many headphones provide noise-isolation and/or noise-cancellation functions designed to reduce the degree

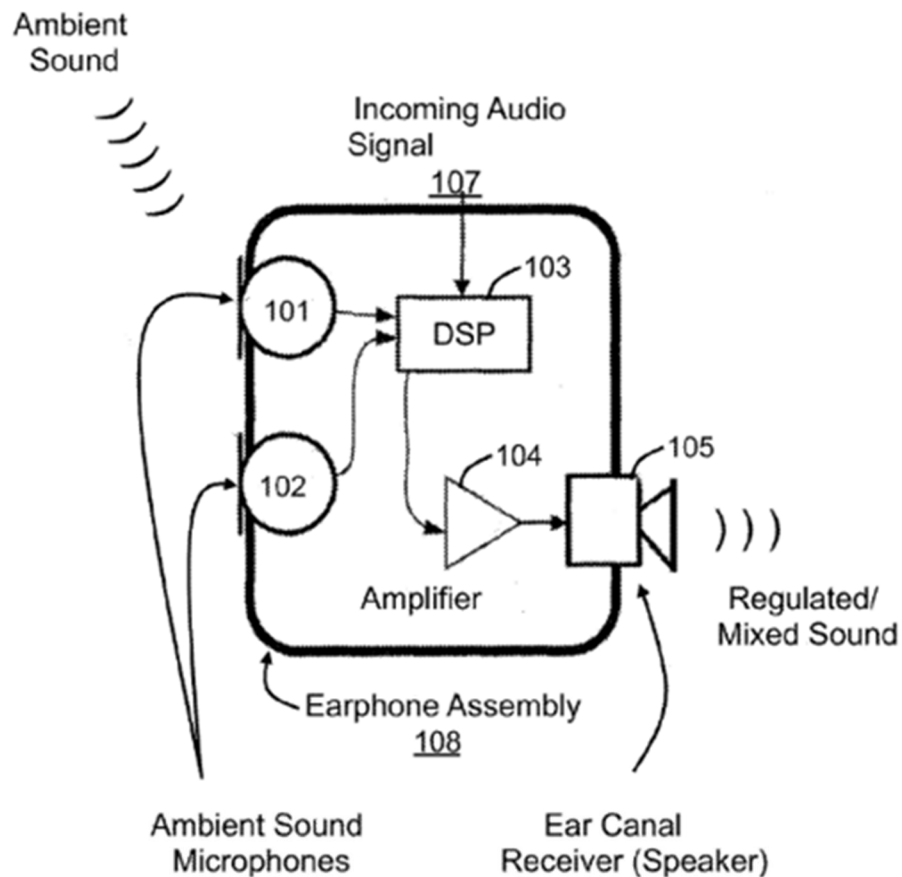
⁵ To be clear, I am relying on *Melanson* and *DiCenso* as evidence of the knowledge of a person having ordinary skill in the art and they are not part of the unpatentability ground 2.

to which a user can hear ambient sounds. As such, a user may not be able to hear when someone is trying to get his or her attention. Additionally, in many cases, in order to communicate with others, the user must pause the media player and/or remove the headphones in order to converse with others.” *Id.* ¶[0005].

170. It was also known that it was advantageous to provide selective, controlled pass-through of ambient sound, rather than providing pass-through of all sounds all of the time. This is corroborated, for example, by *Rast* and *Kirsch*.⁶ *Rast* explained that “a need exists for the development of methods for controlling acoustic isolation, so that important events are not missed and non-important noises can be properly identified and ignored.” *Rast* ¶¶[0007]-[0009]. Similarly, *Kirsch* explains that it was known “to acoustically or electronically mix audio from the environment with the audio signal received from [a] playback device,” but a drawback of that technique is that “the listener typically hears all audio from the environment rather than just the specific environmental sounds that the listener desires to hear.” *Kirsch* ¶¶[0001]-[0005].

⁶ To be clear, I am relying on *Rast* and *Kirsch* as evidence of the knowledge of a person having ordinary skill in the art and they are not part of the unpatentability ground 2.

171. *Usher* is analogous to the '643 patent, as it is within the same field of endeavor and/or reasonably pertinent to one or more problems addressed by the '643 patent. *Usher* discloses an earphone similar to *Asada* and discloses techniques “for automatically detecting when an earphone user and a second nearby user are engaged in a voice conversation, and activating a sound pass-through system such that the nearby voice source is automatically heard by the user of the sound isolating earphone.” *Usher* ¶[0019]. Like *Asada*, *Usher* discloses an earphone that fully occludes the ear canal and includes a processor and various microphones for implementing an ambient sound pass-through feature. *Usher* ¶¶[0019]-[0020]. Particularly relevant here, *Usher* discloses implementing two ambient microphones in the earphone *Id.* ¶¶[0020]-[0022], FIG. 1A.



Earphone 100

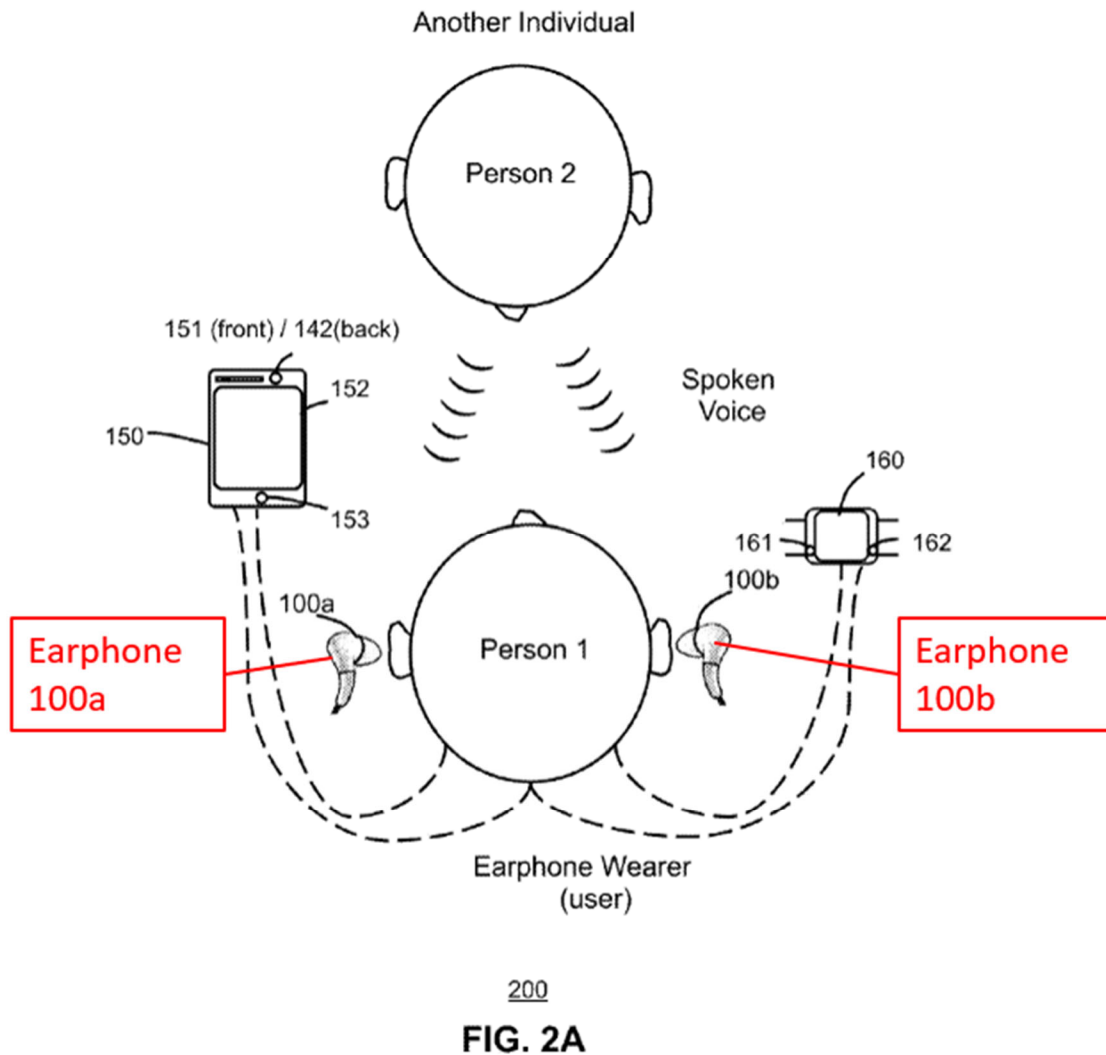
100

FIG. 1A

Usher, FIG. 1A (annotated)

172. *Usher* further discloses using the ambient microphones in the earphone to implement beamforming to, for example, permit manual capture of a sound source. *Id.* ¶[0028]. In particular, *Usher* explains with reference to Figure 2A that “the microphones or any portion thereof in any of the devices **100, 100 a, 100 b**, 150, and 160 can work cooperatively to enhance situational awareness

as contemplated by the various embodiments herein.” *Id.* As one example, *Usher* teaches that microphones can be used “in an array, for example, beamforming for localization of a user’s voice or for permitting manual capture of a sound source.” *Id.*; see also Claim 8.



Usher, FIG. 2A (annotated)

173. *Usher* further teaches that the “second ambient microphone 102 captures ambient sounds, allowing the processor to localize the direction and the

proximity of an incoming acoustic sound of the second individual speaking to the user” and “[i]t thereafter determines the proximity of the individual with respect to the user wearing the earphone 100; and adjusts the gain of the ambient sound pass-through of the ambient sound microphone (one or both 101/102) reproduced by the internal speaker 105 as a function of the direction and proximity.” *Id.* ¶[0040].

174. Beamforming was a known technique in devices like *Asada* and *Usher* that enables a spatially selective pass-through of ambient sound. With beamforming, the user could advantageously be provided an ambient sound signal that allowed the user to hear a sound of interest (such as another person speaking) while suppressing other background noise that was not of interest. This is corroborated, for example, by *Basu*, published in May 2001 and describing “Smart Headphones” for “enhancing auditory awareness by selectively passing speech sounds in the environment to the user.” *Basu* at Abstract, Introduction, Section 2.2. *DiCenso* similarly discloses reproducing ambient sound “in a spatially correct manner” when “using more than one microphone 140.” *DiCenso* ¶[0032]. And *Kirsch* discloses using beamformers to pass-through sounds of interest and suppress other sounds. *Kirsch* ¶¶[0017]-[0020] (“Because microphone arrays 105(0) and 105(1) include multiple

microphones, beamformers 110(0) and 110(1) are able to spatially filter environmental audio in a directional manner”).⁷

175. *Usher* also discloses controlling ambient sound pass-through based upon a detection of whether “an earphone user and a second nearby user are engaged in a voice conversation.” *Usher* ¶¶[0019], [0029]. If a user is listening to music and the earpiece processor detects that the user is speaking, then the earphone processor can selectively filter (amplify/attenuate) audio content and ambient sound, where the gain of each signal is adjusted based on close voice activity detection. *Id.* ¶[0026]. In particular, *Usher* discloses a method in Figure 2B for controlling ambient sound pass-through based on voice activity detection. *Id.* ¶¶[0029]-[0033]. “If...user voice activity is detected, the gain of the incoming audio signal is decreased ... and the ambient sound pass-through gain is increased.” *Id.* ¶[0030]. If user voice activity is not detected, then “the gain of the ambient sound pass-through gain is decreased ..., and the gain of the incoming audio signal is increased.” *Id.* ¶[0033].

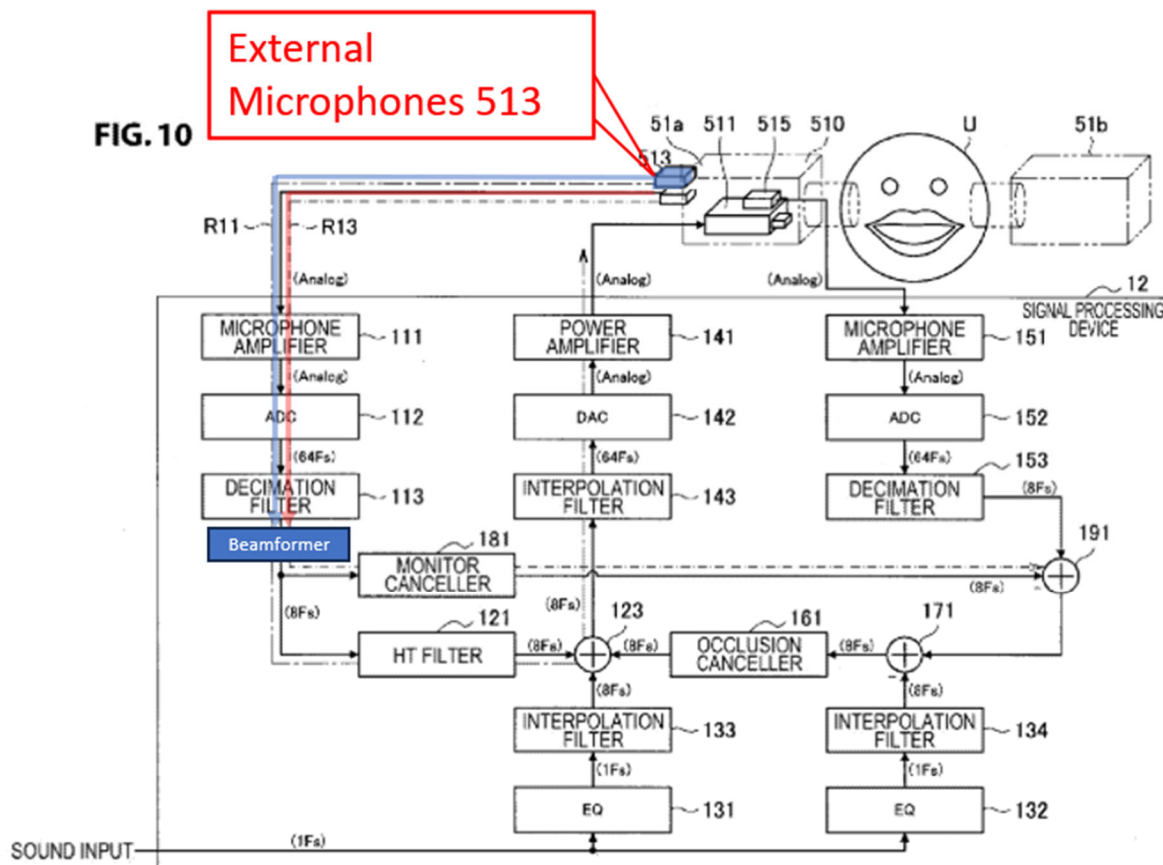
⁷ To be clear, I am relying on *Basu*, *DiCenso*, and *Kirsch* as evidence of the knowledge of a person having ordinary skill in the art and they are not part of the unpatentability ground 2.

176. A POSITA would have understood that *Usher's* teachings would improve *Asada's* disclosure because it would allow a user of *Asada's* device to receive spatially selective and controlled ambient sound pass-through. In particular, a POSITA would have found it obvious to implement *Usher's* teaching related to having multiple ambient microphones for beamforming in *Asada's* earphone because it amounted to the use of a known technique (*Usher's* teachings of multiple ambient microphones and beamforming) to improve similar devices (*Asada* and *Usher* are similarly directed to ambient sound passthrough for occluding earphones) in the same way (to provide *Asada's* earphone with additional microphones to implement beamforming).

177. Similarly, a POSITA would have found it obvious to implement *Usher's* teaching related to controlling ambient pass-through based on voice activity detection in *Asada's* earphone because it amounted to the use of a known technique (*Usher's* teachings activating or deactivating passthrough based on voice activity detection) to improve similar devices (*Asada* and *Usher* are similarly directed to ambient sound passthrough for occluding earphones) in the same way (to provide *Asada's* earphone with controlled ambient sound passthrough).

178. The *Asada-Usher* combination discloses or suggests *Asada's* head-mounted device (shown in Figure 10) including two or more external

microphones akin to *Asada's* external microphone 513 and *Asada's* signal processing device implementing beamforming. The beamformed signal is processed for ambient pass through and controlled based on voice activity detection. If voice activity is detected per *Usher's* teachings, *Asada's* HT filter 121 amplifies the beamformed signal, and if no voice activity is detected, the HT filter 121 does not amplify the beamformed signal. The beamformed signal processed by HT filter 121 is added to the "sound input" and "noise reduction signal" in accordance with *Asada's* teachings. The beamformed signal is also processed by the monitor canceller 181 and subtracted from the internal microphone signal by subtracting unit 191 per *Asada's* teachings.



Asada FIG. 10 (modified and annotated)

2. Claim 1

a. [1.pre]: A device, comprising:

179. I have been asked to assume the preamble is limiting. In my opinion, *Asada* discloses “a device.”

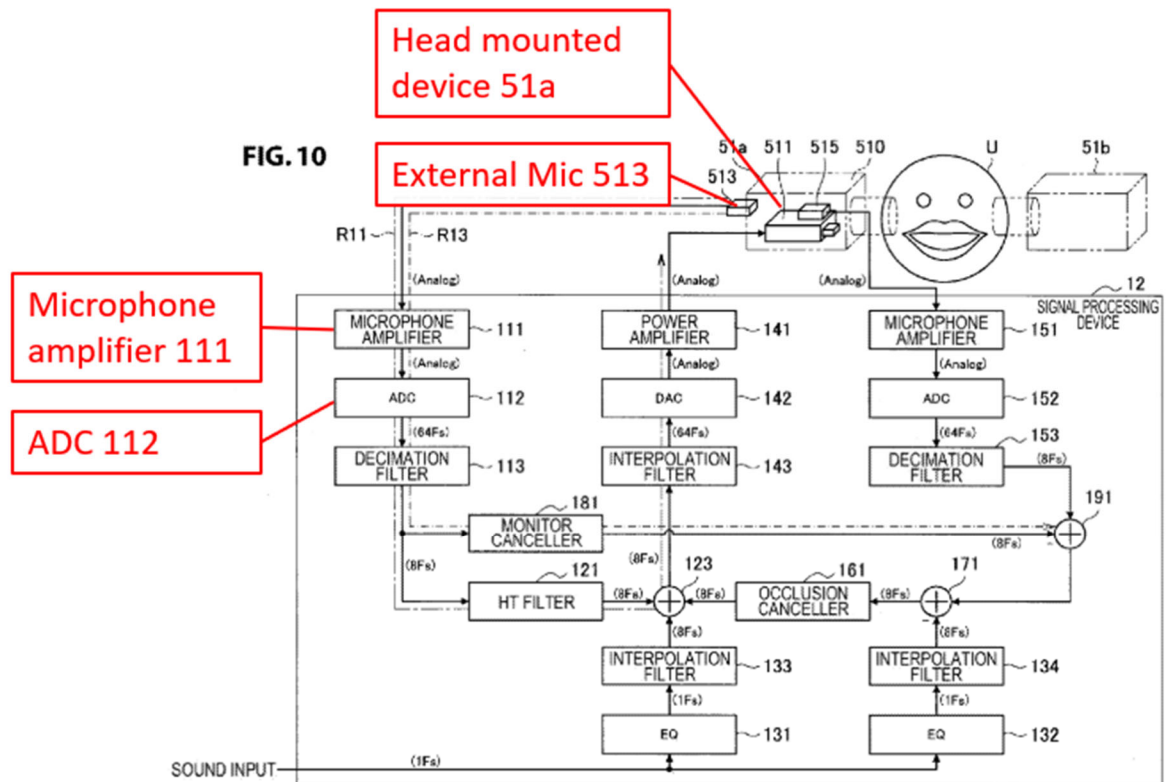
180. *Asada* discloses a “head-mounted device” implemented as an “ear canal-type earphone.” *Asada* ¶[0047], FIG. 3.

181. Accordingly, a POSITA would have understood *Asada* to disclose or suggest a head-mounted device implemented as an ear canal-type earphone (“[a] device”).

b. [1.1]: a first ambient microphone configured to generate a first ambient signal, wherein the first ambient microphone is part of an earpiece;

182. In my opinion, *Asada* discloses or suggests “a first ambient microphone configured to generate a first ambient signal, wherein the first ambient microphone is part of an earpiece.”

183. *Asada* discloses that the head-mounted device includes an “external microphone 513” that “directly collects a sound (a so-called ambient sound).” *Asada* ¶¶[0063], [0068]. *Asada* further discloses that “[t]he analog acoustic signal output on the basis of the sound collection result of the external microphone 513 undergoes gain adjustment performed by the microphone amplifier 111 and then converted into a digital signal through the ADC 112.” *Asada* ¶[0132], FIG. 10.



Asada FIG. 10 (annotated)

184. Accordingly, in my opinion, a POSITA would have understood Asada to disclose or suggest an earphone that includes an external microphone that collects ambient sound (“a first ambient microphone ..., wherein the first ambient microphone is part of an earpiece”) and outputs a signal (“configured to generate a first ambient signal”).

- c. **[1.2]: a second ambient microphone configured to generate a second ambient signal, wherein the second ambient microphone is part of the earpiece;**

185. In my opinion, *Asada* in combination with *Usher* discloses or suggests “a second ambient microphone configured to generate a second ambient signal, wherein the second ambient microphone is part of the earpiece.”

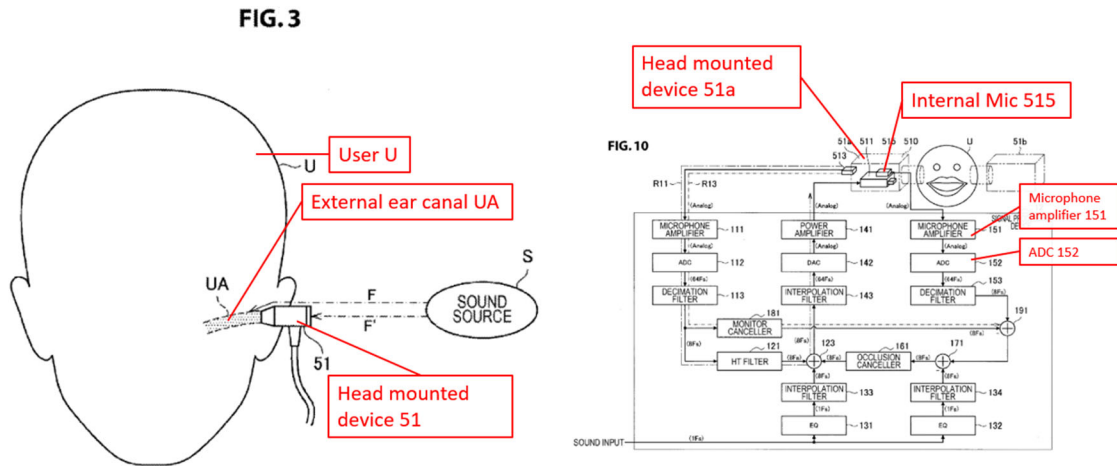
186. As explained in §X.C.1, in the *Asada-Usher* combination, it would have been obvious to a POSITA to incorporate two or more external microphones akin to *Asada*’s external microphone 513 into *Asada*’s head-mounted device.

187. Accordingly, in my opinion, a POSITA would have understood the *Asada-Usher* combination to disclose or suggest an earphone including a second external microphone (“a second ambient microphone ... wherein the second ambient microphone is part of the earpiece”) that outputs a signal (“configured to generate a second ambient signal”).

- d. **[1.3]: an ear canal microphone configured to generate an ear canal signal, wherein the ear canal microphone is part of the earpiece;**

188. In my opinion, *Asada* discloses or suggests “an ear canal microphone configured to generate an ear canal signal, wherein the ear canal microphone is part of the earpiece.”

189. *Asada* discloses that the head-mounted device includes an “internal microphone 515” that “face[s] the direction of the external ear canal UA” so it is “capable of collecting the sound propagating to the internal space.” *Asada* ¶¶[0085]-[0086]. *Asada* further discloses that “the analog acoustic signal output on the basis of the sound collection result of the internal microphone 515 undergoes gain adjustment performed by the microphone amplifier 151 and converted into a digital signal through the ADC 152.” *Id.* ¶[0134].



Asada, FIGs. 3, 10 (annotated)

190. Accordingly, a POSITA would have understood the *Asada-Usher* combination to disclose or suggest an earphone including an internal microphone facing the ear canal and capable of collecting the sound propagating to the internal space (“an ear canal microphone ... wherein the ear canal microphone is part of the earpiece”) that outputs a signal (“configured to generate an ear canal signal”).

e. [1.4]: a speaker, wherein the speaker is part of the earpiece;

191. In my opinion, *Asada* discloses or suggests “a speaker, wherein the speaker is part of the earpiece.”

192. *Asada* discloses that the head-mounted device includes a speaker. *Asada* ¶[0067].

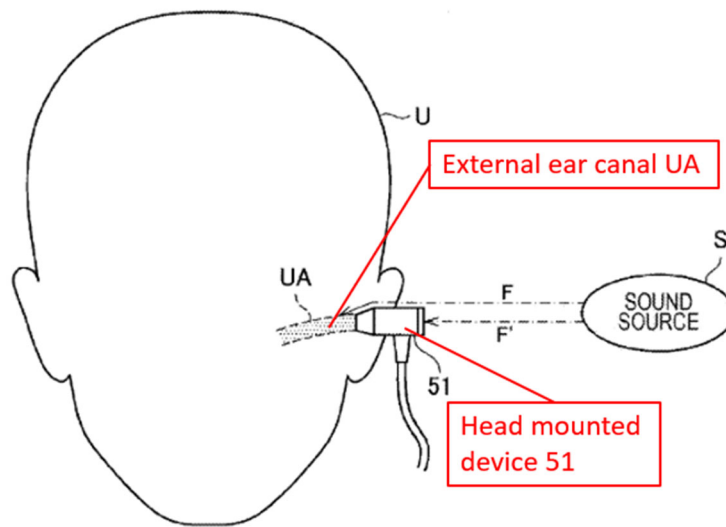
193. Accordingly, a POSITA would have understood the *Asada-Usher* combination to disclose or suggest an earphone including a speaker (“a speaker, wherein the speaker is part of the earpiece”).

f. [1.5]: an eartip, configured to seal the earpiece between a first side and a second side of the earpiece;

194. In my opinion, *Asada* discloses or suggests “an eartip, configured to seal the earpiece between a first side and a second side of the earpiece.”

195. *Asada* illustrates the earphone in Figure 3, which shows “an ear hole insertion portion having a shape insertable into the ear hole of the user.” *Asada* ¶[0065]. *Asada* further discloses that the earphone has a “high hermeticity (in other words, a high shielding property against the external environment).” *Asada* ¶[0042]; see also *id.* ¶¶[0043]-[0044], [0080]-[0081].

FIG. 3



Asada FIG. 3 (annotated)

196. A POSITA would have understood that for the earphone to have high hermeticity and shielding from the external environment, the ear hole insertion portion seals the ear canal. This is consistent with how a POSITA would have understood this feature in the context of the '643 patent. *See* '643 patent, 6:16-36 (“The assembly is designed to be inserted into the user's ear canal 131, and to form an acoustic seal with the walls 129 of the ear canal at a location 127 between the entrance 117 to the ear canal and the tympanic membrane (or ear drum) 133. Such a seal is typically achieved by means of a soft and compliant housing of assembly 113. Such a seal creates a closed cavity 131 of approximately 5 cc between the in-ear assembly 113 and the tympanic membrane 133. As a result of this seal, the ECR (speaker) 125 is able to generate

a full range frequency response when reproducing sounds for the user. This seal also serves to significantly reduce the sound pressure level at the user's eardrum resulting from the sound field at the entrance to the ear canal 131. This seal is also a basis for a sound isolating performance of the electro-acoustic assembly.”)

197. Accordingly, in my opinion, a POSITA would have understood the *Asada-Usher* combination to disclose or suggest a head-mounted device implemented as an earphone with an ear hole insertion portion that has high hermeticity (“an eartip, configured to seal the earpiece between a first side and a second side of the earpiece”).

- g. [1.6.] and [1.7]: a memory that stores instructions; and a processor, wherein the processor is part of the earpiece, wherein the processor is operatively connected to the first ambient microphone, wherein the processor is operatively connected to the second ambient microphone, wherein the processor is operatively connected to the ear canal microphone, wherein the processor is operatively connected to the speaker, wherein the processor is operatively connected to the memory, wherein the processor is configured to execute the instructions to perform operations, the operations comprising;**

198. In my opinion, *Asada* discloses or suggests “a memory that stores instructions; and a processor, wherein the processor is part of the earpiece, wherein the processor is operatively connected to the first ambient microphone, wherein the processor is operatively connected to the second ambient microphone, wherein the processor is operatively connected to the ear canal

microphone, wherein the processor is operatively connected to the speaker, wherein the processor is operatively connected to the memory, wherein the processor is configured to execute the instructions to perform operations, the operations.”

199. As I discussed in §X.C.1, *Asada* discloses a signal processing device housed within the head-mounted device. *Asada* ¶[0099], FIG. 8. *Asada* further discloses that the signal processing device includes a processor and memory and implements the components of the signal processing device. *Asada* ¶¶[0196], [0197] (“The components of the signal processing devices 11 to 14 (particularly, the HT filter 121, the occlusion canceller 161, the monitor canceller 181, or the like) may be implemented by the processor 901.”). A POSITA would have understood that “or the like” includes the other components of the signal processing device, such as the adding units and the decimation/interpolation filters, which are also implemented after the ADC step in the digital domain. Thus, *Asada*’s broad assertion that “[t]he components of the signal processing devices 11 to 14 ... may be implemented by the processor” discloses, and at a minimum suggests, to a POSITA such an implementation. *Asada* ¶[0008] (explaining “processor” “add[s] the difference signal and the noise reduction signal to the input acoustic signal”). This is consistent with the fact that the signals are converted to digital signals by the analog-to-digital

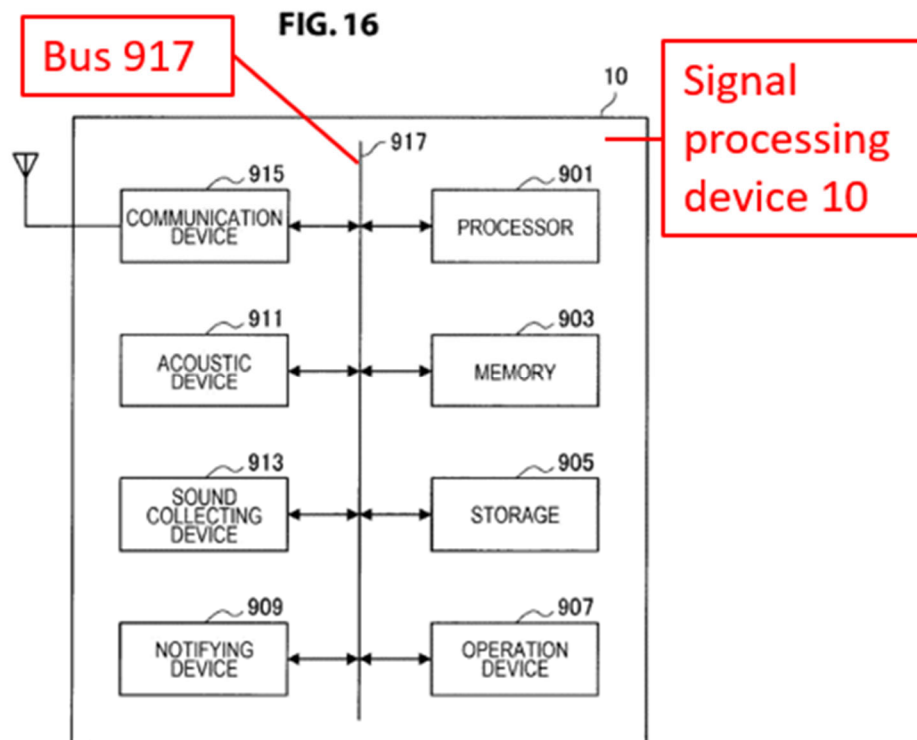
converters (ADC) 112 and 152 from microphones 513 and 515 and are converted from digital signal by the digital-to-analog converter (DAC) 142 for transmission to the speaker 511. *Asada*, [0130], Fig. 10. A POSITA would have understood from these teachings that the components operating in the digital domain are implemented in processor 901.

200. The memory “stores programs and data executed by the processor 901.” *Asada* ¶[0198]. *Asada* further discloses “creat[ing] a program causing hardware such as a processor, a memory, and a storage which are installed in a computer to perform functions similar to those of the components of the signal processing device.” *Id.* ¶[0207]. A POSITA would have understood that programs comprise software instructions to be executed by a processor. This is corroborated, for example, by the *Computer Dictionary*, which defines “software” as “[c]omputer programs; instructions that cause the hardware—the machines—to do work.”⁸

201. With reference to Figure 16—an exemplary hardware configuration for the signal processing device 12 in Figure 10—a bus 917 connects the

⁸ To be clear, I am relying on *Computer Dictionary* as evidence of the knowledge of a person having ordinary skill in the art and it is not part of the unpatentability ground 2.

processor to the memory, a “sound collecting device 913,” which may be implemented as the external microphone and internal microphone, and an “acoustic device 911,” which may be implemented as a speaker. *Asada* ¶¶[0195], [0196], [0203], [0202], [0206]. As explained in §X.C.1, the *Asada-Usher* combination includes a second external microphone. Thus, a POSITA would have understood the *Asada-Usher* combination to disclose or suggest the processor connected via a bus to the second external microphone.



Asada, FIG. 16 (annotated)

202. Accordingly, in my opinion, a POSITA would have understood the *Asada-Usher* combination to disclose or suggest an earphone including a signal

processing circuit with a processor and memory that stores programs to be executed by the processor to perform functions of the signal processing device (“a memory that stores instructions; and a processor, ... wherein the processor is configured to execute the instructions to perform operations”) and where the processor is connected by a bus to memory, two external microphones, an internal microphone, and a speaker (“wherein the processor is operatively connected to the first ambient microphone, wherein the processor is operatively connected to the second ambient microphone, wherein the processor is operatively connected to the ear canal microphone, wherein the processor is operatively connected to the speaker, wherein the processor is operatively connected to the memory”).

- h. [1.8]-[1.10]: receiving a first microphone signal, wherein the first microphone signal is at least one of the first ambient signal or a modified first ambient signal; receiving a second microphone signal, wherein the second microphone signal is at least one of the ear canal signal or a modified ear canal signal; receiving a third microphone signal, wherein the third microphone signal is at least one of the second ambient signal or a modified second ambient signal;**

203. In my opinion, *Asada* in combination with *Usher* discloses or suggests “receiving a first microphone signal, wherein the first microphone signal is at least one of the first ambient signal or a modified first ambient signal; receiving a second microphone signal, wherein the second microphone

signal is at least one of the ear canal signal or a modified ear canal signal; receiving a third microphone signal, wherein the third microphone signal is at least one of the second ambient signal or a modified second ambient signal.”

204. As explained in §X.C.1, the *Asada-Usher* combination includes first and second external microphones that output a signal (“first ambient signal” and “second ambient signal,” respectively). As explained in §X.C.2.d, the *Asada-Usher* combination includes an internal microphone that outputs a signal (“ear canal signal”).

205. *Asada* discloses or suggests implementing the components of the signal processing device with the processor. *Asada* ¶[0197]. *Asada* discloses performing various signal processing steps on the signals from the external and internal microphones. *See generally Asada* ¶¶[0105]-[0119]. A POSITA would have understood that for the processor to implement the components of the signal processing device to perform various signal processing functions, the processor would receive the signals output from the microphones.

206. Accordingly, a POSITA would have understood the *Asada-Usher* combination to disclose or suggest the processor of the earphone executing instructions to receive the signal output by the first external microphone (“receiving a first microphone signal, wherein the first microphone signal is at least one of the first ambient signal or a modified first ambient signal”), receive

the signal output by the internal microphone (“receiving a second microphone signal, wherein the second microphone signal is at least one of the ear canal signal or a modified ear canal signal”), and receive the signal output by the second external microphone (“receiving a third microphone signal, wherein the third microphone signal is at least one of the second ambient signal or a modified second ambient signal”).

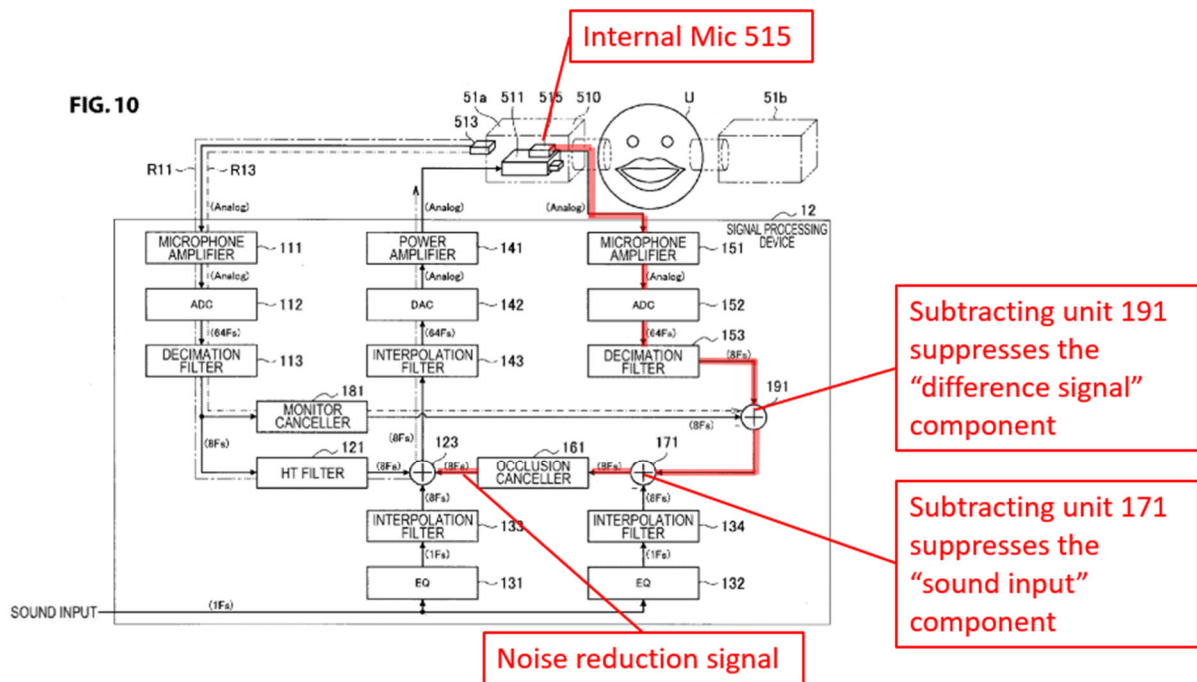
i. [1.11]: generating a background noise reduction signal using either the first and second microphone signals or the second and third microphone signals;

207. In my opinion, *Asada* in combination with *Usher* discloses or suggests “generating a background noise reduction signal using either the first and second microphone signals or the second and third microphone signals.”

208. *Asada* discloses that the signal processing circuit includes an “occlusion canceller 161” that “generates [a] noise reduction signal on the basis of the acoustic signal output from the subtracting unit 171.” *Asada* ¶[0093]. A POSITA would have understood that, in the *Asada-Usher* combination, the “noise reduction signal” is a “background noise reduction signal.”

209. As context, *Asada* explains that the signal output by the internal microphone includes three components: (1) “a component of the sound output from the speaker,” (2) “a component of the ambient sound propagating to the internal space via the mounting unit 510” (i.e., the ambient sound propagating

into the user's external ear canal), and (3) "a component of a voice of the user propagating to the external ear canal UA." *Asada* ¶[0087]. A signal from the external microphone 513 is processed by the monitor canceller 181, which outputs a "difference signal" similar to the HT filter 121. *Asada* ¶¶[0107]-[0116]. Then, "[t]he subtracting unit 191 subtracts the difference signal output from the monitor canceller 181" and "the subtracting unit 171" subtracts the sound input component. *Asada* ¶[0116].



Asada FIG. 10 (annotated)

210. The signal that is output from the subtracting unit 171 that is input to the occlusion canceller 161 is "an acoustic signal in which the component corresponding to a difference signal and the component corresponding to the

sound input among the components of the acoustic signal collected by the internal microphone 515 are suppressed.” *Id.* ¶[0117]. Thus, *Asada* discloses that the occlusion canceller generates a “noise reduction signal” based on an acoustic signal in which the “difference signal” corresponding to the ambient sound has been suppressed and in which the speaker output has been suppressed.

211. As explained in §X.C.1, the *Asada-Usher* combination discloses or suggests beamforming using the signals output from the two external microphones. In the combination, the beamformed signal is processed by the monitor canceller 181 and the beamformed “difference signal” subtracted from the internal signal by subtracting unit 191. A POSITA would have understood that the content of the beamformed difference signal does not include “the ambient sound propagating to the internal space,” which is a component of the internal microphone signal, as explained above.

212. Thus, a POSITA would have understood that in the *Asada-Usher* combination, subtracting unit 191 does not suppress the ambient sound propagating into the internal space. In other words, the output of the subtracting unit 191 includes a component of the ambient sound that leaked into the user’s ear canal because the subtracting unit 191 is only suppressing the component of the internal microphone signal that corresponds to the beamformed difference

signal. Thus, the input to the occlusion canceller includes a component of the ambient sound that propagated into the external ear canal.

213. A POSITA would have understood that the ambient sound that propagated into the ear canal is “background noise” in the context of the ’643 patent because, for example, the ’643 patent describes measuring a background noise signal from the electronic ambient sound signal, and explains that background noise may enter into the ear canal.’643 patent, 2:11-13, 3:17-35, 8:61-67, 13:55-14:11; 9:18-27 (“In noisy ambient environments, the voice captured at the ASM 111 includes the background noise from the environment, whereas, the internal voice created in the ear canal 131 captured by the ECM 123 has less noise artifacts, since the noise is blocked due to the occlusion of the earpiece 100 in the ear. ***It should be noted that the background noise can enter the ear canal if the earpiece 100 is not completely sealed.***”) Further, a POSITA would have understood that the signal input to the occlusion canceller would include a component of background noise, and the noise reduction signal output by the occlusion canceller would have the effect of suppressing that residual background noise when output from the speaker, i.e., it would be a “background noise reduction signal.”

215. Accordingly, in my opinion, the *Asada-Usher* combination discloses or suggests the processor of the earphone executing instructions to generate a noise reduction signal (“generating a background noise reduction signal”) based on a signal collected by the internal microphone including residual ambient noise (“using either the first and second microphone signals or the second and third microphone signals”).

j. [1.12]: mixing an audio content signal and the background noise reduction signal generating a mixed signal; and

216. In my opinion, *Asada* in combination with *Usher* discloses or suggests “mixing an audio content signal and the background noise reduction signal generating a mixed signal.”

217. *Asada* discloses that the signal processing device includes an “adding unit 123” that adds the difference signal output from the HT filter 121 and the noise reduction signal output from the occlusion canceller 161 to the sound input. *Asada* ¶[0096]. *Asada* further discloses that the output of the adding unit 123 is “the addition result of the sound input, the difference signal, and the noise reduction signal.” *Id.* ¶[0097].

218. *Asada* discloses that the “sound input” corresponds to “audio content or a received signal in a voice call.” *Asada* ¶[0073].

“functions to combine the ambient sound signal with the audio signal” and that “[b]y way of adjusting the *mix switch 74*, the user can control the relative amplitude or ratio of the ambient sound signal to the audio signal as represented by the output of the adder 82.” *Boersma* ¶[0062].⁹

221. Accordingly, a POSITA would have understood the *Asada-Usher* combination to disclose or suggest the processor of the earphone executing instructions to add a background noise reduction signal to the sound input (“mixing an audio content signal and the background noise reduction signal generating a mixed signal”).

k. [1.13]: sending a modified mixed signal to the speaker.

222. In my opinion, the *Asada* in combination with *Usher* discloses or suggests “sending a modified mixed signal to the speaker.”

223. *Asada* discloses that “the addition result of the adding unit 123 is up-sampled to a digital signal of 64 Fs by the interpolation filter 143, converted into an analog acoustic signal by the DAC 142, and input to the power amplifier 141,” and then “the analog acoustic signal undergoes gain adjustment performed

⁹ To be clear, I am relying on *Boersma* as evidence of the knowledge of a person having ordinary skill in the art and they are not part of the unpatentability ground 2.

225. Accordingly, in my opinion, a POSITA would have understood the *Asada-Usher* combination to disclose or suggest the processor of the earphone executing instructions to up-sample the signal output from the adding unit (“sending a modified mixed signal to the speaker”)

3. Claim 2: The device according to claim 1, wherein the operations further comprise: generating an ambient signal from at least one of the first ambient signal or the second ambient signal or a combination of both

226. In my opinion, *Asada* in combination with *Usher* combination discloses or suggests this claim.

227. As explained in §X.C.1, the *Asada-Usher* combination comprises a head-mounted device including two or more external microphones akin to *Asada*’s external microphone 513 to implement beamforming. The beamformed signal output from the *Asada-Usher* beamformer is consistent with how a POSITA would have understood an “ambient sound signal” in the context of the ’643 patent because it is a signal that represents ambient sound. A POSITA would have understood that beamforming involves combining microphone signals. This is corroborated, for example, by *Woodruff*, which describes a an earpiece with microphones and a sound pickup channel that “may be the result of combining multiple microphone signals, e.g., by a beamforming process performed on a multi-channel output from a microphone array.” *Woodruff*

¶[0024].¹⁰ Therefore, a POSITA would have understood that the beamformed signal was generated “from at least one of the first ambient signal or the second ambient signal or a combination of both.”

228. Accordingly, in my opinion, a POSITA would have understood the *Asada-Usher* combination to disclose or suggest the processor of the earphone executing instructions to beamform the signals from the first and second external microphones (“generating an ambient signal from at least one of the first ambient signal or the second ambient signal or a combination of both”).

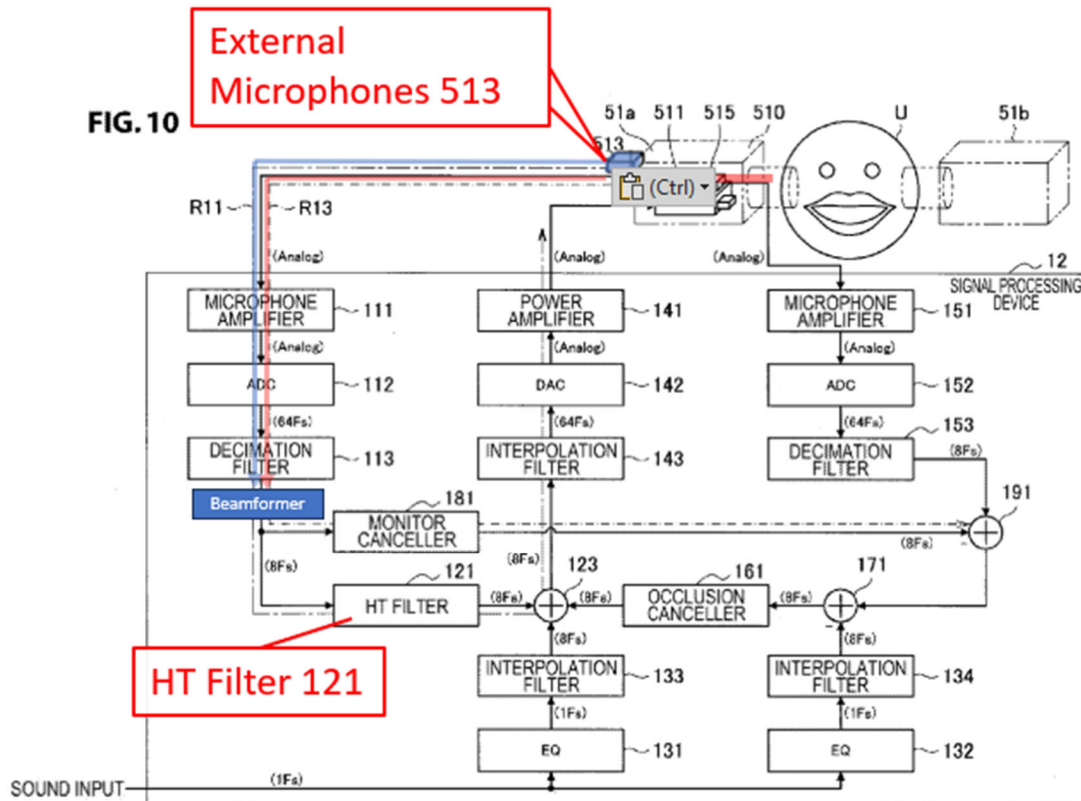
4. Claim 3: The device according to claim 2, wherein the operations further comprise: sending a modified ambient signal to the speaker.

229. In my opinion, *Asada* in combination with *Usher* combination discloses or suggests this claim.

230. As explained in §X.C.3, the *Asada-Usher* combination discloses or suggests implementing beamforming in *Asada*’s head-mounted device (“generating an ambient signal”). A POSITA would have further understood that

¹⁰ To be clear, I am relying on *Woodruff* as evidence of the knowledge of a person having ordinary skill in the art and it is not part of the unpatentability ground 2.

the combination discloses or suggests filtering the beamformed signal through *Asada*'s HT filter 121.



Asada, FIG. 10 (annotated)

231. A POSITA would have understood that, in the combination, HT filter 121 retains its function of filtering the input signal. In particular, *Asada* discloses that the HT filter may adjust the gain of the input signal to be higher or lower than if the user was not wearing the head-mounted device, so that the device can “control the volume of the ambient sound heard by the user U in accordance with an input state of the sound input or a type of sound input.”

Asada ¶[0078]. Thus, a POSITA would have understood the *Asada-Usher*

combination to disclose or suggest amplifying or attenuating the beamformed input signal, in part to account for input state or type of sound of the sound input signal (e.g., the volume of the sound input).

232. As discussed in §X.C.2.j, the adding unit 123 adds the sound input, background noise reduction signal, and output of the HT filter, and the combined signal is then amplified and sent to the speaker. As explained in §X.C.2.g, *Asada* discloses that the processor implements the functions of the signal processing circuit.

233. Accordingly, in my opinion, a POSITA would have understood the *Asada-Usher* combination to disclose or suggest the processor in the earphone executing instructions to filter the beamformed ambient signal through an HT filter which is ultimately sent to the speaker (“sending a modified ambient signal to the speaker”).

5. Claim 4: The device according to claim 3, where the modified ambient signal is the ambient signal.

234. In my opinion, *Asada* in combination with *Usher* combination discloses or suggests this claim.

235. As discussed in §X.C.1, the *Asada-Usher* combination discloses or suggests that if voice activity is detected per *Usher*’s teachings, *Asada*’s HT filter 121 amplifies the beamformed signal, and if no voice activity is detected, the HT filter 121 does not amplify the beamformed signal. A POSITA would

have understood that when the HT filter does not filter (e.g., amplify or attenuate) the beamformed input signal, then the output of the HT filter would just be the beamformed signal (“ambient signal”).

236. Accordingly, a POSITA would have understood the *Asada-Usher* combination to disclose or suggest the processor of the head-mounted device not filtering the beamformed input signal (“where the modified ambient signal is the ambient signal”).

- 6. Claim 5: The device according to claim 3, wherein the operations further comprise: generating the modified ambient signal by filtering an ambient signal, wherein the ambient signal is generated from at least the first ambient sound signal or the second ambient sound signal.**

237. In my opinion, *Asada* in combination with *Usher* combination discloses or suggests this claim.

238. As explained in §X.C.3, the *Asada-Usher* combination discloses or suggests implementing beamforming in *Asada*’s head-mounted device (“generating an ambient signal from at least one of the first ambient signal or the second ambient signal or a combination of both”). As explained in §X.C.4, the *Asada-Usher* combination discloses or suggests filtering the beamformed signal with an HT filter, which generates a “modified ambient signal.” Thus, a POSITA would have understood the *Asada-Usher* combination to disclose or suggest “generating the modified ambient signal by filtering an ambient signal.”

239. As explained in §X.C.3, the beamformed signal is generated from at least one of the first ambient sound signal or the second ambient sound signal.

240. Accordingly, a POSITA would have understood the *Asada-Usher* combination to disclose or suggest the processor of the head-mounted device passing the beamformed input signal through an HT filter (“generating the modified ambient signal by filtering an ambient signal, wherein the ambient signal is generated from at least the first ambient sound signal or the second ambient sound signal.”).

7. Claim 6: The device according to claim 3, wherein the operations further comprise: generating a modified ambient signal by filtering the ambient signal and modifying an amplitude of at least one frequency of the ambient signal.

241. In my opinion, *Asada* in combination with *Usher* combination discloses or suggests this claim.

242. As explained in §X.C.4, the *Asada-Usher* combination discloses or suggests filtering the beamformed signal with an HT filter, including by amplifying or attenuating the signal, which generates a “modified ambient signal.” A POSITA would have understood that amplifying or attenuating the beamformed signal would modify an amplitude of at least one frequency of the signal because amplifying a signal raises the amplitude of at least one frequency

component of the signal and attenuating a signal decreases the amplitude of at least one frequency component of the signal.

243. Accordingly, in my opinion, a POSITA would have understood the *Asada-Usher* combination to disclose or suggest the earphone processor executing instructions to pass the beamformed signal through an HT filter which may amplify the signal (“generating a modified ambient signal by filtering the ambient signal and modifying an amplitude of at least one frequency of the ambient signal”).

8. Claim 7: The device according to claim 1, wherein the modified mixed signal is the mixed signal.

244. In my opinion, *Asada* in combination with *Usher* combination discloses or suggests this claim.

245. As explained in §X.C.2.k, the *Asada-Usher* combination discloses or suggests an interpolation filter that up-samples the signal output from the adding unit 123 prior to output from the speaker (“sending a modified mixed signal to the speaker”). *Asada* further discloses that there are circumstances in which the head-mounted device may not reduce the sampling rate of the microphone signals based on a calculation of the efficiency gains to be obtained by down-sampling. *Asada* ¶[0148]. A POSITA would have understood that if the signals were not down-sampled, then they would not need to be up-sampled. Thus, a POSITA would have understood *Asada* to disclose or suggest certain

conditions under which the interpolation filter would not need to up-sample the signal.

246. Accordingly, a POSITA would have understood the *Asada-Usher* combination to disclose or suggest the earphone processor executing instructions to not up-sample the gain of the signal output from the adding unit (“wherein the modified mixed signal is the mixed signal”).

9. Claim 8: The device according to claim 1, wherein the operations further comprise: generating the modified mixed signal by mixing the mixed signal with an ambient signal, wherein the ambient signal is generated from at least one of the first ambient signal, the second ambient signal or a combination of both.

247. In my opinion, *Asada* in combination with *Usher* combination discloses or suggests this claim.

248. As explained in §X.C.2.j, *Asada* discloses the signal processing device includes “adding unit 123” that adds the difference signal output from the HT filter 121 and the noise reduction signal output from the occlusion canceller 161 to the sound input. *Asada* ¶[0096].

249. As explained in §X.C.4, a POSITA would have understood the *Asada-Usher* combination discloses or suggests a beamformed signal is processed by HT filter 121 and output as a beamformed “difference signal.” Therefore, the *Asada-Usher* combination discloses or suggests adding unit 123 adding a beamformed difference signal to the noise reduction signal and sound

input (the “mixed signal”) and up-sampling the resulting signal by an interpolation filter (the “modified mixed signal”).

250. As discussed in §IX.C, a POSITA would have understood this claim to require generating the “mixed signal” and then mixing the “ambient sound signal” with “the mixed signal.”

251. As discussed in §X.A.6, with respect to the *Svean-Beasley-Andrea* combination, there are three potential implementations for mixing three signals together. For the same reasons discussed there, it would have been obvious to mix the noise-reduction signal with the sound input (to generate the “mixed audio signal”) and then mix the resulting signal with the beamformed difference signal (“ambient sound signal”) to generate the “modified mixed signal.”

252. At the very least, a POSITA would have recognized that *Asada* does not specify how to add the three signals, and adding the noise reduction signal and audio signal first and then adding the ambient sound signal to the result was a known technique applicable to the summation in *Asada*, with predictable results.

253. Accordingly, a POSITA would have understood the *Asada-Usher* combination to disclose or suggest the earphone processor executing instructions to mix the noise reduction signal with the sound input signal, then further mixing in the beamformed difference signal (“generating the modified mixed signal by

mixing the mixed signal with an ambient signal, wherein the ambient signal is generated from at least one of the first ambient signal, the second ambient signal or a combination of both”).

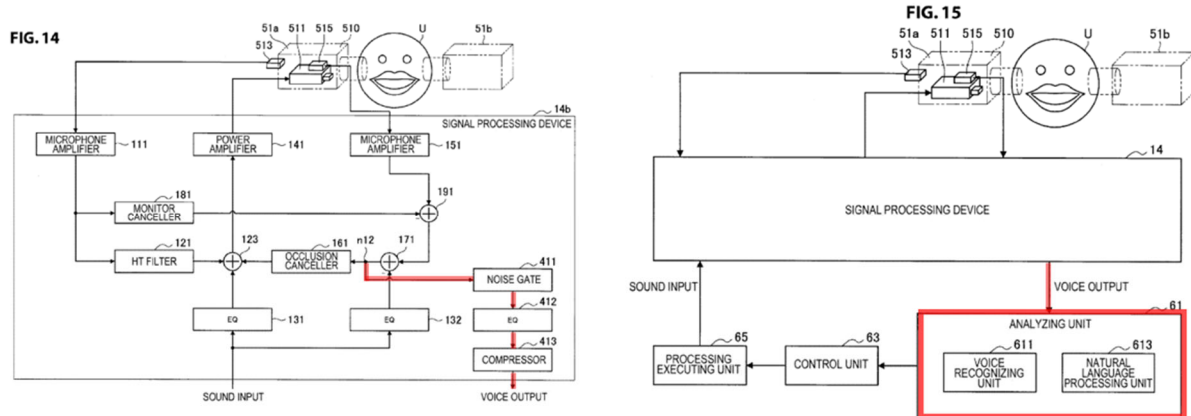
254. Alternatively, to the extent Patent Owner argues claim 8 does not require two-step mixing as discussed in §IX.C, the *Asada-Usher* combination renders this limitation obvious because it discloses or suggests mixing all three signals together.

10. Claim 9: The device according to claim 8, wherein the operations further comprise: analyzing at least one of the ambient signal or the ear canal signal or a combination of both, to detect a user’s voice.

255. In my opinion, *Asada* in combination with *Usher* combination discloses or suggests this claim.

256. *Asada* discloses an embodiment in Figures 13-15 in which the signal captured by *Asada*’s internal microphone is processed and output to analyzing unit 61 including voice-recognizing unit 611 and natural language processing unit 613. *Asada* ¶¶[0180]-[0182]; FIGs. 14, 15. A POSITA would have recognized that the embodiment in Figures 13-15 builds on the embodiment in Figure 10 because the circuit of signal processing device 14a/14b is the same as the signal processing device 12 in Figure 10 except for additional components related to voice detection, and the omission of the ADC/DAC and interpolation filters. *Asada* notes that the ADC/DAC are omitted “to facilitate

understanding.” *Asada* ¶[0160]. A POSITA would have understood the same to be true of the decimation and interpolation filters because the Figure 13-15 embodiment is also compatible with those filters.



Asada FIGs. 14 and 15 (annotated)

257. After the signal is processed by the voice-recognizing unit and natural language processing unit, control unit 63 obtains the result and instructs a processing execution unit to execute a specified function, such as reproducing audio content. *See Asada* ¶¶[00187]-[00191]. A POSITA would have understood *Asada*’s voice-recognizing unit detects the user’s voice. A POSITA would have considered it obvious to implement these functional units with the earphone processor in view of *Usher*.

258. *Usher* discloses an earphone including a processor detecting a user’s voice based on an analysis of signals from an ambient microphone. *Usher* ¶[0030]. *Usher*’s voice detection has similar functionality to *Asada*’s analyzing

unit. A POSITA would have been motivated to further modify the *Asada-Usher* combination to implement *Asada*'s analyzing unit in the processor of *Asada*'s earphone and would have had a reasonable expectation of success in doing so. Although *Asada* does not disclose that voice recognition based on the internal microphone signal is implemented by the processor of the head-mounted device, *Asada* does not preclude doing so, and *Asada* explains that the configuration of functional components shown in Figure 15 is just an example. *Asada* ¶[0193].

259. Moreover, a POSITA would have understood there were benefits to implementing voice recognition functionality in the earphone, such as reduced latency because the signals do not need to be transmitted to an external device before processing, and a more compact device because the functionality would be in a single processor instead of multiple components. Thus, a POSITA would have found it obvious to modify the *Asada-Usher* combination to implement *Usher*'s teaching in the processor in *Asada*'s earphone because it amounted to the use of a known technique (*Usher*'s earphone processor detecting the user's voice) to improve a similar device (the *Asada-Usher* head-mounted device) in the same way (to implement a head-mounted device capable of performing voice recognition).

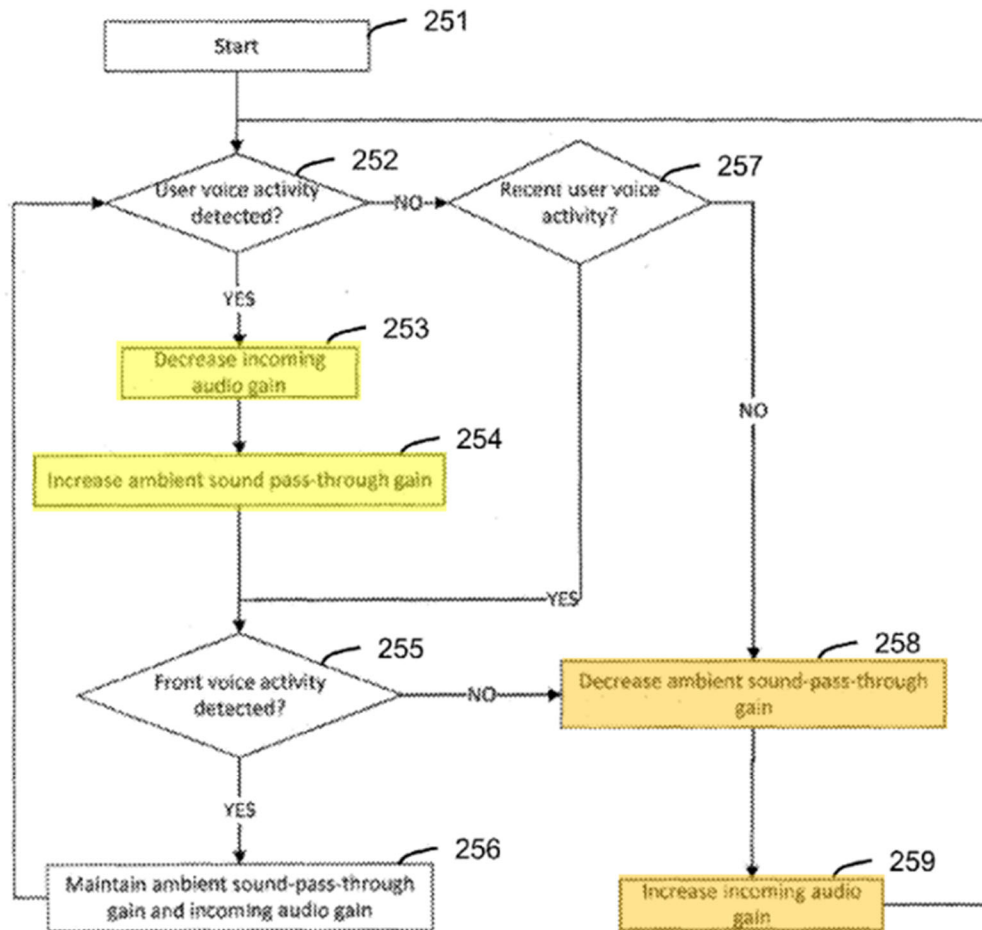
260. Accordingly, the *Asada-Usher* combination discloses or suggests the earphone processor executing instructions to process and analyze the internal

microphone signal with an analyzing unit including voice recognition (“analyzing at least one of the ambient signal or the ear canal signal or a combination of both, to detect a user’s voice”).

- 11. Claims 10 and 11: Claim 10 (“The device according to claim 9, wherein the operations further comprise: reducing the audio content signal prior to generating the mixed signal if the user’s voice is detected.”); Claim 11 (“The device according to claim 9, wherein the operations further comprise: reducing the ambient signal prior to generating the mixed signal if the user’s voice is not detected.”)**

261. In my opinion, *Asada* in combination with *Usher* combination discloses or suggests these claims.

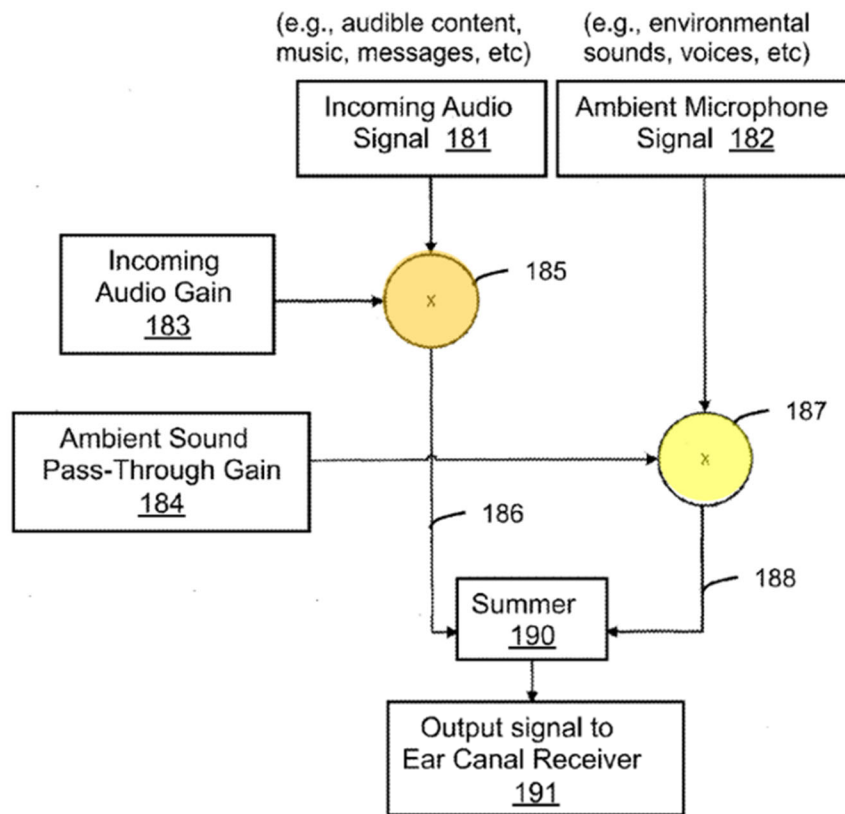
262. As discussed in §X.C.1, the *Asada-Usher* combination discloses or suggests that if voice activity is detected per *Usher*’s teachings, *Asada*’s HT filter 121 amplifies the beamformed signal, and if no voice activity is detected, the HT filter 121 does not amplify the beamformed signal.



250
FIG. 2B

Usher, FIG. 2B (annotated)

263. Usher discloses the respective gain adjustments are made before the signals being mixed. *Id.* ¶[0025], FIG. 1B.



180

FIG. 1B

Usher, FIG. 1B (annotated)

264. Accordingly, the *Asada-Usher* combination discloses or suggests the earphone processor executing instructions to reduce the gain of the incoming sound input signal if the user's voice is detected ("reducing the audio content signal prior to generating the mixed signal if the user's voice is detected") and reduce the gain of the beamformed difference signal if the user's voice is not detected ("reducing the ambient signal prior to generating the mixed signal if the user's voice is not detected").

XI. SECONDARY CONSIDERATIONS

265. I am not aware of any evidence in the '643 patent's prosecution history or elsewhere supporting any secondary considerations arguments, or evidence of nexus of such alleged evidence to the challenged claims. *See generally* EX1004, §VIII.B. To the extent Patent Owner asserts the existence of any secondary considerations in its responses, I reserve the right to address any such evidence.

XII. CONCLUSION

266. The findings and opinions set forth in this declaration are based on my work and examinations to date.

267. I may continue my examinations. I may also receive additional documentation and other factual evidence over the course of this IPR that will allow me to supplement and/or refine my opinions. I reserve the right to add to, alter, or delete my opinions and my declaration upon discovery of any additional information. I reserve the right to make such changes as may be deemed necessary.

268. In signing this declaration, I recognize that the declaration will be filed as evidence in an IPR before the PTAB. I also recognize that I may be subject to cross-examination in the case and that cross-examination will take place within the United States. If cross-examination is required of me, I will

appear for cross-examination within the United States during the time allotted for cross-examination.

269. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Date: June 25, 2024



Nathaniel Polish