

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

BOSE CORPORATION,
Petitioner,

v.

INGENIOSPEC, LLC,
Patent Owner.

Case No. IPR2025-01547
Patent No. 8,582,789

**DECLARATION OF DAVID V. ANDERSON, PH.D.
IN SUPPORT OF PETITION FOR
INTER PARTES REVIEW OF U.S. PATENT NO. 8,582,789**

Bose Exhibit 1003 Bose v. IngenioSpec
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I, David V. Anderson, declare:

1. I have been retained by Wolf, Greenfield & Sacks, P.C., counsel for Petitioner Bose Corporation, to assess claims 1-82 (the “challenged claims”) of U.S. Patent No. 8,582,789 (EX1001, “the ’789 patent”). I am being compensated for my time at my standard rate of \$650.00 per hour, plus actual expenses. My compensation is not dependent in any way upon the outcome of this matter.

I. PERSONAL AND PROFESSIONAL BACKGROUND

2. I am a professor in the School of Electrical and Computer Engineering at the Georgia Institute of Technology (“Georgia Tech”) in Atlanta, Georgia. I received my Ph.D. in Electrical and Computer Engineering from Georgia Tech, and I received my B.S. and M.S. in Electrical Engineering from Brigham Young University.

3. In both my studies and research, I have had the opportunity to work extensively with audio signal processing techniques, including the use of such techniques to provide hearing compensation for hearing-impaired individuals.

4. For example, from 1993 to 1994, I designed and implemented audio signal processing methods for hearing aids at Sonic Innovations. From 1994 to 1999, I performed research in audio signal processing. During that time, I also worked as a consultant to multiple companies developing algorithms for general

speech enhancement in wireless telephone systems, speech quality assessment, and speech detection.

5. In my employment prior to Georgia Tech, as well as in my subsequent studies and research, I have worked extensively in areas related to research, design, and implementation of audio processing algorithms and applications, including for audio enhancement. I have designed and taught a graduate course on multimedia systems and another on signal processing in the context of human perception. The latter course covered hearing aids, perceptual quality of audio, audio enhancement, and various related topics. These courses and my research have covered many topics relevant to the subject matter of the '789 patent and the cited prior art. In particular, concepts such as amplifying particular audio frequencies to account for an individual's unique hearing characteristics.

6. I also have extensive experience with the practical implementation of audio processing algorithms, and related topics through my research and consulting.

7. My curriculum vitae is provided as Exhibit 1004.

II. MATERIALS CONSIDERED

8. In forming my opinions, I have reviewed the following documents, and any other document cited in this declaration:

Exhibit	Description
1001	U.S. Patent No. 8,582,789
1002	Prosecution History of U.S. Patent No. 8,582,789
1005	U.S. Patent No. 7,388,962
1006	U.S. Patent Appl. Publ. No. 2004/0208333 (“Cheung”)
1007	U.S. Patent Appl. No. 10/826,527 (“Priority Application”)
1008	U.S. Patent Appl. Publ. No. 2004/0136555 (“Enzmann”)
1009	Prosecution History of U.S. Patent No. 7,388,962
1010	WIPO Patent Appl. Publ. No. WO 01/54458 A2 (“Eaton”)
1011	U.S. Patent Appl. Publ. No. 2001/0041602 (“Berger”)
1012	U.S. Patent No. 5,636,285 (“Sauer”)
1013	WIPO Patent Appl. Publ. No. WO 98/31193 A1 (“Fretz”)
1014	U.S. Patent No. 6,389,142 (“Hagen”)
1015	WIPO Patent Appl. Publ. No. WO 99/05840 A1 (“DeJaco”)
1016	U.S. Patent No. 3,829,623 (“Willis”)
1017	U.S. Statutory Invention Registration H417 (“Miles”)
1018	<i>IngenioSpec, LLC v. Bose Corp.</i> , 2:24-cv-00822 (E.D. Tex.), Dkt. No. 1-7 (Exhibit 7 to Complaint)
1019	<i>IngenioSpec, LLC v. Sony Corp.</i> , 2:24-cv-00820 (E.D. Tex.), Dkt. No. 1-8 (Exhibit 8 to Complaint)
1020	<i>IngenioSpec, LLC v. Samsung Elecs. Co.</i> , 2:24-cv-00819 (E.D. Tex.), Dkt. No. 1-9 (Exhibit 9 to Complaint)
1021	<i>IngenioSpec, LLC v. LG Elecs., Inc.</i> , 2:24-cv-00823 (E.D. Tex.), Dkt. No. 1-8 (Exhibit 8 to Complaint)

1022	U.S. Patent Application Serial No. 10/826,529
1023	WIPO Patent Appl. Publ. No. WO 1991/015902 A1
1024	U.S. Patent Appl. Publ. No. 2002/0141599 A1
1025	WIPO Patent Appl. Publ. No. WO 2001/028310 A2
1026	U.S. Patent Appl. Publ. No. 2002/0031228 A1
1027	Wayne Tomasi, <i>Electronic Communications Systems: Fundamentals Through Advanced</i> (4th Ed. 2001)
1028	U.S. Patent No. 4,792,977
1029	U.S. Patent Appl. Publ. No. 2002/0176584 A1
1030	U.S. Patent No. 3,946,168
1031	U.S. Patent No. 6,134,334
1032	U.S. Patent Appl. Publ. No. 2002/0067825 A1
1033	U.S. Patent Appl. Publ. No. 2002/0111197 A1
1034	U.S. Patent No. 6,006,115
1035	European Patent No. 1,161,064 B1
1036	Oxford English Reference Dictionary (2nd Ed. 1996)
1037	U.S. Patent No. 2,112,569
1038	U.S. Patent No. 4,335,281
1039	U.S. Patent No. 2,305,905
1040	U.S. Patent No. 2,484,052
1041	European Patent No. 1,372,353 B1
1042	WIPO Patent Appl. Publ. No. WO 02/25906 A2
1043	GB Patent No. 604,357
1044	U.S. Patent No. 2,411,190
1045	European Patent Appl. Publ. No. 0,002,051 A1
1046	U.S. Patent No. 2,744,158
1047	U.S. Patent No. 4,284,847

1048	U.S. Patent Appl. No. 10/826,531
1049	U.S. Patent Appl. No. 10/826,528
1050	U.S. Patent Appl. No. 10/826,537
1051	U.S. Patent No. 3,531,595
1052	U.S. Patent Appl. Publ. No. 2002/0068610
1053	U.S. Patent Appl. Publ. No. 2002/0069031
1054	U.S. Patent No. 5,047,860
1055	U.S. Patent No. 6,118,877
1056	U.S. Patent No. 4,870,688
1057	U.S. Patent No. 5,663,727
1058	U.S. Patent Appl. Publ. No. 2004/0137967
1059	U.S. Patent No. 5,825,897
1060	WIPO Patent Appl. Publ. No. 03/056790

9. I have also relied on my education, experience, research, training, and knowledge in the relevant art, and my understanding of any applicable legal principles described in this declaration.

III. MY UNDERSTANDING OF PATENT LAW

10. In developing my opinions, I discussed various relevant legal principles with Bose's attorneys. I understood those legal principles when they were explained to me and have relied upon those legal principles, as explained to me, in the course of forming the opinions set forth in this declaration. My understanding in this respect is as follows:

11. I understand that “*inter partes* review” (IPR) is a proceeding before the United States Patent & Trademark Office for evaluating the patentability of an issued patent’s claims based on prior art patents and printed publications.

12. I understand that, in this proceeding, Bose has the burden of proving that the challenged claims are unpatentable by a preponderance of the evidence. I understand that “preponderance of the evidence” means that a fact or conclusion is more likely true than not true.

13. I understand that, in IPR proceedings, claim terms in a patent are given their ordinary and customary meaning as understood by a person of ordinary skill in the art (“POSA”) in the context of the entire patent and the prosecution history pertaining to the patent. If the specification provides a special definition for a claim term that differs from the meaning the term would otherwise possess, the specification’s special definition controls. I have applied these standards in preparing the opinions in this declaration.

14. I understand that determining whether a particular patent or printed publication constitutes prior art to a challenged patent claim can require determining the effective filing date (also known as the priority date) to which the challenged claim is entitled. I understand that for a patent claim to be entitled to the benefit of the filing date of an earlier application to which the patent claims priority, the earlier application must have described the claimed invention in sufficient detail to convey

with reasonable clarity to a POSA that the inventor had possession of the claimed invention as of the earlier application's filing date. I understand that a disclosure that merely renders the claimed invention obvious is not sufficient written description for the claim to be entitled to the benefit of the filing date of the application containing that disclosure.

15. I understand that for an invention claimed in a patent to be patentable, it must be, among other things, new (novel—*i.e.*, not anticipated) and not obvious from the prior art. My understanding of these two legal standards is set forth below.

A. Anticipation

16. I understand that, for a patent claim to be “anticipated” by the prior art (and therefore not novel), each and every limitation of the claim must be found, expressly or inherently, in a single prior art reference. I understand that a claim limitation is disclosed for the purpose of anticipation if a POSA would have understood the reference to disclose the limitation based on inferences that a POSA would reasonably be expected to draw from the teachings in the reference when read in light of the POSA's knowledge and experience.

17. I understand that a claim limitation is inherent in a prior art reference if that limitation is necessarily present when practicing the teachings of the reference, regardless of whether a person of ordinary skill recognized the presence of that limitation in the prior art.

B. Obviousness

18. I understand that a patent claim may be unpatentable if it would have been obvious in view of a single prior art reference or a combination of prior art references.

19. I understand that a patent claim is obvious if the differences between the subject matter of the claim and the prior art are such that the subject matter as a whole would have been obvious to a person of ordinary skill in the relevant field at the time the invention was made. Specifically, I understand that the obviousness question involves a consideration of:

- the scope and content of the prior art;
- the differences between the prior art and the claims at issue;
- the knowledge of a person of ordinary skill in the pertinent art; and
- if present, objective factors indicative of non-obviousness, sometimes referred to as “secondary considerations.” To my knowledge, the Patent Owner has not asserted any secondary considerations with respect to the ’789 patent at the time of my submitting this declaration.

20. I understand that in order for a claimed invention to be considered obvious, a POSA must have had a reason for combining teachings from multiple prior art references (or for altering a single prior art reference, in the case of obviousness in view of a single reference) in the fashion proposed.

21. I further understand that in determining whether a prior art reference would have been combined with other prior art or with other information within the knowledge of a POSA, the following are examples of approaches and rationales that may be considered:

- combining prior art elements according to known methods to yield predictable results;
- simple substitution of one known element for another to obtain predictable results;
- use of a known technique to improve similar devices in the same way;
- applying a known technique to a known device ready for improvement to yield predictable results;
- applying a technique or approach that would have been “obvious to try,” i.e., choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success.
- known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations would have been predictable to one of ordinary skill in the art;
- some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention. I understand that this teaching, suggestion or motivation may come from a prior art reference or from the knowledge or common sense of one of ordinary skill in the art.

22. I understand that for a single reference or a combination of references to render the claimed invention obvious, a POSA must have had a reasonable expectation of success in being able to arrive at the claimed invention by altering or combining the applied references.

IV. THE PERSON OF ORDINARY SKILL IN THE ART

23. In rendering the opinions set forth in this declaration, I have been asked to consider the claims of the '789 patent and the prior art through the eyes of a POSA. I have considered factors such as the educational level and years of experience of those working in the pertinent art, the types of problems encountered in the art, the teachings of the prior art, patents and publications of other persons or companies, and the sophistication of the technology.

24. As I discuss in more detail below in Section V, the '789 patent generally relates to hearing-enhancement systems and techniques for enhancing an individual's ability to hear an audio signal. This field would include hearing aids, which have been around for decades, as well as conventional headphones which have existed for decades.

25. I have been instructed to assume a person of ordinary skill in the art is not a specific real individual, but rather a hypothetical individual having the qualities reflected by the factors discussed above.

26. Taking these factors into consideration, it is my opinion that a person of ordinary skill in the art of the '789 patent would have had at least a bachelor's degree in electrical engineering or a related field, plus at least two years of industry or graduate-level experience with designing sound-amplifying devices, including

hearing aids and/or headphones. Work experience can substitute for formal education and additional formal education can substitute for work experience.

27. For purposes of this declaration, I have been asked to assume that the date of the alleged invention is April 15, 2003. By that date, I was at least a person of ordinary skill in the art, as shown by my qualification and work experience above.

28. In this declaration, and for all of my opinions herein, I have applied the knowledge of a person of ordinary skill in the art as of April 15, 2003.

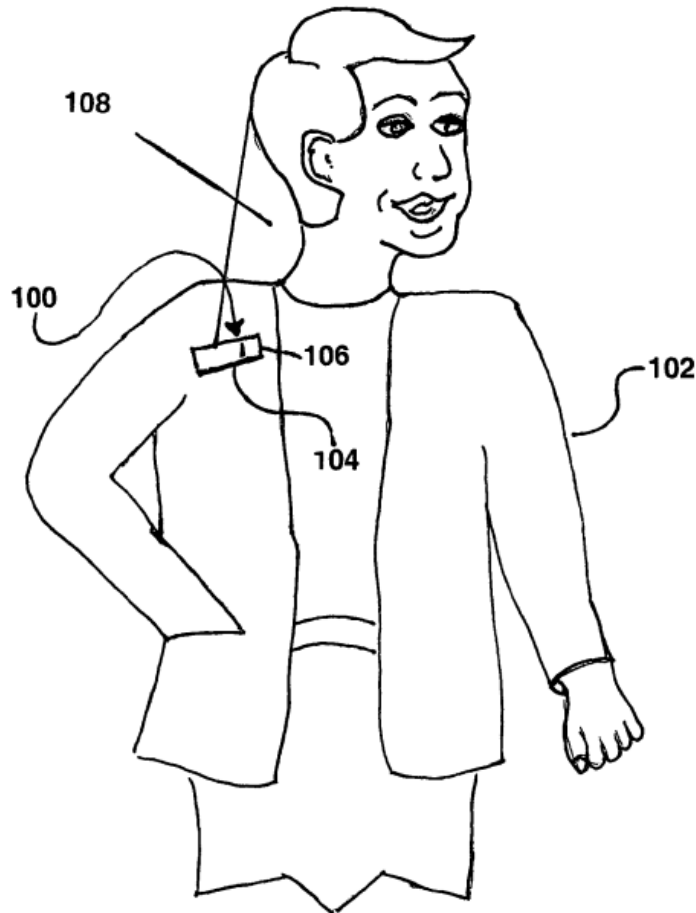
V. THE '789 PATENT

29. The '789 patent is directed to a hearing-enhancement system for individuals with hearing impairments. EX1001, 1:53-55, 3:3-5. The patent says many hearing-impaired individuals do not wear hearing aids due to drawbacks with then-conventional devices, including an uncomfortable "occlusion" effect that occurs when hearing aids are located inside a user's ear. EX1001, 1:57-63, 2:13-64. As the patent observes, the occlusion effect "is the hollowness, echoic or stuffed sensation of hearing one's own voice as one talks with a hearing aid inside one's ear." EX1001, 2:13-17.

30. The patent addresses the occlusion effect by using a device with a "directional speaker" that is located outside the user's ear, *e.g.*, on the user's clothing. EX1001, 3:18-24, 5:58-63. The speaker is directed at the user's ear and

transmits audio towards the user's ear using ultrasonic audio signals. EX1001, 5:66-6:17.

31. Figure 2 (shown below) depicts “a person wearing one embodiment of the present invention.” EX1001, 5:10-11.



32. As shown above, the system comprises an “interface unit 100” that includes “a directional speaker 104 and a microphone 106. The speaker 104 can be in a line of sight of an ear of the user.” EX1001, 5:58-63. In Figure 2's embodiment,

the interface device and its speaker is positioned on the user's clothing and apart from the user's ear.

33. When a user wearing the system shown above is talking to a friend, for example, the microphone 106 “picks up the friend's speech, namely, her audio signals,” and those signals are transmitted by the speaker as “modulated ultrasonic signals in air towards the ear of the user. The transmitted signals are demodulated in air to create the output audio signals. Based on ultrasound transmission, the speaker 104 generates directional audio signals and sends them as a cone (virtual cone) 108 to the user's ear.” EX1001, 5:64-6:7. In other words, the system uses ultrasonic signaling to direct the audio signals specifically at the user's ear as opposed to broadcasting those signals in an omnidirectional manner.

34. In the Figure 2 embodiment, the system is operating similar to a typical hearing aid—it captures audio in the user's environment via a microphone and transmits that captured audio via a speaker to user. The principal distinction between the Figure 2 embodiment and a conventional hearing aid is that the captured audio in the Figure 2 embodiment is transmitted via **ultrasonic** signals by a **directional**

speaker located apart from a user's ear whereas a conventional hearing aid positions its **non-directional** speaker in the user's ear and **does not use ultrasonic signals**.¹

35. In addition to functioning as a typical hearing aid, the patent also discloses embodiments in which the system functions as a cellular phone or a "personalized listening unit" that wirelessly receives audio from other media sources like a television, radio, or phone. EX1001, 10:21-32, 11:66-12:29, 13:53-14:38. In those embodiments, the audio that is output by the system's speaker comes from the wirelessly connected media source like a cellphone, television, or radio. In these embodiments, the system functions similar to a conventional wireless headphone.

36. By using a directional speaker and positioning that speaker apart from the user's ear, the patent explains that "the user's ear remains free from any inserted objects and thus is free from the annoying occlusion effect, enabling the user to continue to hear sounds without interference." EX1001, 13:6-9; *see also* Abstract ("Based on the system, the user's ear remains free from any inserted objects and thus is free from annoying occlusion effects."); 3:50-56 (similar); 7:11-14 (similar).

¹ Throughout the declaration, I use **bold** for emphasis. I use *italics*, however, when directly quoting the language of the challenged claims.

37. As I explained above, the patent's speaker is directional and it outputs ultrasonic audio signals. Both of those concepts would have been known to a person of ordinary skill in the art by April 2003, and I provide some brief background below.

38. A directional speaker is a type of speaker that focuses sound waves into a narrow beam rather than sending sound in all directions as a conventional broadcasting speaker would. Directional speakers allow audio to be targeted toward the listener, reducing general noise pollution because only those individuals within the targeted beam of the signal can hear the audio. As the patent recognizes, there are many different ways to design a directional speaker. EX1001, 6:5-17.

39. For example, a person of ordinary skill in the art would have known that one common technique for designing a directional speaker was the use of multiple speakers working together to create constructive and destructive interference patterns that shape their respective sound output into a beam. This approach was known as a phased array and is one technique that the '789 patent identifies for forming its directional speaker. EX1001, 3:35-36. The patent also describes the use of a "physical cone or a horn that directly transmits directional audio signals." EX1001, 6:7-9.

40. Ultrasonic signals can also be used to make a speaker directional. EX1001, 6:5-7. Ultrasonic signals are sound waves that are transmitted at frequencies too high for humans to hear, typically above 20 kHz. Such signals can

be used in medical imaging to visualize internal organs, *e.g.*, an ultrasound to view a baby. But those signals can also be used to transmit audio in a focused beam so that the audio can be targeted in a particular direction—the higher the frequency of the signal, the narrower (or more focused) the beam can be made. EX1001, 11:56-59. As the '789 patent explains, the ultrasonic signals are demodulated in the air so that they eventually transform from a high frequency to one that humans can hear. EX1001, 3:27-30 (“The transmitted [ultrasonic] signals are transformed back into audio signals by air to form the output audio signals.”).

41. The patent describes embodiments in which the audio signal that the directional speaker outputs is modified, *e.g.*, amplified, based on a user’s particular hearing characteristics. EX1001, Abstract (“At least a portion of the output audio signals are modified to enhance the hearing of the user.”), 3:59-67 (“[T]he user’s hearing is profiled so that frequency amplification is tailored to the user.”), 13:32-38 (“[S]ignals driving a speaker in a system of the present invention can be modified based upon user information stored in the system. As such, the audio sound being produced by the speaker can be customized for (or personalized to) the user.”).

42. An example of a hearing characteristic that the patent identifies is the particular audio frequencies that a user has difficulty hearing. EX1001, 6:30-43. As was known to a person of ordinary skill in the art, an individual with a hearing impairment typically is unable to hear certain audio frequencies as well as a non-

impaired individual would at the same volume (or amplification). For example, an individual with high-frequency hearing loss—a common type of hearing impairment—has difficulty hearing high frequencies such as those between 2,000 and 3,000 Hertz. *See, e.g.*, EX1001, 6:44-47 (discussing this common form of hearing impairment).

43. With the patent’s system, an audio signal that the directional speaker is intended to output is first modified to account for a user’s hearing characteristic by, for example, increasing power for the audio signal at the specific frequencies that the user would otherwise have difficulty hearing. EX1001, 3:30-33, 3:44-46. In other words, to account for an individual’s inability to hear, *e.g.*, frequencies above 2,000 Hertz, the system increases the amplification (*i.e.*, volume) for audio at those frequencies whereas audio at other frequencies is not amplified.

44. Increasing audio-frequency power to compensate for hearing impairments was conventional in the hearing-aid field **long** before 2003. For example, U.S. Patent No. 2,112,569 (EX1037) was issued almost a century ago in **1938** and it describes a hearing aid that is “capable of being varied over wide ranges to provide a large number of different amplification characteristics.” EX1037, 1:51-2:2. The hearing aid can be “accurately calibrated” for each user with its “gradually controlled characteristics in any principal portion of the audible sound spectrum,” thereby “enabl[ing] the most satisfactory amplification characteristic by either air or

bone conduction to be found for a given hard of hearing person.” EX1037, 1:51-2:12.

45. As another example, U.S. Patent No. 2,305,905 (EX1039), issued in **1942**, noted that “[i]t is well known that the frequency response characteristic of the normal human ear is not linear and that in certain forms of deafness one portion of the response characteristic of the ear is affected more seriously than other portions, that is, certain types of deafness result from a failure of the ear mechanism to respond to sounds of certain definite frequencies. EX1039, 1:37-44. The patent then discloses that “a device which is designed to compensate for the deficiency of the affected ear should provide sound vibrations adjusted to the particular deficiency of the individual user’s ear,” for example, the hearing aid device may “include[] a peaked amplifier having a frequency response characteristic which may be adjusted by a simple control device to compensate for the particular deficiencies of each individual user.” EX1039, 1:44-55.

46. As yet another example, U.S. Patent No. 2,484,052 (EX1040), issued in **1949**, stated that “[i]t is well known that many individuals having impaired hearing have a hearing loss limited to a restricted part of the frequency range and that a hearing aid designed to amplify the audible range with uniform frequency response characteristics has to be provided with response control means for selectively attenuating the amplification of the hearing aid output in the restricted

part of the audio-frequency range in which the users hearing is not impaired and excessive amplification would disturb or even cause injury.” EX1040, 1:46-2:2

47. In addition to reviewing the patent’s specification and claims, I also reviewed its file history.

48. The patent’s claims as originally filed were rejected for non-statutory double patenting over U.S. Patent No. 7,388,962. EX1002, 117-121.

49. The applicants responded to this rejection by filing a terminal disclaimer (EX1002, 161), and the claims were subsequently allowed because the Examiner said that the originally-filed claims were **narrower** than the claims of the ’962 patent. EX1002, 175-177 (in the “Reasons for Allowance” section, stating that the “claims in the patent application (7388962) are broader than the scope of the claims in the present application [*i.e.*, the ’789 patent’s application]”).

50. I disagree with the Examiner that the originally-filed claims of the ’789 patent were somehow narrower than the issued claims of the ’962 patent. The claims of the ’789 patent are actually significantly broader.

51. For example, both independent claims of the ’962 patent (and thus all dependent claims) recite a “*hearing enhancement system*” that includes “*a directional speaker*” that (i) “*transmits*” or “*outputs*” “*ultrasonic signals*” and (ii) “*is configured to be spaced apart from at least one of the ears of the user so that at least a portion of the ultrasonic signals is transformed into output audio signals*”

outside the at least one of the ears of the user.” EX1005, independent claims 1 and 23. In other words, all claims of the ’962 patent narrowly require a very specific type of speaker: a **directional** speaker that transmits **ultrasonic** signals and is **positioned apart** from the user’s ear.

52. In stark contrast, the originally-filed claims (and the currently-issued claims) of the ’789 patent merely recite “*a speaker*”—generically—with no requirement that it be directional, that it transmit ultrasonic signals, or that it be configured such that it would be “spaced apart” from a user’s ear when worn. *See, e.g.*, EX1002, 30-33; EX1001, independent claims 1 and 13. The “*speaker*” in the originally-filed (and now-issued) claims—on their face—encompasses any type of speaker, which makes those claims broader than the claims of the ’962 patent which require a specific type of speaker.

53. After the applicants filed the terminal disclaimer and after the Examiner allowed the originally-filed claims, the applicants then filed serial requests for continued examination, adding the claims that became claims 29-82. EX1002, 221-235; 277-292; 317-335.

VI. PRIORITY ANALYSIS

54. Bose’s counsel asked me to review application No. 10/826,527 (EX1007), which is the application that became the ’962 patent. Hereinafter, I refer to this application as “the Priority Application.” I understand that the ’789 patent is

a continuation of the '962 patent, and that the written description of the Priority Application is nearly identical to the specification of the '789 patent.

55. Bose counsel asked me to provide my opinion as to what invention(s) the written description of the Priority Application demonstrates to a person of ordinary skill in the art that the named inventors possessed at the time the Priority Application was filed on April 15, 2004.

56. For the reasons discussed below, my opinion is that a person of ordinary skill in the art would have read the Priority Application's written description to convey that the named inventors had allegedly invented a very particular type of speaker. Specifically, the written description uniformly describes a speaker with three distinct features: it is **directional**, outputs **ultrasonic** signals, and is intended to be **positioned outside** the user's ear. A person of ordinary skill in the art would not have understood the Priority Application's written description to convey that the alleged invention encompassed a different type of speaker such as one that is intended, for example, to be positioned inside the user's ear—indeed, as I discuss below, the fundamental “idea” described in the Priority Application is avoiding the need to position a speaker inside a user's ear given known drawbacks to such positioning.

57. The Priority Application begins by explaining that many individuals who would benefit from hearing aids do not wear them due to certain known

drawbacks that were associated with then-existing hearing aids. EX1007, [0004]-[0014]. According to the Priority Application, there are “three major types of hearing aids—the ‘behind-the-ear’ (BTE) style, the ‘in-the-ear’ (ITE) style, and the completely-in-the-canal (CIC) style.” EX1007, [0007]. A person of ordinary skill in the art would have been familiar with these three styles, and examples of each are shown below:



See <https://www.nidcd.nih.gov/health/hearing-aids>.

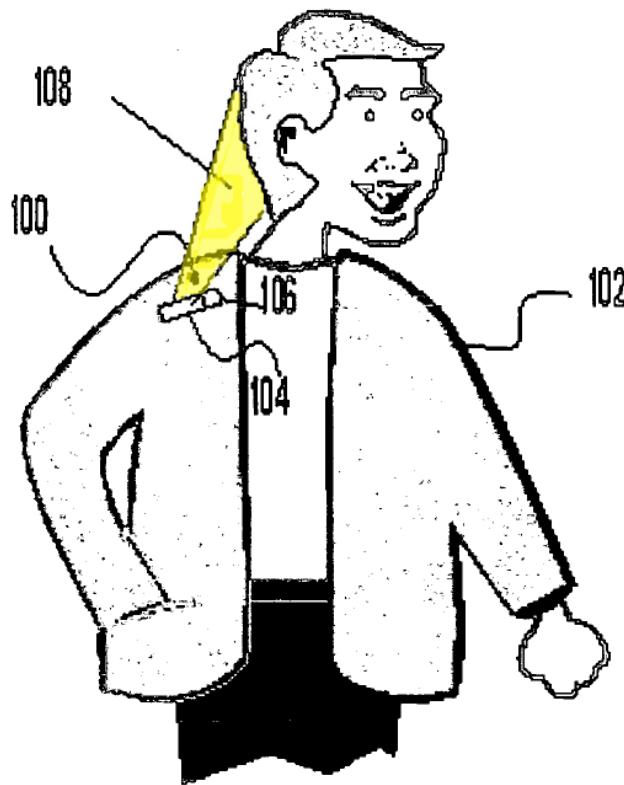
58. For “behind-the-ear” hearing aids, the Priority Application reports that they have certain advantages but also explains that “for those wearing hearing aids, they usually prefer a more inconspicuous type, such as an ITE (or CIC) hearing aid, which is located inside the ear canal.” EX1007, [0007]. That is, due to their somewhat bulky size, BTE hearing aids are more visible to others and thus draw more unwanted attention than either ITE or CIC hearing aids. *See also* EX1007, [0006] (describing the “stigma towards wearing” hearing aids as a reason “many people with mild or moderate hearing loss do not wear one”). The Priority Application then focuses on the less-conspicuous ITE or CIC styles of hearing aids.

59. For “in-the-ear” (ITE) and “completely-in-the-canal” (CIC) hearing aids, the Priority Application identifies their known drawbacks as including (i) the need to be **customized** to fit “into the patient’s [ear] canal” (EX1007, [0009]), and (ii) the corresponding (and disturbing) **occlusion** effects that are associated with positioning the device in the user’s ear (EX1007, [0012]). The occlusion effect, the Priority Application explains, “is the hollowness, echoic or stuffed sensation of hearing one’s own voice as one talks with a hearing aid inside one’s ear.” EX1007, [0007]. The Priority Application therefore plainly disparages hearing aids with speakers positioned inside a user’s ear, like ITEs and CICs, as having specific drawbacks (*e.g.*, occlusion, need for customization) that discouraged hearing-impaired individuals from using them.

60. To address those drawbacks, the Priority Application’s “present invention” is a “system that enhances an individual’s hearing based on a directional speaker.” EX1007, [0015]. The speaker is positioned apart from the user’s ear such that it can be worn on a user’s clothing. EX1007, [0016]-[0017] (“A user can wear the system on his clothing, and the speaker can be directed towards an ear of the user when worn.”).

61. An embodiment of the “present invention” is depicted in Figure 2. EX1007, [0032]. As seen in that figure (reproduced below), the invention includes an interface unit 100 with a directional speaker 104 that is positioned on the user’s

clothing, and thus apart from the user's ear. EX1007, [0044]-[0045]. The directional speaker is "in a line of sight of an ear of the user" and transmits modulated "ultrasonic signals in air towards the ear of the user" via a virtual cone 108 (yellow below). EX1007, [0045]-[0046]. The ultrasonic signals are "demodulated in air to create [] output audio signals" that the user can hear. EX1007, [0046].



EX1007 at p. 32 (FIG. 2).

62. The Priority Application repeatedly describes the "speaker" for its invention as directional, ultrasonic, and positioned apart from the user's ear:

- Title ("**Directional** Hearing Enhancement Systems");

- [0003] (“The present invention relates ... to a hearing enhancement system whose audio signals are **directional**.”);
- [0015] (“The present invention pertains to a hearing enhancement system that enhances an individual's hearing based on a **directional** speaker.”);
- [0017]-[0018] (Then, the **directional** speaker transmits the **ultrasonic** signals in air towards an ear of the user. ... The directivity of the audio signals is increased due to the **ultrasonic** signals.);
- [0020] (“Since the **directional** speaker is **not attached to or inserted in the ear**, the user can still hear the audio signals directly from the audio source.”);
- [0044]-[0046] (“The hearing enhancement system 10 includes an interface unit 14, which includes a **directional** speaker 16 Again, the interface unit 100 includes a **directional** speaker 104 and a microphone 106. ... Then, the **directional** speaker 104 transmits the modulated **ultrasonic** signals in air towards the ear of the user.”);
- [0051] (“Since the hearing enhancement system **does not require having any hearing aid inserted into the ear**, the low to mid frequencies can be received at the ear unaltered.”);
- [0060] (discussing signal processing considerations given that “[s]ince **the ear canal is open**, the user can be hearing the audio signals both from the sender and the system”; also discussing approaches “to transform the input audio signals to **ultrasonic** signals”);
- [0075] (“With the **ear canal remaining open**, the user can still use a phone directly.”);
- [0082] (discussing practical reasons why a user may prefer a **directional** speaker, such as that the “user might not want people to pick up what he is hearing[, i.e.,] the user may prefer more privacy”).

63. The Priority Application also incorporates by reference another application from the same inventor that discloses “[d]ifferent embodiments of the

directional speakers.” EX1007, [0046]. That application (EX1022) also repeatedly describes speakers that are directional, ultrasonic, and positioned apart from the user’s ear:

- Abstract (“A wireless communication system based on a **directional** speaker is disclosed.”);
- [0052] (describing “examples of characteristics of a **directional** speaker,” such as a “**directional** speaker [that] use[s] a piezoelectric thin film,” where “[a]ppropriate voltages applied through the electrodes to the piezoelectric thin film create vibrations of the thin film to generate the modulated **ultrasonic** signals”);
- [0055] (describing “the distance between the [directional speaker] and the ear being, for example, 8 inches”);
- [0058]-[0074] (describing various embodiments of directional speakers using different “mechanisms to direct the **ultrasonic** signals,” such as using “a grating, a malleable wire, or a wedge,” or by using “acoustic phase array” “as shown in FIG. 5”);
- [0076] (“Fig. 6 shows one example of the interface unit 100 attached to a jacket 102 of the user. The interface unit 100 includes a **directional** speaker 104 and a microphone 106. The directional speaker 104 emits **ultrasonic** signals in the general direction towards an ear of the user.”);
- [0104] (describing that “a speaker is transmitting from, such as, the shoulder of the user” and that the “speaker is considered directional if in the vicinity of **the user’s ear or in the vicinity 6-8 inches away from the speaker**, 75% of the power of its audio signals is within an area of less than 50 square inches”);
- [0112]-[0113] (“A number of embodiments have been described where a device is attachable to the clothing worn by a user.”).

64. The incorporated-by-reference application also disparages the use of speakers that go into the user’s ear as “not natural” and “annoying.” EX1022, [0007]

(“Having something plugged into one’s ear is not natural and is annoying to many, especially for long phone calls.”).

65. Consistent with its written description, the Priority Application’s as-filed claims are directed to speakers that are directional, ultrasonic, and positioned apart from the user’s ear. EX1007 at pp. 26-29. For example, independent claim 1 recites a “*hearing enhancement system*” that includes a “*directional speaker attachable to clothing worn by the user,*” and which “*transmits [] ultrasonic signals.*” EX1007 at p. 26. Independent claim 22 likewise recites “*a directional speaker attachable to clothing worn by the user*” and which “*outputs ultrasonic signals.*” EX1007 at p. 28.

66. The Priority Application identifies the fact that the speaker is positioned apart from the user’s ear as **the key** to addressing the drawbacks the Priority Application identified as associated with ITE and CIC hearing aids that had speakers positioned inside a user’s ear. For example, the Abstract of the Priority Application explains that because “the user’s ear **remains free** from any inserted objects” the user “is free from annoying occlusion effects.” EX1007 at p. 30.

67. Similarly, the Priority Application explains that:

Since the directional speaker **is not attached to or inserted in the ear**, the user can still hear the audio signals directly from the audio source. Not only would such an approach **eliminate the occlusion effect**, with **no hearing aid in the ear canal**, the natural resonance of the ear canal (typically around 2700 Hz) boosts the audio signal strength in the 2 to

3 kHz ranges. Furthermore, **without the hearing aid in the ear canal**, there is no insertion loss due to the hearing aid.

EX1007, [0020].

68. Likewise, the Priority Application explains that: “With **no hearing aid inserted into one ear**, the audio signals do not experience any insertion loss, and **there is also no occlusion** effect due to the user’s own voice.” EX1007, [0051]. It also says: “With the ear canal remaining open, the user can still use a phone directly. EX1007, [0075]. And it says: “Since the ear canal is open, the user can be hearing the audio signals both from the sender and the system.” EX1007, [0060]. The Priority Application could not be clearer that a **key** to the invention is the fact that the speaker is positioned apart from the user’s ear.

69. When listing “**advantages of the invention**,” the Priority Application says: “the user’s ear remains free from any inserted objects and thus is free from the annoying occlusion effects, enabling the user to continue to hear sounds without interference.” EX1007, [0095]. It likewise says: “the system is relatively inexpensive” because it does not “requir[e] an individually-fitted ear mold”—that is, it need not be customized to fit inside the user’s ear. EX1007, [0095].

70. Indeed, **all** of the “**advantages**” the Priority Application identifies are directly attributable to the location of the speaker being somewhere apart from the user’s ear. I’ve created the table below to illustrate that:

“Advantage” Identified in [0095]	Relationship to Speaker’s Location
“(a) users are provided with non-invasive, hands-free wireless communications capability”	The system is “non-invasive” because the system (including its speaker) is located apart from the user’s ear. That is, nothing goes in the user’s ear, making it “non-invasive” when compared to prior-art hearing aids that went into or near the user’s ear.
“(b) the user’s ear remains free from any inserted objects and thus is free from the annoying occlusion effects, enabling the user to continue to hear without interference”	The ear “remains free” because the speaker is not positioned near or in the ear.
“(c) the system can be inconspicuous due to its relatively small form factor, such 2[-inch] by 3[-inch]”	Because the system’s speaker does not go in the ear, the system can be larger than a typical CIC or ITE hearing aid which is much smaller than 2-in. x 3-in. Yet, the system can still be small enough to be inconspicuous when, <i>e.g.</i> , worn on a shirt.
“(d) the system can be inconspicuous, and would not be seen as a hearing enhancing device because it can be mistaken as a cell phone”	Because the system’s speaker does not go in the ear, the system can be designed to look like a cell phone rather than a hearing aid.
“(e) the system would not create feedback and resonance due to misalignment in its positioning as in many of the existing hearing aids”	Because the system’s speaker does not go in the ear, there is no concern about it being misaligned within the user’s ear which was a known cause of unwanted feedback and resonance in prior-art hearing aids that went into the user’s ear. For example, the Priority Application at [0013] says: “Another challenge of an ITE (or CIC) hearing aid is in positioning its receiver and microphone

	because slight misalignment can lead to feedback and resonance.”
“(f) the system can have a shape easy to adapt to the profile of a human being, such as in a shape comfortably residing on the shoulder of a user”	The system can be worn “on the shoulder of a user” because the system’s speaker is positioned apart from the user’s ear and not constrained to fit inside the ear.
“(g) the system is relatively inexpensive, compared to existing hearing aids—this can, for example, be due to the lack of requiring an individually-fitted ear mold”	Because the system’s speaker does not go in the ear, there is no need for “an individually-fitted ear mold.”
“(h) the system is relatively easy to handle, such as to change or to recharge batteries, depending on the embodiment.”	Because the system can be worn by a user or positioned somewhere in a room near the user, it can be larger than typical hearing aids, making it easier to handle. For example, the Priority Application at [0014] says: “Users want the ITE (or CIC) hearing aids to be small to make them inconspicuous. However, the inherent small size of the hearing aids brings along its problems.... Further, due to its small size and shape, ITE (or CIC) hearing aids are more difficult to handle. For example, sometimes it is cumbersome to switch batteries.”

71. The Priority Application uniformly identifies the location of the speaker apart from the user’s ear as a key to the invention and the reason why the invention purportedly addresses the known problems associated with then-existing hearing aids. A person of ordinary skill in the art would not read the Priority Application as suggesting that these problems could be addressed with a speaker that

is positioned in the user's ear—indeed, the Priority Application is clear that such positioning is the cause of those problems.

72. That the speaker is positioned apart from the user's ear also ties directly to the speaker's other two key features: directionality and ultrasonic signaling. Because the speaker is positioned some distance from the user's ear, the audio signals it outputs “are transmitted in an open environment” and thus “people next to the user might pick up the audio signals.” EX1007, [0026].

73. This makes sense. With a typical hearing aid, the speaker is positioned in the ear so the likelihood that someone nearby would hear the speaker's audio output is minimal. But if that same speaker was positioned on a user's shirt, the speaker's audio output would be audible to anyone nearby. The use of a directional speaker that transmits a focused beam (or cone) of ultrasonic signals toward the user's ear reduces the likelihood that others near the user will hear the audio from the speaker—such third parties would only hear the audio if they were within the transmitted beam, which is unlikely if the beam/cone is the short distance between a user's shirt and his or her ear.

74. Although the Priority Application describes various embodiments of the alleged invention, all of those embodiments relate to implementation details of the invention that do not in any way alter the speaker's three main features. For example, [0092] describes various ultrasonic frequencies that can be used, and

paragraphs [0093]-[0094] describe different ways the speaker can direct the ultrasonic signals toward the user's ear. But neither paragraph suggests that the use of ultrasonic signals or a directional speaker are optional. Likewise, [0096] describes different ways the speaker can be worn by a user such as on his clothing or as a necklace, but all of the identified options nonetheless position the speaker some distance apart from the user's ear. None of the various embodiments suggest that the inventors intended for their hearing-enhancement system to include an embodiment in which the system's speaker is positioned in the user's ear—again, such positioning would go against the very idea of the patent which is to avoid the drawbacks associated with positioning speakers in a user's ear.

75. In summary, my review of the Priority Application reveals that the application conveys to a person of ordinary skill in the art that the inventors possessed what they believed to be a novel hearing-enhancement system in which the system's speaker was directional, transmitted ultrasonic signals, and **importantly** positioned some distance away from the user's ear. That latter feature is the key aspect of the “invention” as it avoids the various drawbacks that the Priority Application said prior-art hearing aids had such as the occlusion effect and the need for customization.

76. At no point does the Priority Application describe a system having a speaker that is positioned within the user's ear. The only place such a system is

described is when the Priority Application discusses the problems associated with ITE and CIC hearing aids such as the occlusion effect that they create because those devices position their speakers inside the user's ear or ear-canal.

VII. UNPATENTABILITY GROUNDS

77. In this section I set forth my opinion as to whether certain claims of the '789 Patent are novel or non-obvious in view of the prior art. The principal references I discuss below are Cheung (EX1006), Enzmann (EX1008), Eaton (EX1010), Sauer (EX1012), Hagen (EX1014), Fretz (EX1013), Berger (EX1011), DeJaco (EX1015), and Willis (EX1016) (collectively, "the Relevant Prior Art"). In my performing my analysis, I have been asked by Bose's counsel to assume each of those references qualifies as prior art to the '789 Patent.

78. As I explained above in Section V, the '789 Patent relates generally to a "hearing enhancement system." EX1001, 1:53-55. Although the patent focuses primarily on hearing aids, a person of ordinary skill in the art would have understood that "hearing enhancement" applies more broadly and includes audio processing techniques found in more traditional headphone/headset technology.

79. In my opinion, each of the Relevant Prior Art references falls within the same field of endeavor ("hearing enhancement systems") as the '789 Patent. Indeed, all of the Relevant Prior Art except for DeJaco relate specifically to hearing aids, and DeJaco discloses audio processing techniques (*i.e.*, automatic volume/gain

control) that are directly applicable to hearing enhancement systems like hearing aids. *See infra* Section VII.I. For these same reasons, the Relevant Prior Art references are also reasonably pertinent to the problem addressed by the '789 patent—*i.e.*, how to enhance audio for users.

A. Ground 1: Cheung Anticipates or Renders Obvious Claims 1-82

80. I have been instructed by counsel for Bose to assume that Cheung (EX1006) qualifies as prior art to the Challenged Claims. With that assumption, Cheung anticipates and/or renders obvious claims 1-82 for the reasons I discuss below.

81. Notably, Cheung is the published version of the Priority Application that I discussed in Section VI and thus Cheung contains the same disclosures as those found in the specification of the '789 patent. It is thus unsurprising that if Cheung is prior art, then it anticipates or at least renders obvious the challenged claims.

1. Claim 1

a. [1PRE]: “A hearing enhancement system for a user, comprising:”

82. Cheung discloses a “*hearing enhancement system.*” Cheung at Abstract (“A hearing enhancement system that enhances a user’s hearing based on a directional speaker is disclosed.”).

- b. [1A]: “an audio system configured to receive input signals for broadcasting, and configured to up-convert the received input signals into up-converted signals to be wirelessly transmitted;”

83. Cheung discloses an embodiment in which its system comprises an “interface unit” with a directional speaker that “accesses audio signals from portable or non-portable [audio or audio-video] instruments” like a cellphone or television. Cheung at [0090]-[0092] (“In one embodiment, the system is further designed to pick up, capture or **access audio signals from** portable or non-portable **instruments**, with the **interface unit** serving as a personalized listening unit. ... The **audio signals from these instruments** can be **up-converted** and transmitted as a WiFi signal to be picked up by the system. ... **The instruments** can be used in a private environment, such as at home, or attached to the user. This **can include entertainment units, such as televisions**, stereo systems, CD players, or radios. ... Private use can include a phone, which can be a desktop phone with a conference speaker or a **cell phone**.”); *see also* Cheung at Abstract (“In yet another embodiment, the system can also access audio signals from other portable or non-portable **instruments**, wired or wirelessly, **such as** from home **entertainment units, phones**, microphones at a conference or speakers at a movie theater.”), claims 18-19 (claiming that the “system” comprises “an interface unit” that can access audio signals wirelessly from another instrument such as “**an entertainment unit**” (claim 18) or “**a phone**” (claim 19)).

84. A cellphone and a television are each examples of “*an audio system configured to receive input signals for broadcasting*” as each receives input signals for broadcasting (*e.g.*, voice-audio from a cellular network or television-audio from a television network). The ’789 patent confirms this understanding of the claim language as dependent claims 3 and 4, respectively, limit the “*audio system*” of claim 1 to “*a television*” (claim 3) or a “*a phone*” (claim 4).

85. Cheung also discloses embodiments in which the connection between its interface unit and a phone or television is wireless, *e.g.*, via a WiFi or Bluetooth connection. Cheung at [0091]-[0092] (“If transmission is wireless, the system can be designed to include the electronics to capture wireless signals from the instruments through a wireless local area network, such as WiFi or Bluetooth.”); *see also* Cheung at Abstract (“In yet another embodiment, the system can also access audio signals from other portable or non-portable instruments, wired or wirelessly, such as from home entertainment units, phones, microphones at a conference or speakers at a movie theater.”), claim 16 (“[T]he system can also access audio signals from another instrument...wirelessly through a wireless local area network.”).

86. In these wireless embodiments, the “audio signals” from the phone/television are “up-converted and transmitted” as wireless signals. Cheung at [0091] (“The audio signals from these instruments can be up-converted and transmitted as a WiFi signal to be picked up by the system.”).

87. A person of ordinary skill in the art would have understood “up-converted” to mean that the audio signals have been transformed for wireless transmission at a higher frequency (RF). This higher frequency band is known as a carrier frequency, and it is used in wireless communication systems to enable efficient transmission with small antennas and avoid interference, among other benefits. For example, common WiFi frequencies are 2.4 GHz and 5 GHz so an audio signal from a television or phone that is to be transmitted as a WiFi signal must be up-converted to these higher WiFi operating frequencies.

c. [1B]: “wireless receiver configured to wirelessly receive the up-converted signals;”

88. In the wireless embodiments, Cheung’s system includes “the electronics to capture wireless signals from the instruments [*i.e.*, phone/television] through a wireless local area network, such as WiFi or Bluetooth.” Cheung at [0091] (“If transmission is wireless, the system can be designed to include the electronics to capture wireless signals from the instruments through a wireless local area network, such as WiFi or Bluetooth. The audio signals from these instruments can be up-converted and transmitted as a WiFi signal to be picked up by the system.”).

89. A person of ordinary skill in the art would have understood Cheung to disclose an embodiment in which Cheung’s “interface unit” is the component in Cheung’s system that includes “the electronics to capture wireless signals” and that these electronics include a “*wireless receiver*” to receive, *i.e.*, “capture,” the up-

converted wireless signals that the phone/television transmits. Cheung at [0090]-[0091] (“[T]he system is further designed to pick up, **capture** or access **audio signals** from portable or non-portable instruments, with the **interface unit** serving as a personalized listening unit. ... If transmission is wireless, the system can be designed to include **the electronics to capture wireless signals** from the instruments through a wireless local area network, such as WiFi or Bluetooth.”). This is at least because the interface unit, as the system’s “personalized listening unit,” is the part of the system that must capture audio signals (*e.g.*, wireless signals in the wireless embodiments) so that it can process them and then play them for a listener. Cheung at [0090]-[0091]; *see also* Cheung at [0074] (“The system (interface unit and/or the base unit)...”).

d. [1C]: “a down-converter configured to down-convert the received up-converted signals into down-converted signals;”

90. In the wireless embodiment, Cheung’s interface unit “down-converts the WiFi signal to re-generate the audio signals for the user,” which Cheung would have performed with a down-converter. Cheung at [0091] (“If transmission is wireless, the system can be designed to include the electronics to capture wireless signals from the instruments through a wireless local area network, such as WiFi or Bluetooth. The audio signals from these instruments can be up-converted and

transmitted as a WiFi signal to be picked up by the system. The system then down-converts the WiFi signal to re-generate the audio signals for the user.”).

91. A person of ordinary skill in the art would have understood for the interface unit to re-generate audio signals from an incoming WiFi signal which is an up-converted RF signal, it must first down-convert the signal to baseband using a down-converter (*e.g.*, a circuitry that performs down-conversion of input signals) so that the audio can be further processed and played to the user.

e. **[1D]: “a modifier configured to modify the down-converted signals into modified signals based on at least one hearing characteristic of the user to enhance the hearing of the user; and”**

92. Cheung teaches that “a portion of the input audio signals is amplified more than another portion to enhance the hearing of the user.” Cheung at claim 1 (reciting that “a portion of the input audio signals is amplified more than another portion to enhance the hearing of the user”); *see also* Cheung at [0022]-[0023] (“The decrease in hearing may not be uniform across all audio frequencies. As a result, amplifying the received audio signals can be frequency dependent. One approach focuses on amplifying high audio frequencies. Another approach amplifies only a certain band of the audio frequencies. ... In a third approach, the user's hearing is profiled so that frequency amplification is tailored to the user.”), FIG. 3, claim 22 (reciting that the system’s “computing unit transforms the input audio signals into

modified audio signals by modifying certain frequencies differently than other frequencies to enhance the ability of the user to hear the input audio signals”).

93. Cheung further discloses a “computing unit,” *e.g.*, a processor, that “transforms the input audio signals into modified audio signals by modifying certain frequencies differently than other frequencies to enhance the ability of the user to hear the input audio signals.” Cheung at claim 22. POSAs would have understood that Cheung’s “computing unit,” *i.e.*, “*modifier*,” is part of Cheung’s “interface unit” because the “interface unit” is described as the component that receives, processes, and plays the audio to the user, as I explained above in Sections VII.A.1.b-d for [1A]-[1C] and below in Section VII.A.1.f for [1E], and what Cheung’s “computing unit” performs is part of the processing functionality of the interface unit.

94. Moreover, given Cheung’s disclosure that the interface unit is “a personalized listening device” ([0090]), POSAs would have understood that each interface unit would include the computing unit to perform frequency dependent amplification tailored to the user (as discussed above in this Section), thereby delivering **personalized** listening experience. [0090] (“In one embodiment, the system is further designed to pick up, capture or access audio signals from portable or non-portable instruments, with the interface unit serving as a personalized listening unit.”).

95. Cheung further discloses that the modification (or amplification) made to the audio signal by the computing unit is based on the user's "*hearing characteristic*." [0023] ("The system can then adjust the amplification of the audio signals across the frequencies based on the user's hearing profile."), [0057]-[0060] ("FIG. 4 shows a number of embodiments regarding calibration of a user's hearing across various frequencies. Calibration enables the system to determine (e.g., estimate) the hearing sensitivity of the user. Through calibration, the user's hearing profile can be generated."), claim 6 ("reciting "wherein the at least one characteristic of the hearing of the user is determined through calibration.").

f. [1E]: "a speaker configured to generate audio output signals from the modified signals for the user."

96. Cheung's system includes "*a speaker*" as recited in limitation [1E].

97. For example, Cheung's interface unit includes a directional speaker that outputs the modified audio signals. Abstract ("In one embodiment, the system can include an interface unit that has a directional speaker and a microphone."), claim 22 ("A hearing enhancement system for a user comprising: a directional speaker attachable to clothing worn by the user"), [0048] ("[T]he directional speaker 104 transmits the modulated ultrasonic signals in air towards the ear of the user."), FIG. 1.

2. Dependent Claims 2-12

- a. **Claim 2: “A hearing enhancement system as recited in claim 1, wherein the up-converted signals are in the WiFi frequency band.”**

98. *Supra* limitation [1B] (discussing Cheung’s use of WiFi); *see also* Cheung at [0091].

- b. **Claim 3: “A hearing enhancement system as recited in claim 1, wherein the audio system is selected from the list consisting a television, a stereo system, a CD player and a radio.”**

99. *Supra* limitation [1A] (explaining how Cheung discloses an “*audio system*” in the form of, *e.g.*, a television); *see also* [0092].

- c. **Claim 4: “A hearing enhancement system as recited in claim 1, wherein the audio system is a phone.”**

100. *Supra* limitation [1A] (explaining how Cheung discloses an “*audio system*” in the form of, *e.g.*, a cellphone); *see also* [0092].

- d. **Claim 5: “A hearing enhancement system as recited in claim 1, wherein the audio system receives the input signals from a microphone.”**

101. In the embodiment in which Cheung’s interface unit receives audio signals wirelessly from a phone, the input signals are “*from a microphone,*” *i.e.*, the microphone on the calling party’s phone.

102. Likewise, the embodiment in which Cheung's interface unit receives audio signals wirelessly from a television, the input signals are "*from a microphone,*" *i.e.*, the microphone that recorded the television program's audio.

- e. **Claim 6: "A hearing enhancement system as recited in claim 1, wherein the down-converted signals are modified such that a portion of the audio output signals has an increased power to enhance the hearing of the user."**

103. In Cheung's system, at least a portion of the audio output from the directional speaker has "higher power with respect to the received audio signals at corresponding frequencies to enhance the hearing of the user." Cheung at [0019]. A person of ordinary skill in the art would have understood that Cheung's system performs this power enhancement in Cheung's wireless embodiments in which the system functions as a "personalized listening unit" because those embodiments are intended to aid "hearing impaired people" at home. Cheung at [0031], [0090].

104. Cheung discloses several different techniques for increasing the power of, *i.e.*, amplifying, the audio signal that is to be output by the directional speaker. For example, one technique "focuses on amplifying high audio frequencies." Cheung at [0022]; *see also* Cheung at [0051]. "Another approach amplifies only a certain band of the audio frequencies." Cheung at [0022]. "In a third approach, the user's hearing is profiled so that frequency amplification is tailored to the user." Cheung at [0023]. *See also* Cheung at [0052]-[0054].

- f. Claim 7: “A hearing enhancement system as recited in claim 6, wherein the portion with increased power is selected based on frequency, and wherein a higher frequency portion has increased power.”**

105. As I discussed above for claim 6, Cheung discloses several approaches to frequency-dependent amplification including one approach that “focuses on amplifying high audio frequencies.” Cheung at [0022].

- g. Claim 8**

- (1) [8PRE]: “A hearing enhancement system as recited in claim 1,”**

106. *Supra* [1PRE].

- (2) [8A]: “wherein the at least one hearing characteristic of the user is determined via calibrating the user’s hearing,”**

107. Cheung discloses techniques for “calibration of a user's hearing across various frequencies.” Cheung at [0057]. As Cheung explains, “[c]alibration enables the system to determine (e.g., estimate) the hearing sensitivity of the user. Through calibration, the user’s hearing profile can be generated.” Cheung at [0057]; *see also* Cheung at [0054] (“In a third approach, amplification across frequencies is directly tailored to the hearing needs of the user. This can be done through calibration.”); [0058]-[0060] (describing various calibration techniques); claim 6 (“A hearing enhancement system as recited in claim 5 wherein the at least one characteristic of the hearing of the user is determined through calibration.”).

(3) [8B]: “wherein the power of the audio output signals can be changed as a function of frequency, and”

108. As I discussed for claims 6 and 7, Cheung discloses frequency-dependent amplification techniques in which “amplifying the received audio signals can be frequency dependent.” Cheung at [0022]. For example, if the user’s “*hearing characteristic*” is such that the user cannot hear high frequency audio, then one frequency-dependent amplification approach “focuses on amplifying high audio frequencies.” Cheung at [0022]; *see also* Cheung at [0023] (“In a third approach, the user’s hearing is profiled so that frequency amplification is tailored to the user.... The system can then adjust the amplification of the audio signals across the frequencies based on the user’s hearing profile.”).

(4) [8C]: “wherein the user can change the power of the audio output signals.”

109. Cheung discloses the use of a “general volume controller that allows the user to adjust the output power of the speaker.” Cheung at [0056].

h. Claim 9: “A hearing enhancement system as recited in claim 1, wherein the speaker is configured to generate ultrasonic signals, with at least a portion of the ultrasonic signals transformed into the audio output signals in air”

110. Cheung explains that its directional “speaker transmits the ultrasonic signals, which are transformed into output audio signals by interaction with air.” Cheung at Abstract; *see also* Cheung at claim 1 (“the speaker transmits the ultrasonic

signals; at least a portion of the ultrasonic signals is transformed into output audio signals by interaction with air”).

i. Claim 10: “A hearing enhancement system as recited in claim 1, wherein the speaker is a directional speaker.”

111. *Supra* limitation [1E] (discussing Cheung’s directional speaker).

j. Claim 11: “A hearing enhancement system as recited in claim 1, wherein the speaker is an ear speaker.”

112. The term “*ear speaker*” is used in the ’789 patent to describe a conventional speaker on a cellphone and the patent says the term is also known as an “earpiece.” EX1001, 13:53-65 (“The ear speaker can also be referred to [as] an earpiece.”).

113. The relevant paragraph equating “*ear speaker*” with “earpiece” was added to the originally-filed application during prosecution, and the applicants said the additional disclosure was not new matter because it came from U.S. Patent Appl. No. 10/826,531, which was incorporated by reference. EX1002, 154. That application (EX1048) explains that an example of an earpiece is the “small speaker” that is “designed to be placed against the user’s ear when the cellular telephone is in use.” EX1048 at [0004].

114. For example, Figure 1A from the application depicts an earpiece 114 as the small built-in speaker found on the top of a cellphone where it would be

positioned near (but still not in) the user's ear during use. EX1048, Figure 1A (below).

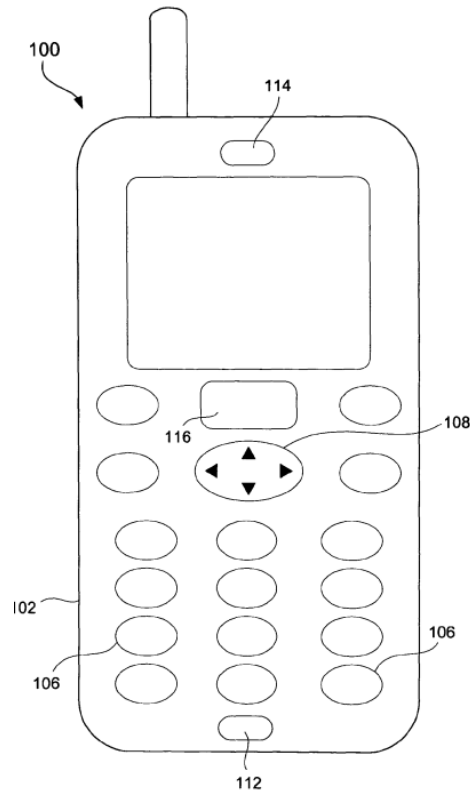


FIG. 1A

115. A person of ordinary skill in the art would therefore understand that “*ear piece*” as used in the ’789 patent to encompass speakers like the conventional built-in speakers commonly found on cellphones in 2003 (and today) and that are intended to deliver audio to a user’s ear.

116. Cheung discloses an embodiment in which its “*speaker*” is an “*ear speaker*.” Specifically, the directional speaker in each of Cheung’s embodiments is

an “*ear speaker*” because the speaker delivers audio to the user’s ear like the conventional earpiece on a cellphone.

117. Separately, Cheung also incorporates by reference the same application and corresponding disclosure that the applicants added to the ’789 patent when adding claims reciting an “*ear speaker*” to the patent. *See* Cheung at [0002]. Therefore, to the extent that the cited-to disclosure provides written description support for claim 11, that same disclosure also anticipates the claim if Cheung is prior art.

k. Claim 12: “A hearing enhancement system as recited in claim 1, wherein the speaker is in a headset.”

118. Cheung discloses that its “system,” which can be the interface unit alone in some embodiments, “can function as the **headset** of a phone, and can be coupled to the phone in a wireless manner, such as through WiFi or Bluetooth.” Cheung at [0092]; *see also* Cheung at [0074] (“The system (interface unit and/or the base unit)...”). When Cheung’s system, *i.e.*, interface unit, is used as a “headset of a phone,” then Cheung’s speaker “*is in a headset.*”

3. Independent Claim 13

119. Claim 13 is similar to claim 1 except that claim 13 recites a “*hearing enhancement apparatus for a user*” rather than a “*hearing enhancement system for a user.*”

120. As discussed for claim 1, Cheung’s system includes an “*interface unit*” that is “wirelessly coupled to an audio system,” *e.g.*, a cell phone or television. Cheung at Abstract. Cheung’s “*interface unit*” is thus a “*hearing apparatus for a user*” as recited in the preamble of claim 13.

121. As I also discussed with respect to claim 1, Cheung teaches embodiments in which the “interface unit” includes the “*wireless receiver*,” “*down-converter*,” “*modifier*,” and “*speaker*” recited in claim 1 (and also in claim 13). *See also* Cheung at [0018]; [0046]; [0081]; [0091]-[0092]; FIG. 1. Cheung therefore anticipates claim 13.

4. Dependent Claims 14-82

122. Dependent claims 14-82 repeat many of the same limitations recited already in dependent claims 2-12, and those limitations are met in Cheung for the reasons I have discussed above already. In the chart below, rather than repeat my analysis, I will refer back to my earlier analysis where applicable.

Claim Language	Cheung Disclosure
Claim 14: A hearing enhancement apparatus as recited in claim 13, wherein the down-converted signals are modified such that a portion of the audio output signals has an increased power to enhance the hearing of the user.	<i>Supra</i> claim 6.
[15PRE]: A hearing enhancement apparatus as recited in claim 14,	<i>See</i> claim 14.

[15A]: wherein the portion with the increased power is selected based on frequency	<i>See claim 7.</i>
[15B]: wherein a higher frequency portion has increased power,	<i>See claim 7.</i>
[15C]: wherein the at least one hearing characteristic of the user is determined via calibrating the user's hearing,	<i>See [8A]</i>
[15D]: wherein the power of the audio output signals can be changed as a function of frequency, and,	<i>See [8B]</i>
[15E] wherein the user can change the power of the audio output signals.	<i>See [8C]</i>

Claim 16: A hearing enhancement apparatus as recited in claim 15, wherein the down-converted signals are further modified based on the noise level of the environment of the apparatus.	Cheung discloses that the amount of amplification applied to the audio signals “can also depend on the ambient power level, or the noise level of the environment of the system.” Cheung at [0069]. In one approach, Cheung’s system “increases the gain of the system so as to ensure that the average power of the output audio signals is higher than the noise level by a certain degree. For example, the average SPL of the output audio signals can be 10 dB above the noise level.” Cheung at [0069]. In another approach, “if the average power level of the environment or the ambient noise level is higher than a threshold value, signal amplification is reduced.” Cheung at [0070]. <i>See also</i> Cheung at [0026] (“The power level of the output audio signals can also be environment dependent. For example, the power of the output audio signals is increased in a noisier environment. But, as the environment becomes very noisy, the amplification can cease or even be decreased.”).
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Claim 17: A hearing enhancement apparatus as recited in claim 16, wherein the apparatus is also configured to operate as at least a part of a phone.	<i>See claim 4.</i>
Claim 18: A hearing enhancement apparatus as recited in claim 14, wherein the portion with increased power is selected based on frequency, and wherein a higher frequency portion has increased power.	<i>See claim 7.</i>
Claim 19: A hearing enhancement apparatus as recited in claim 13, wherein the up-converted signals are in the WiFi frequency band.	<i>Supra claim 2.</i>
Claim 20: A hearing enhancement apparatus as recited in claim 13, wherein the at least one hearing characteristic of the user is determined via calibrating the user's hearing, wherein the power of the audio output signals can be changed as a function of frequency, and wherein the user can change the power of the audio output signals.	<i>Supra [15C]-[15E].</i>
Claim 21: A hearing enhancement apparatus as recited in claim 13, wherein the speaker is configured to generate ultrasonic signals, with at least a portion of the ultrasonic signals transformed into the audio output signals in air.	<i>Supra claim 9.</i>
Claim 22: A hearing enhancement apparatus as recited in claim 13, wherein the down-converted signals are further	<i>Supra claim 16.</i>

modified based on the noise level of the environment of the apparatus.	
Claim 23: A hearing enhancement apparatus as recited in claim 13, wherein the apparatus is also configured to operate as at least a part of a phone.	<i>Supra</i> claim 4.
Claim 24: A hearing enhancement apparatus as recited in claim 13, wherein, the at least one hearing characteristic of the user is wirelessly received and stored in the hearing enhancement apparatus.	Cheung discloses that the “hearing profile” used to determine how the signal should be amplified “can be downloaded into the...system wirelessly.” Cheung at [0060].
Claim 25: A hearing enhancement apparatus as recited in claim 13, wherein, the at least one hearing characteristic of the user is retrieved from a portable media storage device while being physically in contact with the apparatus.	Cheung discloses that the “hearing profile” used to determine how the signal should be amplified can also be stored in a memory device (such as a removable memory card or stick), which can be inserted into the system.” Cheung at [0023]; <i>see also</i> Cheung at [0060].
Claim 26: A hearing enhancement apparatus as recited in claim 13, wherein the speaker is a directional speaker.	<i>Supra</i> claim 10.
Claim 27: A hearing enhancement apparatus as recited in claim 13, wherein the speaker is an ear speaker.	<i>Supra</i> claim 11.

Claim 28: A hearing enhancement apparatus as recited in claim 13, wherein the speaker is in a headset.	<i>Supra</i> claim 12.
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Claim 29: A hearing enhancement apparatus as recited in claim 13, wherein the audio system is configured to operate as a phone, wherein the hearing enhancement apparatus is configured to operate in conjunction with or at least as a part of a mobile phone, wherein the speaker is an ear speaker, and wherein to enhance the hearing of the user, the modifier is configured to modify the down-converted signals into modified signals at one or more frequencies within the audio frequencies, with the one or more frequencies being determined by the at least one hearing characteristic of the user.	<i>Supra</i> claims 4, 6, 11.
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Claim 30: A hearing enhancement apparatus as recited in claim 29, wherein the at least one hearing characteristic of the user is determined via calibrating the user's hearing at least across the one or more frequencies to generate at least a portion of the hearing profile of the user, and wherein the hearing profile is stored in	Cheung discloses calibration techniques that test “a user’s hearing across various frequencies” so as “to determine (e.g., estimate the hearing sensitivity of the user.... For example, the audio frequencies are separated into different bands. The system generates different SPL at each band to test the user's hearing. The specific power level that the user feels most comfortable would be the power level for that band for the user. After testing is done for all of the bands, based on the power levels for each band, the system creates the user's personal hearing profile. In this calibration process, the system can prompt the user and lead the user through an interactive calibration process.”
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the hearing enhancement apparatus.	Cheung at [0057]; <i>see also</i> Cheung at [0058]-[0059] (describing other calibration techniques). The hearing profile that results from Cheung's various calibration techniques is "stored in the hearing enhancement system." Cheung at [0060].
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Claim 31: A hearing enhancement apparatus as recited in claim 30, wherein the hearing enhancement apparatus allows the user to calibrate the user's hearing via a computing device.	Cheung discloses a calibration technique that "can be done remotely through a web site. The web site can guide the user through the calibration process. This can be done, for example, by the user being positioned proximate to a computer terminal that is connected through the Internet..." Cheung at [0058].
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Claim 32: A hearing enhancement apparatus as recited in claim 30, wherein the hearing enhancement apparatus is configured to periodically remind the user to calibrate the user's hearing.	Cheung's system "can also periodically alert the user for re-calibration. The period can be, for example, once a year." Cheung at [0061].
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Claim 33: A hearing enhancement apparatus as recited in claim 30, wherein at least a portion of the at least one hearing characteristic of the user is wirelessly received by and stored in the hearing enhancement apparatus.	<i>Supra</i> claim 24.
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Claim 34: A hearing enhancement apparatus as recited in claim 33, wherein the hearing enhancement apparatus is a headset.	<i>Supra</i> claim 12.
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Claim 35: A hearing enhancement apparatus as recited in claim 33, wherein the hearing enhancement apparatus is a computing device that is wearable.	Cheung's interface unit, as shown in Cheung's Figure 2, is a wearable computing device. <i>See also</i> Cheung at [0098] ("A number of embodiments have been described where a device is attachable to the clothing worn by a user. In one embodiment, attachable to the clothing worn by a user includes wearable by the user. For example, the user can wear a speaker on his neck, like a pendant on a necklace. This also would be considered as attachable to the clothing worn by the user. From another perspective, the necklace can be considered as the 'clothing' worn by the user, and the device is attachable to the necklace.").
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Claim 36: A hearing enhancement apparatus as recited in claim 33, wherein the hearing enhancement apparatus is a mobile phone.	Cheung discloses that "the system," which can be the "interface unit" alone (Cheung at [0074]), can "have the electronics to serve as a cell phone." Cheung at [0077]. <i>See also</i> Cheung at Abstract ("In another embodiment, the system can also be used as a phone."); [0040] ("FIG. 7 shows embodiments of the present invention that can also function as a phone."); claim 14 ("A hearing enhancement system as recited in claim 1 wherein the system also can function as a phone.").
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Claim 37: A hearing enhancement apparatus as recited in claim 36, wherein the hearing enhancement apparatus is configured to periodically remind the user to calibrate the user's hearing.	<i>Supra</i> claim 32.
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Claim 38: A hearing enhancement apparatus as recited in claim 36, wherein the hearing enhancement apparatus includes a user control configured to allow the user to	Cheung's system (<i>i.e.</i>, the interface unit) includes "a general volume controller that allows the user to adjust the output power of the speaker. This
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control the power of the audio output signals on a plurality of frequency bands across the audio frequencies.	adjustment can also be across certain frequency bands.” Cheung at [0056].
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Claim 39: A hearing enhancement apparatus as recited in claim 29, wherein at least a portion of the at least one hearing characteristic is wirelessly received by and stored in the hearing enhancement apparatus.	<i>Supra</i> claim 24.
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Claim 40: A hearing enhancement apparatus as recited in claim 39, wherein the hearing enhancement apparatus is a headset.	<i>Supra</i> claim 12.
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Claim 41: A hearing enhancement apparatus as recited in claim 39, wherein the hearing enhancement apparatus is a computing device that is wearable.	<i>Supra</i> claim 35.
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Claim 42: A hearing enhancement apparatus as recited in claim 39, wherein the hearing enhancement apparatus is a mobile phone.	<i>Supra</i> claim 36.
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Claim 43: A hearing enhancement apparatus as recited in claim 29, wherein the hearing enhancement apparatus is configured to alter a power level of the audio output signals based on a noise level of the environment of the apparatus.	<i>Supra</i> claim 16.
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[44PRE]: A hearing enhancement apparatus as recited in claim 43,	<i>Supra</i> claim 43.
[44A]: wherein the hearing enhancement apparatus is configured to increase the power of the audio output signals as the noise level increases, and	<i>Supra</i> claim 16. Cheung discloses that “[t]he power level of the output audio signals can also be environment dependent. For example, the power of the output audio signals is increased in a noisier environment. But, as the environment becomes very noisy, the amplification can cease or even be decreased.” Cheung at [0026]; <i>see also</i> Chueng at [0069] (“The amplification of the system can also depend on the ambient power level, or the noise level of the environment of the system.... In one embodiment, the system increases the gain of the system so as to ensure that the average power of the output audio signals is higher than the noise level by a certain degree. For example, the average SPL of the output audio signals can be 10 dB above the noise level.”).
[44B]: wherein the hearing enhancement apparatus is configured not to further increase the power of the audio output signals if the noise level is beyond a certain predetermined threshold.	<i>Supra</i> [44A].

Claim 45: A hearing enhancement apparatus as recited in claim 29, wherein the apparatus includes a volume control that is configured to	Cheung’s system (<i>i.e.</i>, interface unit) “is trained to recognize specific recitation... and/or the user’s voice....when the user says sentences like any of the following, the system
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respond to a voice command of the user.	would be automatically turned on: ... Louder.” Cheung at [0063]. <i>See also</i> Cheung at [0056] (discussing manual volume control).
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Claim 46: A hearing enhancement apparatus as recited in claim 13, wherein the hearing enhancement apparatus is a headset.	<i>Supra</i> claim 12.
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Claim 47: A hearing enhancement apparatus as recited in claim 46, wherein the speaker is an ear speaker.	<i>Supra</i> claim 11.
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Claim 48: A hearing enhancement apparatus as recited in claim 47, wherein the audio output signals are changed in view of a preference of the user stored in the apparatus.	Cheung explains that the user hearing profile may include a user preference because “[t]he specific power level that the user feels most comfortable would be the power level for that band for the user.” Cheung at [0057]; <i>see also</i> Cheung at [0060] (“...hearing profile can be stored in the hearing enhancement system.”)
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Claim 49: A hearing enhancement apparatus as recited in claim 48, wherein the audio output signals are changed based on audio sound in the environment of the apparatus.	<i>Supra</i> claim 16.
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Claim 50: A hearing enhancement apparatus as recited in claim 49 further comprising a microphone	Cheung’s interface unit includes a microphone that captures audio in the user’s environment, <i>e.g.</i> , it “picks up the friend’s speech” who is talking to the user wearing the interface unit. Cheung at [0048].
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at least for receiving the audio sound in the environment of the apparatus.	Cheung also discloses techniques for measuring noise level of an environment, which a POSA would have understood was accomplished using the interface unit's microphone. <i>See</i> Cheung at [0069]-[0070].
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Claim 51: A hearing enhancement apparatus as recited in claim 50, wherein the microphone is a directional microphone.	Cheung discloses embodiments in which the speaker on its interface unit is a directional microphone. Cheung at [0067]-[0068] (“The system, namely, the interface unit, can have more than one directional microphone, each pointing in a different direction.”); claim 11 (“A hearing enhancement system as recited in claim 1 wherein the microphone is a directional microphone.”).
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Claim 52: A hearing enhancement apparatus as recited in claim 46, wherein the audio output signals are changed in view of a preference of the user stored in the apparatus.	<i>Supra</i> claim 48.
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Claim 53: A hearing enhancement apparatus as recited in claim 46, wherein the audio output signals are changed based on audio sound in the environment of the apparatus.	<i>Supra</i> claim 49.
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Claim 54: A hearing enhancement apparatus as recited in claim 53 further comprising a microphone at least for receiving the audio sound in the environment of the apparatus.	<i>Supra</i> claim 50.
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Claim 55: A hearing enhancement apparatus as recited in claim 13, wherein the hearing enhancement apparatus is a mobile phone.	<i>Supra</i> claim 36.
Claim 56: A hearing enhancement apparatus as recited in claim 55, wherein the audio output signals are modified in view of a preference of the user stored in the apparatus.	<i>Supra</i> claim 52.
Claim 57: A hearing enhancement apparatus as recited in claim 56, wherein the audio output signals are modified based on audio sound in the environment of the apparatus.	<i>Supra</i> claim 49.
Claim 58: A hearing enhancement apparatus as recited in claim 57 further comprising a microphone at least for receiving the audio sound in the environment of the apparatus.	<i>Supra</i> claim 50.
Claim 59: A hearing enhancement apparatus as recited in claim 58, wherein the microphone is a directional microphone.	<i>Supra</i> claim 51.
Claim 60: A hearing enhancement apparatus as recited in claim 55, wherein the audio output signals are modified based on audio sound in the environment of the apparatus.	<i>Supra</i> claim 49.
Claim 61: A hearing enhancement apparatus as recited in claim 60 further comprising a microphone at least for	<i>Supra</i> claim 50.

receiving the audio sound in the environment of the apparatus.	
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Claim 62: A hearing enhancement apparatus as recited in claim 13, wherein at least a portion of the hearing enhancement apparatus is in a head-mounted electronic device.	<i>Supra</i> claim 12.
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Claim 63: A hearing enhancement apparatus as recited in 62, wherein the apparatus comprises a volume control that is configured to respond to a voice command.	<i>Supra</i> claim 45.
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Claim 64: A hearing enhancement apparatus as recited in 62, wherein the apparatus is configured to recognize at least a voice command from the user and operate according to the voice command.	<i>Supra</i> claim 45.
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Claim 65: A hearing enhancement apparatus as recited in claim 64, wherein the at least one hearing characteristic of the user is identified via measuring the user's hearing at least across a plurality of frequencies.	<i>Supra</i> [8A].
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Claim 66: A hearing enhancement apparatus as recited in claim 65, wherein the hearing enhancement apparatus is configured to alter a power level of the audio output signals so	<i>See</i> claim 16. Additional written description support for claim 66 arguably appears at column 13, lines 39 to 52 of the '789 patent. That paragraph mentions “[n]oise suppression,” was added to the specification during the middle of prosecution, and the applicants said it was not “new matter” because the disclosure was found in two applications (U.S. Patent Appl. Nos. 10/826,528 and
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as to suppress at least a sound level associated with the environment of the apparatus so as to provide noise cancellation.	10/826,537) that had been incorporated by reference. EX1002 at 321, 335. Cheung also incorporates those same two applications and their corresponding disclosures (Cheung at [0002]), and thus those incorporated-by-reference disclosures anticipate claim 66 if that disclosure provides written description support for the claim. <i>See</i> EX1049 at [0049]; EX1050 at [0067].
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Claim 67: A hearing enhancement apparatus as recited in claim 66 further comprising a microphone configured to receive audio sound at the environment of the apparatus for determining the sound level associated with the environment of the apparatus.	<i>Supra</i> claim 50.
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Claim 68: A hearing enhancement apparatus as recited in claim 67, wherein the apparatus is configured to wirelessly couple to a cell phone.	<i>Supra</i> [1A]-[1B].
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Claim 69: A hearing enhancement apparatus as recited in claim 68, wherein based on at least a preference of the user, the power of a first range of frequencies of the audio output signals is increased, and the power of a second range of frequencies of the audio output signals is not increased.	As discussed above for claim 48, the user's unique hearing profile that Cheung's system uses to perform frequency-dependent amplification is based on the user's preference. Cheung at [0057] (explaining the user hearing profile may include a user preference because "[t]he specific power level that the user feels most comfortable would be the power level for that band for the user."). One frequency-dependent amplification that the user's hearing profile would cause to be performed "amplifies only a certain band of the audio frequencies. With the lower audio frequencies typically being louder, the band of amplification can be the higher audio frequencies." Cheung at [0022]; <i>see also</i> Cheung
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	at [0051]-[0052]. That is, “ <i>a first range of frequencies of the audio output signals is increased,</i> ” i.e., a higher frequency range, and “ <i>a second range of frequencies of the audio output signals is not increased,</i> ” i.e., a lower frequency range.
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Claim 70: A hearing enhancement apparatus as recited in claim 64, wherein the hearing enhancement apparatus is configured to alter a power level of the audio output signals so as to suppress at least a sound level associated with the environment of the apparatus so as to provide noise cancellation.	<i>Supra</i> claim 66.
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Claim 71: A hearing enhancement apparatus as recited in claim 70 further comprising a microphone configured to receive audio sound at the environment of the apparatus for determining the sound level associated with the environment of the apparatus.	<i>Supra</i> claim 67.
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Claim 72: A hearing enhancement apparatus as recited in claim 71, wherein the apparatus is configured to wirelessly couple to a cell phone.	<i>Supra</i> [1A]-[1B].
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Claim 73: A hearing enhancement apparatus as recited in claim 72, wherein based on at least a preference of the user, the power of a first range of frequencies of the audio output signals is increased, and the power of a second range of frequencies of the audio output signals is not increased.	<i>Supra</i> claim 69.
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Claim 74: A hearing enhancement apparatus as recited in claim 73, wherein the at least one hearing characteristic of the user is identified via measuring the user's hearing at least across a plurality of frequencies.	<i>Supra</i> claim 65.
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Claim 75: A hearing enhancement apparatus as recited in 62, wherein the apparatus is configured to wirelessly couple to a cell phone.	<i>Supra</i> [1A]-[1B].
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Claim 76: A hearing enhancement apparatus as recited in 62, wherein based on at least a preference of the user, the power of a first range of frequencies of the audio output signals is increased, and the power of a second range of frequencies of the audio output signals is not increased.	<i>Supra</i> claim 69.
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Claim 77: A hearing enhancement apparatus as recited in 62, wherein the at least one hearing characteristic of the user is identified via measuring the user's hearing at least across a plurality of frequencies.	<i>Supra</i> claim 65.
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Claim 78: A hearing enhancement apparatus as recited in claim 77, wherein the hearing enhancement apparatus assists in measuring the user's hearing.	Cheung discloses that “the system [<i>i.e.</i> , the interface unit] can prompt the user and lead the user through an interactive calibration process.” Cheung at [0057].
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Claim 79: A hearing enhancement apparatus as recited in 62, wherein information regarding the at least one hearing characteristic of the user is wirelessly received and stored in the hearing enhancement apparatus.	<i>Supra</i> claim 24.
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Claim 80: A hearing enhancement apparatus as recited in 62, wherein information regarding the at least one hearing characteristic of the user is retrieved from a portable media storage device while the portable media storage device is physically and electrically connected to the apparatus.	<i>Supra</i> claim 25.
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Claim 81: A hearing enhancement apparatus as recited in 62, wherein the hearing enhancement apparatus is configured to alter a power level of the audio output signals so as to suppress at least a sound level associated with the environment of the apparatus so as to provide noise cancellation.	<i>Supra</i> claim 66.
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Claim 82: A hearing enhancement apparatus as recited in claim 81 further comprising a microphone configured to receive audio sound at the environment of the apparatus for determining the sound level associated with the environment of the apparatus.	<i>Supra</i> claim 67.
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B. Ground 2A: Enzmann Anticipates or Renders Obvious Claims 1-2, 4-8, 11-23, 27-30, 43, 46-50, 52-54, 62, 75, 77, and 81-82

1. Enzmann (EX1008)

123. Enzmann discloses an “aided ear bud” that functions as a hearing aid and “as an ear bud device for a wireless phone.” Enzmann at Abstract. Figure 2 (below) illustrates the internal circuitry for the ear bud and shows it connected wirelessly to a cellphone:

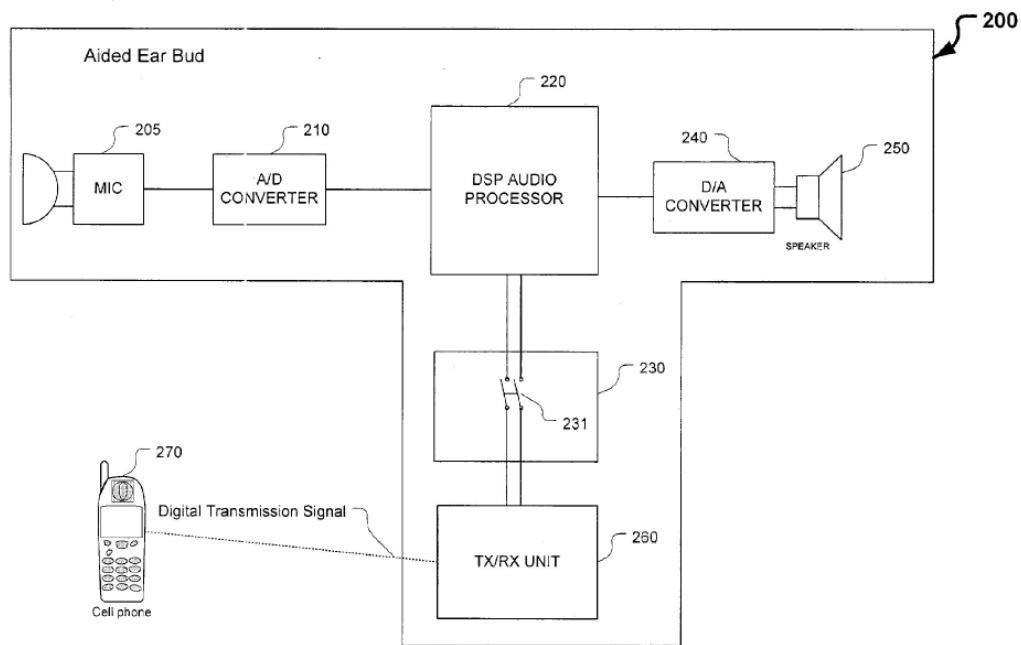


FIG. 2

124. Whether operating as a hearing aid or operating as a wireless earbud for a cellphone, the earbud modifies an incoming audio signal in accordance with predefined characteristics for a user's hearing. *See, e.g.*, Enzmann at [0028] ("The manipulation processes [in conventional hearing aids] may also adjust the incoming signal based on a preprogrammed frequency mapping of the user's hearing characteristics."); [0046] ("The amplification chart 325 contains a series of pre-stored dynamic frequency maps based on the user's hearing characteristics"); [0058] ("In step S700, the process fixes the transmitted signal according to signal stored in the amplification chart. Once the signal has been fixed and verified, the process proceeds to step S800, where this fixed signal is forwarded across the digital switch and fixed by the DSP."); claim 15 ("The source control module of claim 14,

wherein the digital logic unit contains an amplification chart, the amplification chart comprising frequency maps indicating at least: a user's current hearing characteristics"). The connection between the earbud and a phone is "wireless," e.g., Bluetooth. Enzmann, [0034].

125. As I discuss below, Enzmann anticipates and/or renders obvious many claims of the '789 patent, including independent claims 1 and 13.

2. Claim 1

a. [1PRE]: "A hearing enhancement system for a user, comprising:"

126. Enzmann discloses "systems...for providing a hearing aid capable of communicating with a wireless phone." Enzmann at [0002]; *see also* [0011] ("[T]his invention provides systems and methods for adapting a hearing aid to operate as an ear bud device in addition to providing conventional hearing aid functions."), [0026] ("The exemplary embodiments of the systems and methods according to this invention provide a method for adapting a hearing aid so that the hearing aid is able to function as an ear bud device i.e., an aided ear bud.").

b. [1A]: "an audio system configured to receive input signals for broadcasting, and configured to up-convert the received input signals into up-converted signals to be wirelessly transmitted;"

127. Enzmann's system includes a cellphone that wirelessly transmits audio signals received over a cellular network to the earbud. Enzmann at Abstract ("An

aided ear bud device is provided that operates as a hearing aid device as well as an ear bud device for a wireless phone.”); [0032]-[0033] (“In the second operating mode, the TX/ RX unit 260 [of the earbud] transmits and receives communications from the wireless phone 270”); FIG. 2 (element 270). As dependent claim 4 of the ’789 patent confirms, Enzmann’s phone is an “*audio system configured to receive input signals for broadcasting.*”

128. Enzmann’s phone uses a wireless protocol such as Bluetooth to transmit audio signals to the earbud. Enzmann at [0034]. POSAs understood that, in conventional wireless audio systems, audio signals transmitted via an RF carrier in a given band (*e.g.*, the 2.4 GHz band for Bluetooth) would have been **up-converted** by the phone from a lower baseband frequency signal to a higher carrier frequency signal (*e.g.*, by a transceiver/transmitter) for wireless transmission, and subsequently down-converted for audio playback.

129. That an audio signal must be up-converted for transmission (and down-converted for subsequent playback) is a fundamental concept in wireless transmissions with which a person of ordinary skill in the art would have been well aware. For example, the **introductory** chapter of the academic textbook *Electronic Communications Systems: Fundamentals Through Advanced* (EX1027) explains that a typical electronic communications system includes a transmitter, a transmission medium, and a receiver. EX1027 at 2. The transmitter “converts the

original source information to a signal that is more suitable for transmission over a given transmission medium,” *e.g.*, a higher frequency carrier signal. *Id.* The receiver, in turn, “accepts the transmitted signals from the transmission medium and converts them back to their original form.” *Id.*

130. The textbook continues to explain that “it is often necessary to modulate the source information onto a higher-frequency analog signal called a *carrier*. In essence, the carrier signal carries the information through the system.” *Id.* (emphasis original). This modulation is performed in the transmitter, and the “reverse process” (called demodulation) is performed in the receiver and that process “converts the modulated carrier [signal] back to the original information.” EX1027 at 3.

131. The textbook the provides FIGURES 1-2 as a simplified example of a communications system. The figure is shown below, and the textbook explains that the information signals “are *up-converted* from low frequencies to high frequencies in the transmitter and *down-converted* from high frequencies to low frequencies in the receiver.” EX1027 at 4.

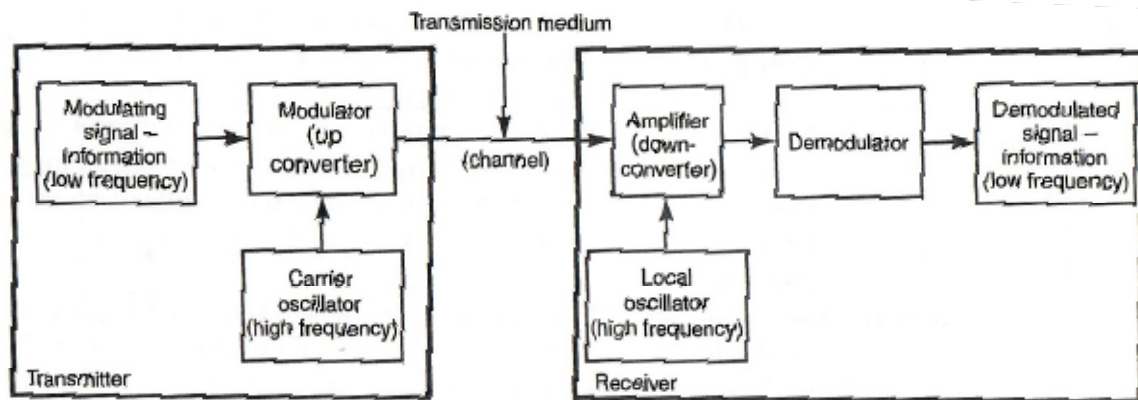


FIGURE 1-2 Communications system block diagram

132. EX1027 thus confirms that a person of ordinary skill in the art would have understood that the cellphone in Enzmann’s system is configured to up-convert the audio signals it receives from a cellular network so that those signals could be transmitted to Enzmann’s earbud. I note as well that Patent Owner also relies on EX1027 to allege that certain Bose earbuds practice limitation [1A]. EX1018 at 4-5.

133. If Patent Owner argues Enzmann does not disclose limitation [1A], then implementing Enzmann’s system such that its cellphone includes circuitry to “*up-convert*” received cellular input signals “*into up-converted signals*” to be transmitted via a wireless medium (*e.g.*, Bluetooth) would have been the use of a known technique to improve similar devices in the same way. POSAs would have understood that the need to up-convert (modulate) an audio signal onto a higher-frequency signal for wireless transmission (and the subsequent need to down-convert

(demodulate) that signal for audio playback) was a fundamental aspect of electronic communication systems, a fact that EX1027 corroborates.

134. If additional corroboration of the background knowledge of a person of ordinary skill beyond EX1027 is needed, then I note the following prior-art references, each of which confirm that the need to up-convert (and then down-convert) audio signals was well known in the art and that the circuits for doing so had become conventional long before the '789 patent was filed:

- EX1054 at 1:14-22 (background section, stating that in the conventional “wireless audio and video transmitter and receiver system apparatus,” “the transmitter transmits an AM modulated audio/video signal via an RF carrier in the 900 MHz band to one or more remote receivers which regenerate [i.e., play back] the original audio/video signal providing both baseband audio and video signal outputs”), 9:13-18 (describing that transmitter 20’s subcomponents, modulator 28 and buffer 29, upconvert the baseband audio signal to higher sub-carrier frequency at 4.5 MHz, e.g., where the “[s]ub-carrier modulator 28 and buffer 29 serve to modulate the base band audio signal such that the output of buffer 29 is an FM modulated audio sub-carrier signal at 4.5 MHz”), 9:52-55 (disclosing that transmitter 20 further upconverts the “audio sub-carrier signal... to an IF [i.e., intermediate frequency] of either 245 MHz or 250 MHz”), 10:15-19 (disclosing that transmitter 20’s subcomponent, “[u]p converter 56,” further “converts the IF signal to an RF signal of 914 or 919 MHz”), 11:64-12:1 (describing the upconverted carrier frequency signal is then wirelessly transmitted from the transmitter’s “antenna 67” to the “receiver antenna 71”), 12:9-13:3 (describing how the receiver 70, including its subcomponents such as down converter 76, down-converts and demodulates the received RF signal at 914 or 919 MHz to lower baseband frequency audio, which is eventually provided to the user via an audio output interface, e.g., “[t]he baseband audio output from the FM detector 98 is fed through an amplifier 99 with a 75 microsecond de-emphasis characteristic and then to audio output connector 101.”).

- EX1025, 1:11-20 (“In general, a transceiver comprises three main components: a transmitter, a receiver, and an LO generator or frequency synthesizer. The function of the transmitter is to modulate, upconvert, and amplify signals for transmission into free space. The function of the receiver is to detect signals in the presence of noise and interference, and provide amplification, down-conversion and demodulation of the detected the signal such that it can be displayed or used in a data processor. ... Transceivers have a wide variety of applications ranging from low data rate wireless applications (such as mouse and keyboard) to medium data rate Bluetooth and high data rate wireless LAN 802.11 standards.”)
- EX1026, [0022] (“The Bluetooth transceiver 22 is also arranged to receive information from the processor 14. The received information is at the baseband frequency and the Bluetooth transceiver upconverts the signals to the Bluetooth frequency so that they can be transmitted by the second antenna. If required, the Bluetooth transceiver 22 will modulate, encode and perform any other required function.”).

c. **[1B]: “wireless receiver configured to wirelessly receive the up-converted signals;”**

135. Enzmann’s earbud includes a “transmit/receive (TX/RX) unit” that “receives communications from the wireless phone.” Enzmann at [0031]-[0033]; *see also* Enzmann at FIG. 2 (depicting the TX/RX unit). The connection between the phone and the transmit/receive unit is “a *wireless* digital connection, such as Bluetooth.” Enzmann at [0034].

d. **[1C]: “a down-converter configured to down-convert the received up-converted signals into down-converted signals;”**

136. Enzmann’s earbud uses Bluetooth to receive audio signals from a phone. Enzmann at [0034]. As I discussed above for limitation [1A], a person of ordinary

skill in the art would have understood audio signals received via Bluetooth would have been down-converted by the earbud—*e.g.*, by Enzmann’s TX/RX unit—from a higher carrier frequency signal to a lower baseband frequency signal.

137. If Patent Owner argues that Enzmann does not disclose limitation [1C], then implementing Enzmann’s system such that its earbud’s TX/RX unit down-converted (demodulated) the received upconverted signal would have been a routine (indeed, expected) design as the reasons I discussed above for limitation [1A].

- e. **[1D]: “a modifier configured to modify the down-converted signals into modified signals based on at least one hearing characteristic of the user to enhance the hearing of the user; and”**

138. As seen in Figure 2, Enzmann’s earbud includes a “source control module 230” that receives data from the TX/RX unit and communicates data to DSP 220. Enzmann at [0032]-[0033]; [0043].

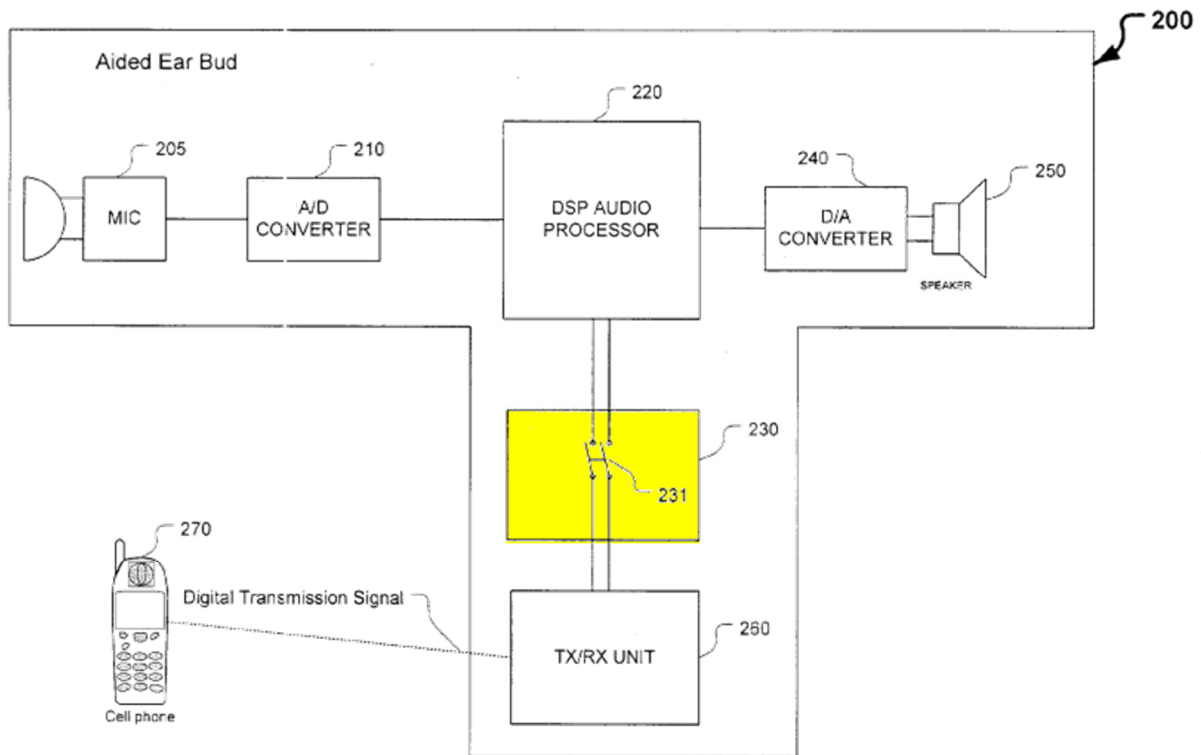


FIG. 2

139. Enzmann's source-control module (including its digital logic 320) by itself or in combination with DSP 220 is a “*modifier*” as claimed. For example, Enzmann explains the source-control module includes an “amplification chart” that contains a “series of pre-stored dynamic frequency maps based on the user’s **hearing characteristics**.” Enzmann at [0046]. The digital logic within the source-control module “receive[s] the transmitted signal from the TX/RX unit 260 and process[es] those signals to an optimal form based on the user’s **hearing**, speaker and ambient noise **characteristics**.” Enzmann at [0046]; *see also* [0028] (“The manipulating processes of the DSP 120 serves both to amplify the converted signal from the A/D converter 110 and correct any degraded signal areas so that an improved signal is

sent to the speaker 140. The manipulation processes may also adjust the incoming signal based on a preprogrammed frequency mapping of the user's hearing characteristics.”); [0050] (“Once the digital switch is closed, signals from the TX/RX unit 260 are **fixed by the digital logic 320** using the complementary characteristics, as discussed above, and **passed to the DSP** audio processor 220. **The DSP audio processor 220 then fixes** and combines a reduced representation of the input from the microphone and outputs the combined signal to the user’s speaker.”); [0057]-[0058]; claims 5-7, 13-18.

140. Figure 5 (below) depicts an amplification chart that Enzmann’s digital logic uses to adjust the decibels of an audio signal at higher frequencies “to produce a result that is very close to the desired [hearing] characteristic.” Enzmann at [0046]; *see also* claim 15 (“...wherein the digital logic unit contains an amplification chart, the amplification chart comprising frequency maps indicating at least: a user’s current hearing characteristics; a desired hearing characteristic...”), claims 13-14, 16-18.

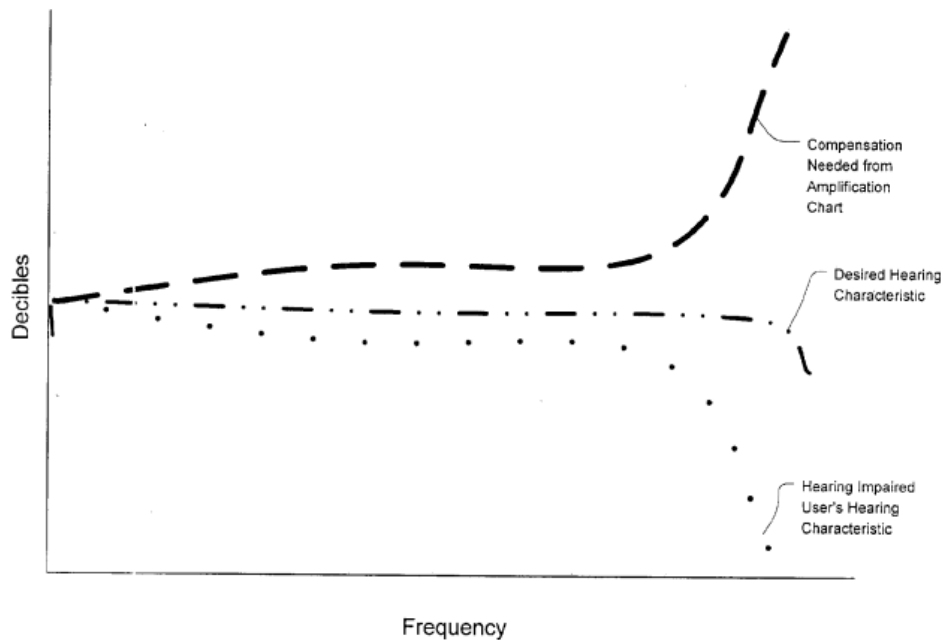


FIG. 5

f. [1E]: “a speaker configured to generate audio output signals from the modified signals for the user.”

141. Enzmann’s aided earbud includes a speaker that outputs audio based on audio signals received from Enzmann’s digital-signal processor, and those signals include audio signals that have been adjusted by Enzmann’s source-control module based on the amplification chart discussed for [1D]. Enzmann at [0050]; *see also* Enzmann at [0057]-[0061] (“In step S500, once the signal has been received to change the aided ear bud to the ear bud state, a digital switch is activated that allows transmitted signals received at the TX/RX unit to pass to the DSP. The process then proceeds to step S600. At step S600, the aided ear bud retrieves the transmitted

signal from the TX/RX unit and then proceeds to step S700. In step S700, the process fixes the transmitted signal according to signal stored in the amplification chart. Once the signal has been fixed and verified, the process proceeds to step S800, where this fixed signal is forwarded across the digital switch and fixed by the DSP.); claim 10 (“A hearing aid comprising: ...an audio output speaker”).

3. Dependent Claims 2, 4-8, 11-12

a. **Claim 2: “A hearing enhancement system as recited in claim 1, wherein the up-converted signals are in the WiFi frequency band.”**

142. Enzmann’s connection between its earbud and phone can be “any kind of wireless...connection.” Enzmann at [0034]. POSAs would have understood “any” wireless connection included WiFi which was a known medium for transmitting audio signals.

143. My opinion that a person of ordinary skill would have interpreted Enzmann’s reference to “any kind of wireless...connection” to include WiFi is corroborated by the following prior-art references that disclose the use of WiFi for wireless audio transmission:

- EX1052, [0014] (“As would be apparent to those skilled in the art, the wireless medium 120 link between the **headset** 100 and the applicable source device(s) may be accomplished utilizing digital wireless link standards such as Bluetooth™ or IEEE 802.11 [i.e., a WiFi standard].”);
- EX1053, [0053] (“Wireless devices used in various embodiments of the present invention include, for instance: streaming audio/video devices, such as cellular phones ... configured with Bluetooth™ or other

wireless connectivity, including WiFi and IEEE 802.11 connectivity ...”).

144. Alternatively, implementing Enzmann’s connection using WiFi would have been the simple substitution of one known element (Bluetooth) for another (WiFi) to obtain predictable results (a wireless connection over which audio signals can be transmitted).

b. Claim 4: “A hearing enhancement system as recited in claim 1, wherein the audio system is a phone.”

145. *Supra* limitation [1A] (discussing how Enzmann’s earbud is wirelessly connected to a cellphone”); *see also* Enzmann at [0030] (“wireless ear bud for the wireless phone”); [0034] (“The connection shown between the TX/ RX unit 260 and the wireless phone 270 is preferably a wireless digital connection, such as Bluetooth, etc.”); [0009] (“[T]he inventor has discerned that there is a need to address the above-mentioned problems by providing a hearing device that functions both as a hearing aid and as a wireless phone ear bud.”)

c. Claim 5: “A hearing enhancement system as recited in claim 1, wherein the audio system receives the input signals from a microphone.”

146. The audio signals that Enzmann’s earbud receives from a phone are “*input signals from a microphone*,” *i.e.*, the microphone on the calling-party’s phone.

- d. **Claim 6: “A hearing enhancement system as recited in claim 1, wherein the down-converted signals are modified such that a portion of the audio output signals has an increased power to enhance the hearing of the user.”**

147. As shown in the top dashed line of Figure 5’s amplification chart (reproduced below), the digital logic in Enzmann’s source-control module modifies audio signals from the phone by increasing sound level (decibels) at higher frequency. Enzmann at [0046].

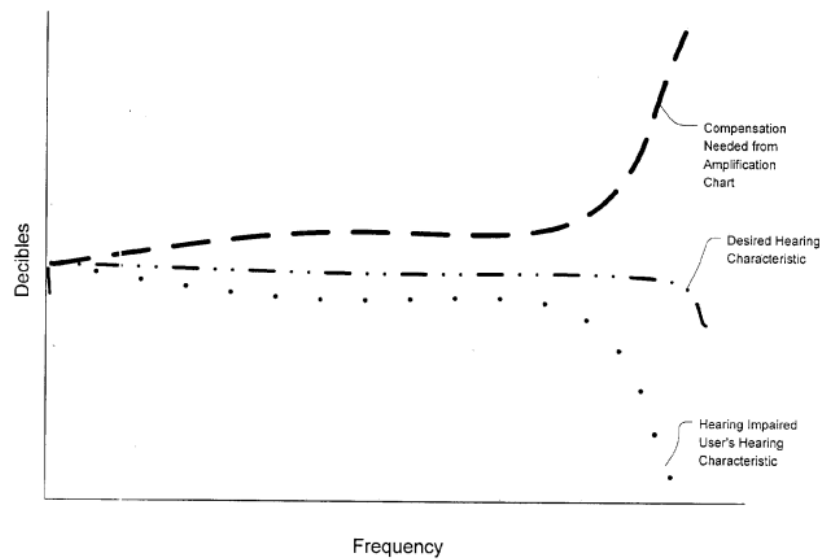


FIG. 5

148. Increasing the decibels of an audio signal requires increasing the power of the signal.

- e. **Claim 7: “A hearing enhancement system as recited in claim 6, wherein the portion with increased power is selected based on frequency, and wherein a higher frequency portion has increased power.”**

149. As shown in Figure 5’s amplification chart (reproduced below), the digital logic in Enzmann’s source-control module applies increased amplification at higher frequencies:

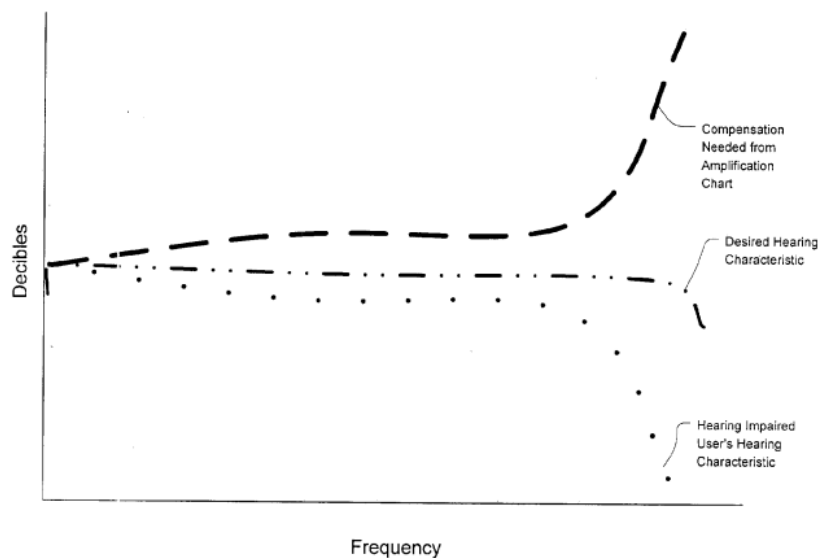


FIG. 5

- f. **Claim 8**

- (1) **[8PRE]: “A hearing enhancement system as recited in claim 1,”**

150. *Supra* [1PRE].

(2) [8A]: “wherein the at least one hearing characteristic of the user is determined via calibrating the user’s hearing,”

151. The ’789 patent explains “[c]alibration enables the system to determine (e.g., estimate) the hearing sensitivity of the user.” EX1001, 7:29-31. One calibration technique involves playing different sound-pressure levels (typically expressed in dB) at different audio frequency bands to test a user’s hearing, with the user indicating which SPL for each frequency band “the user feels most comfortable.” EX1001, 7:33-39.

152. As discussed for limitation [1D], Enzmann’s Figure 5 depicts an amplification chart that Enzmann uses to adjust the decibels of an audio signal at higher frequencies “to produce a result that is very close to the desired [hearing] characteristic.” Enzmann at [0046]. As seen below, Enzmann’s amplification chart identifies (a) the frequencies a specific user has difficulty hearing, (b) the frequencies a non-hearing impaired user is expected to hear, and (c) the increase in decibels needed to compensate for the user’s specific hearing impairment. *Id.*

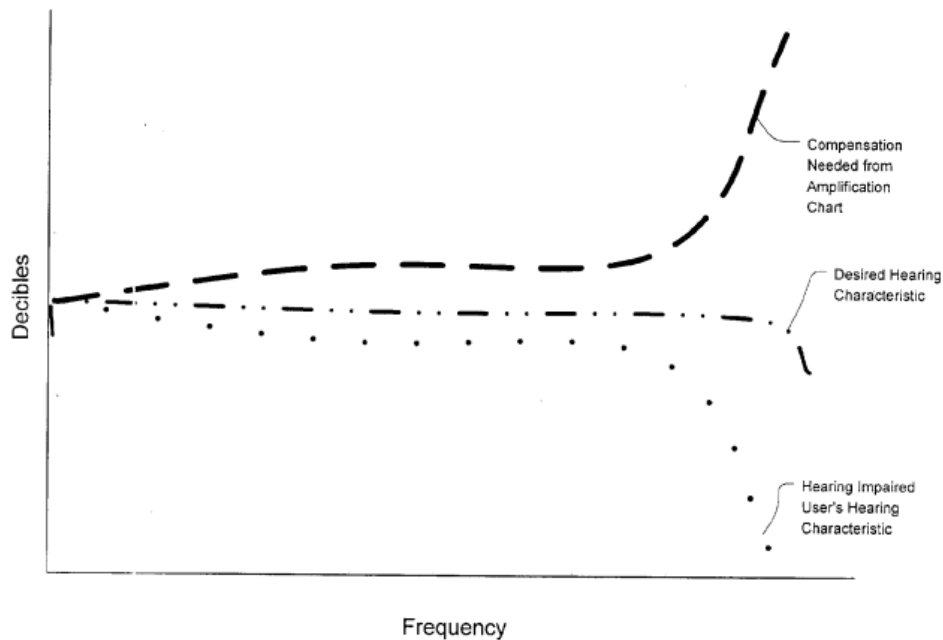


FIG. 5

153. A person of ordinary skill in the art would have considered Enzmann's amplification chart to include information typically found in an audiogram, which is a visual representation of a user's hearing that has been used long before 2003. In Figure 5, the Y axis represents sound intensity (measured in dBs), while the X axis represents audio frequency in Hz.

154. The dotted line at the bottom of Enzmann's amplification chart is a form of audiogram, and the dashed line at the top depicts the amount of amplification needed to allow the user to better hear the audio at certain frequencies. Enzmann at [0046]. The dashed-dotted line in the middle is an exemplary audiogram for a user

with “desired” hearing characteristics, and it is those “desired” characteristics that Enzmann aims to achieve with the depiction amplification.

155. Audiograms were well known as the following references demonstrate:

- EX1037 (from 1936) at FIGS. 1-3; *see also* page 2, right column, line 65 to page 3, left column, line 12 (explaining that Figure 1’s audiogram shows hearing ability of “a perfect ear,” and that Figures 2-3 “show the audiograms of two actual cases of defective hearing”);
- EX1028 (from 1986) at 1:5-31 (“Hearing impaired persons differ considerably in the degree and pattern of their hearing loss. This is reflected in their audiograms. An audiogram is a chart of hearing threshold level (HTL) versus frequency.”);
- EX1043 (from 1941) at 1:33-46 (“[T]he exact level of hearing-loss of the patient can be plotted or marked, for each frequency selected, on a chart (sometimes known as an “audiogram”) in which hearing-loss in decibels is marked on a vertical axis against frequency in cycles per second marked along a horizontal axis”);
- EX1044 (from 1944) at 1:7-25 (describing that people “who are hard of hearing have different types of hearing loss,” and that “the audiogram ... may indicate, in one person, a loss of the high notes of the audio frequency range; in another person, a loss of the low notes thereof; ... [etc.]”);
- EX1045 (from 1977) at Figs. 1-6, 7:26-10:34 (describing six patient cases and corresponding audiograms in Figs. 1–6, each audiogram showing a different type of hearing loss and used to assess hearing improvement over time); and
- EX1046 (from 1950) at 1:15-21 (describing that “the audiogram [] is the threshold of hearing for pure tones of different frequencies,” and that “[t]ill now the corresponding values of intensity of sound and frequency were read after adjustment and then entered by hand as coordinates into a diagram thus getting the points of the audiogram curve to be recorded.”), 2:14-21 (explaining that, in an audiogram, “the system of coordinates has been chosen so that the hearing degree of the patient is indicated in comparison with the hearing degree of the normal

hearing. Therefore the intensity of the test tone which is just sufficient to be perceived by a normal hearing is chosen as zero-value the audiogram of the normal hearing coinciding the axis 16 of the system.”).

156. A person of ordinary skill in the art would have known that creating an audiogram chart—like the one Enzmann’s Figure 5 depicts—“typically involves playing a set of tones through headphones while adjusting the level and frequency of the tones, and having the patient indicate whether each tone can be heard or is inaudible.” EX1029, [0005]. In addition to EX1029, this background knowledge that a person of ordinary skill would have possessed is corroborated by the following references:

- EX1043 at 1:20-46 (describing increasing “the intensity or volume of tone ... until the note is heard by the patient,” and then the “intensity is [] reduced ... until the patient no longer hears the note,” thereby “the exact level of hearing-loss of the patient can be plotted or marked, for each frequency selected, on a chart ... known as an ‘audiogram’”);
- EX1046 at 1:52-57 (“The test tones can be varied, not only with regard to their frequency but also with regard to their intensity, in a logarithmically divided scale and are produced by an earphone...”), 2:4-12 (“After the hearing minimum or threshold has been found for a certain frequency, the measuring point can be marked by a stylus which is put through the slot of the pointer 10 and the hole of the pointer 11 in correspondence with the slot.”);
- EX1047 at 8:3-21 (explaining the execution process of an “automatic threshold identification subroutine” to obtain audiograms for a test subject, “wherein the test tones transmitted to the earphones worn by the subject begin at a sound level of thirty decibels. The ‘bracketing’ subroutine decrements the sound level by ten decibels if the test subject indicates that he hears the thirty decibel level, and awaits a response by the subject. If the subject does not respond, the subroutine then increments the sound level by five decibels. If the test subject indicates

(by means of response device 40) that he hears the most recent test tone the intensity is again decremented by ten decibels. This procedure is continued, in order to 'bracket' the threshold level of the test subject at a particular frequency. If, at a particular frequency, the subject does not hear the initial test tone at the thirty decibel level, the bracketing subroutine increases the sound level in fifteen decibel steps until the subject responds."), 11:39-47 (describing that the test begins with tones presented to the test subject through earphones, and the "test subject is instructed to momentarily depress a button of the hand-held response device [] as soon as any sequence of two or three random beeping tones ceases to beep").

157. The above-described typical practice for creating an audiogram is the same calibration technique that the '789 patent describes:

FIG. 4 shows a number of embodiments regarding calibration of a user's hearing across various frequencies. Calibration enables the system to determine (e.g., estimate) the hearing sensitivity of the user. Through calibration, the user's hearing profile can be generated. The user can perform calibration by himself. For example, the audio frequencies are separated into different bands. The system generates different SPL at each band to test the user's hearing. The specific power level that the user feels most comfortable would be the power level for that band for the user. After testing is done for all of the bands, based on the power levels for each band, the system creates the user's personal hearing profile. In this calibration process, the system can prompt the user and lead the user through an interactive calibration process.

EX1001, 7:29-41.

158. In view of his or her background knowledge of audiograms, a person of ordinary skill in the art would have understood that Enzmann's amplification chart was created using a similar calibration technique and/or creating the amplification chart in that conventional matter would have been the obvious use of a known technique for implementing Enzmann's teachings. Enzmann's amplification chart

therefore represents (or would have been implemented to represent) “*at least one hearing characteristic of the user [that] is determined via calibrating the user’s hearing.*”

(3) [8B]: “wherein the power of the audio output signals can be changed as a function of frequency, and”

159. As I discussed with respect to claims 6-7, the amplification chart shown in Enzmann’s Figure (reproduced below) modifies audio signals from the phone by increasing sound level (decibels) at higher frequencies. Enzmann at [0046]. Increasing the decibels of an audio signal requires “*chang[ing],*” *i.e.*, increasing, the power of the signal at those higher frequencies, *i.e.*, “*as a function of frequency.*”

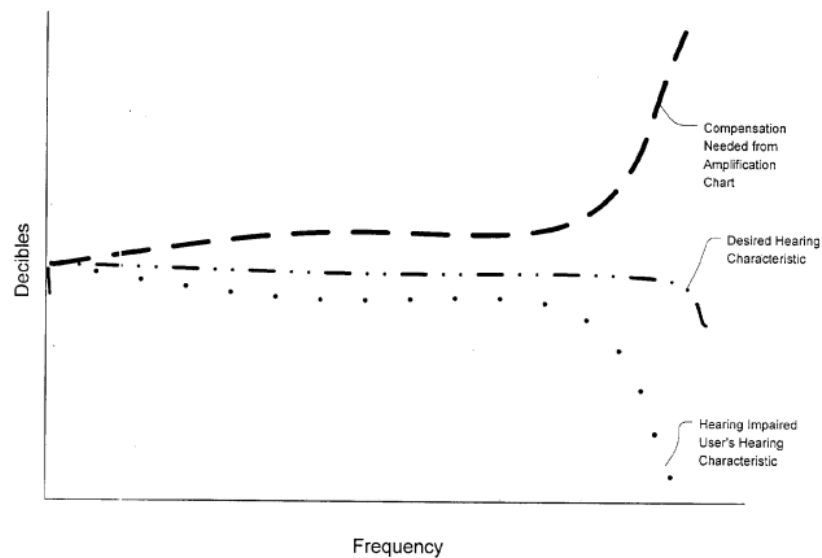


FIG. 5

(4) [8C]: “wherein the user can change the power of the audio output signals.”

160. Although Enzmann does not explicitly state that users can “*change the power of the audio output signals*,” a person of ordinary skill in the art would have known hearing aids, like Enzmann’s earbud, include means by which a user could adjust the hearing aid’s volume as that was the conventional design. *See, e.g.*, EX1012, 1:19-24 (“For manual operation, these hearing aids have, for example, an on/off switch, a switch for switching between ‘normal’ operation using the microphone and operation in a telephone coil mode, and a volume control (potentiometer). Mechanical switches are also provided for modifying the transmission characteristic of the hearing aid.”); EX1014, 4:65-67 (“The volume control 28 allows the hearing aid wearer to adjust the volume or amplification level of the hearing aid 16.”); FIG. 3.

161. Providing a user the means to adjust a hearing aid’s (or headphone’s) volume (*e.g.*, to increase it in a noisy environment or decrease it in a quiet environment) is such a common-sense and conventional design that a person of ordinary skill in the art would have understood Enzmann’s earbud to include such functionality. If not explicitly disclosed in Enzmann, then implementing Enzmann’s earbud such that its volume could be adjusted by a user would have been a routine design choice that benefited patients by allowing them to adjust volume to their preferred comfort levels.

g. Claim 11: “A hearing enhancement system as recited in claim 1, wherein the speaker is an ear speaker.”

162. Enzmann’s earbud fits in a user’s ear. Enzmann at [0008] (explaining ear buds are “placed in or in close proximity to the ear”).

h. Claim 12: “A hearing enhancement system as recited in claim 1, wherein the speaker is in a headset.”

163. Although Enzmann’s hearing aid uses an earbud-type design, a person of ordinary skill in the art would have known that there are other design choices for hearing aids, including a headset-type design.

164. For example, Figure 6 (below) from EX1011 depicts a hearing-aid in the form of a wireless headset. *See also* EX1011 at [0041].

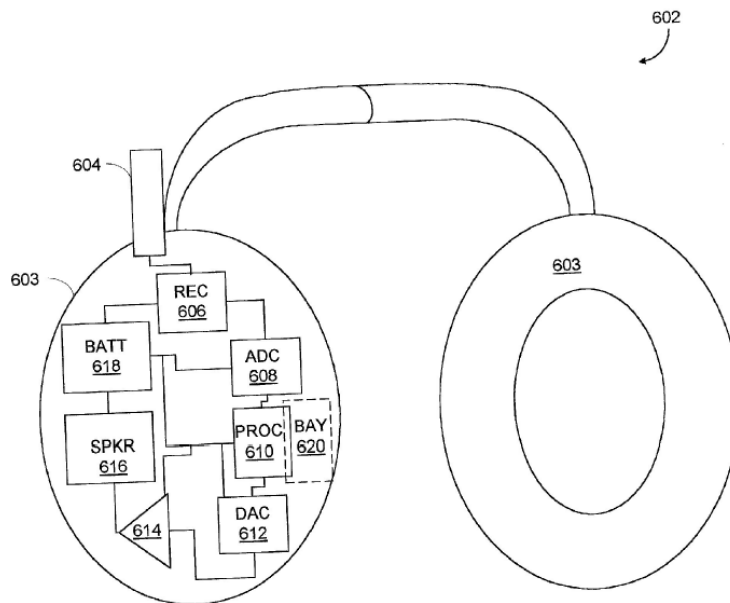


FIGURE 6

165. Likewise, EX1023 describes headphones and headsets with hearing-aid functionality. EX1023 at 2:30-3:26 (discussing drawbacks of prior art “wireless

transmission methods” that “have been proposed to eliminate the problem with the connection cord from the television set to the listener's headphone,” and disclosing “an assistive listening method and apparatus which enables the hearing impaired listener to have sound frequencies and levels tailored to compensate for a particular hearing loss ... in a manner which overcomes the limitations and drawbacks of the prior art”). Specifically, EX1023 discloses a headset 114 (shown in Figure 2, with the full system described at 10:26-12:10) that receives wireless RF television signals from television-side transmitter 58 via a receiver subsystem 82 and plays back compensated signals tailored to a hearing-impaired user. *See, e.g.*, 9:34-35 (“An antenna 64 radiates an RF signal [e.g., television signal] generated by the transmitter 58”), 10:26-28 (describing that the “subsystem 82 includes a receiving antenna 84” to receive the RF signals from the “transmitter 58”), 11:14-21 (“The left path 100 ... leads ... through an audio amplifier 110 to a left earphone 112 of the headset 114. The right channel path 96 leads through a power amplifier 122 to a right earphone of the headset 114.”), 11:35-12:10 (“[I]t is entirely practical to provide the RF signal [wirelessly] from the transmitter 58 to a number of different receiver subsystems 82. Each receiver subsystem 82 may be effectively tailored to the hearing loss characteristics of the particular listener”); FIG. 2.

166. Implementing Enzmann’s earbud using a headset design rather than Enzmann’s earbud design would have been a routine design choice for POSAs, a

choice that is consistent with Enzmann's teaching its ear bud device "is essentially a **headphone** type device." Enzmann at [0008]; *see also* Enzmann at [0063] (explaining that "many alternatives, modifications and variations [of the invention] will be apparent to those skilled in the art").

4. Independent Claim 13

167. Claim 13 is similar to claim 1 except claim 13 recites a "*hearing enhancement **apparatus** for a user*" rather than a "*hearing enhancement system for a user*." As discussed for claim 1, Enzmann's system includes an earbud with a "*wireless receiver*," "*down-converter*," "*modifier*," and "*speaker*" as recited in claim 13.

168. Enzmann's earbud meets claim 13's "*hearing apparatus*," and Enzmann anticipates (or renders obvious) claim 13 for the same reason it anticipates (or renders obvious) claim 1.

5. Dependent Claims 14-20, 22-23, 27-30, 43, 46-50, 52-54, 62, 75, 77 and 81-82.

- a. Claim 14: A hearing enhancement apparatus as recited in claim 13, wherein the down-converted signals are modified such that a portion of the audio output signals has an increased power to enhance the hearing of the user.**

169. *Supra* claims 6, 13.

b. Claim 15

- (1) [15PRE]: A hearing enhancement apparatus as recited in claim 14,**

170. *Supra* claim 14.

- (2) [15A]: wherein the portion with the increased power is selected based on frequency,**

171. *Supra* claims 6-7.

- (3) [15B]: wherein a higher frequency portion has increased power,**

172. *Supra* claims 6-7.

- (4) [15C]: wherein the at least one hearing characteristic of the user is determined via calibrating the user's hearing,**

173. *Supra* [8A].

- (5) [15D]: wherein the power of the audio output signals can be changed as a function of frequency, and,**

174. *Supra* [8B].

- (6) [15E]: wherein the user can change the power of the audio output signals.**

175. *Supra* [8C].

- c. **Claim 16: A hearing enhancement apparatus as recited in claim 15, wherein the down-converted signals are further modified based on the noise level of the environment of the apparatus.**

176. Enzmann explains that the digital logic within the source-control module “process[es]” the down-converted signals “to an optimal form based on the user’s hearing, speaker and **ambient noise characteristics**.” Enzmann at [0046]; *see also* Enzmann at [0047] (“The **ambient noise characteristic** is usually dynamic and updated as the **noise levels around the ear bud** change.”).

- d. **Claim 17: A hearing enhancement apparatus as recited in claim 16, wherein the apparatus is also configured to operate as at least a part of a phone.**

177. *Supra* claims 4, 16.

- e. **Claim 18: A hearing enhancement apparatus as recited in claim 14, wherein the portion with increased power is selected based on frequency, and wherein a higher frequency portion has increased power.**

178. *Supra* claims 6-7, 14.

- f. **Claim 19: A hearing enhancement apparatus as recited in claim 13, wherein the up-converted signals are in the WiFi frequency band.**

179. *Supra* claims 2, 13.

- g. Claim 20: A hearing enhancement apparatus as recited in claim 13, wherein the at least one hearing characteristic of the user is determined via calibrating the user's hearing, wherein the power of the audio output signals can be changed as a function of frequency, and wherein the user can change the power of the audio output signals.**

180. *Supra* claims 8, 13.

- h. Claim 22: A hearing enhancement apparatus as recited in claim 13, wherein the down-converted signals are further modified based on the noise level of the environment of the apparatus.**

181. *Supra* claims 13, 16.

- i. Claim 23: A hearing enhancement apparatus as recited in claim 13, wherein the apparatus is also configured to operate as at least a part of a phone.**

182. *Supra* claims 4, 13.

- j. Claim 27: A hearing enhancement apparatus as recited in claim 13, wherein the speaker is an ear speaker.**

183. *Supra* claims 11, 13.

- k. Claim 28: A hearing enhancement apparatus as recited in claim 13, wherein the speaker is in a headset.**

184. *Supra* claims 12-13.

- l. Claim 29: A hearing enhancement apparatus as recited in claim 13, wherein the audio system is configured to operate as a phone, wherein the hearing enhancement apparatus is configured to operate in conjunction with or at least as a part of a mobile phone, wherein the speaker is an ear speaker, and wherein to enhance the hearing of the user, the modifier is configured to modify the down-converted signals into modified signals at one or more frequencies within the audio frequencies, with the one or more frequencies being determined by the at least one hearing characteristic of the user.**

185. *Supra* claims 4, 6, 11, 13, 17.

- m. Claim 30: A hearing enhancement apparatus as recited in claim 29, wherein the at least one hearing characteristic of the user is determined via calibrating the user's hearing at least across the one or more frequencies to generate at least a portion of the hearing profile of the user, and wherein the hearing profile is stored in the hearing enhancement apparatus.**

186. *Supra* claim 8.

- n. Claim 43: A hearing enhancement apparatus as recited in claim 29, wherein the hearing enhancement apparatus is configured to alter a power level of the audio output signals based on a noise level of the environment of the apparatus.**

187. *Supra* claims 16, 29.

- o. Claim 46: A hearing enhancement apparatus as recited in claim 13, wherein the hearing enhancement apparatus is a headset.**

188. *Supra* claims 12-13.

- p. **Claim 47: A hearing enhancement apparatus as recited in claim 46, wherein the speaker is an ear speaker.**

189. *Supra* claims 11, 46.

- q. **Claim 48: A hearing enhancement apparatus as recited in claim 47, wherein the audio output signals are changed in view of a preference of the user stored in the apparatus.**

190. As discussed above for claim 8, Enzmann's amplification chart is (or would have been) determined by calibrating a user's hearing, which reflects the user's preferences for adequate hearing.

- r. **Claim 49: A hearing enhancement apparatus as recited in claim 48, wherein the audio output signals are changed based on audio sound in the environment of the apparatus.**

191. *Supra* claims 16, 48.

- s. **Claim 50: A hearing enhancement apparatus as recited in claim 49 further comprising a microphone at least for receiving the audio sound in the environment of the apparatus.**

192. Enzmann discloses that its "ear bud[]" comprises a microphone 205," and that the microphone captures "[a]mbient noise." Enzmann at [0031], [0033].

- t. **Claim 52: A hearing enhancement apparatus as recited in claim 46, wherein the audio output signals are changed in view of a preference of the user stored in the apparatus.**

193. *Supra* claims 46, 48.

- u. **Claim 53: A hearing enhancement apparatus as recited in claim 46, wherein the audio output signals are changed based on audio sound in the environment of the apparatus.**

194. *Supra* claim 16, 46.

- v. **Claim 54: A hearing enhancement apparatus as recited in claim 53 further comprising a microphone at least for receiving the audio sound in the environment of the apparatus.**

195. *Supra* claim 50, 53.

- w. **Claim 62: A hearing enhancement apparatus as recited in claim 13, wherein at least a portion of the hearing enhancement apparatus is in a head-mounted electronic device.**

196. Enzmann at [0008] (“The ear bud device...is essentially a **headphone-type device**”); *see also supra* claim 12.

- x. **Claim 75: A hearing enhancement apparatus as recited in 62, wherein the apparatus is configured to wirelessly couple to a cell phone.**

197. *Supra* claim 4, 62.

- y. **Claim 77: A hearing enhancement apparatus as recited in 62, wherein the at least one hearing characteristic of the user is identified via measuring the user's hearing at least across a plurality of frequencies.**

198. *Supra* claim 30, 62.

- z. **Claim 81: A hearing enhancement apparatus as recited in 62, wherein the hearing enhancement apparatus is configured to alter a power level of the audio output signals so as to suppress at least a sound level associated with the environment of the apparatus so as to provide noise cancellation.**

199. *Supra* claim 16, 62.

200. In Enzmann, “ambient noise” that the earbud’s microphone captures is “typically **reduced in volume**” before being combined with the input audio signal from, *e.g.*, a cellular phone. Enzmann at [0040]; *see also* Enzmann at [0027], [0046]-[0047]. The combined audio output signal is then played for the user. Enzmann at [0046]-[0047].

201. Enzmann’s earbud therefore is configured to “*alter a power level of the audio output signals,*” *i.e.*, the portion of the audio output that is ambient noise, “*so as to suppress at least a sound level associated with the environment of the apparatus so as to provide noise cancellation,*” as claimed.

- aa. **Claim 82: A hearing enhancement apparatus as recited in claim 81 further comprising a microphone configured to receive audio sound at the environment of the apparatus for determining the sound level associated with the environment of the apparatus.**

202. *Supra* claim 50, 62, 81.

C. Ground 2B: Enzmann in View of Eaton Renders Claims 24, 31, 33-35, 39-41, and 78-79 Obvious.

203. The claims addressed in this section either directly or via dependency require the “*at least one hearing characteristic of the user*” recited in independent claim 13 be “*wirelessly received and stored in the hearing enhancement apparatus.*” These claims would have been obvious over Enzmann in view of Eaton for the reasons I discuss below.

1. Eaton (EX1010)

204. Eaton discloses techniques for using a mobile device—like a phone—to program hearing aids. Eaton at Abstract; 2:15-20; 4:10-16; 6:30-33; claim 24. Eaton teaches adjusting “audiological parameters” for a hearing aid so as to “tailor[]” those parameters “for a specific patient.” Eaton at 4:13-16. To tailor the audiological parameters, the patient’s hearing “is tested to obtain aural responses to various conditions. These responses are then used to determine which audiological parameters to adjust as well as the ranges of audiological parameter values that may be adjusted.” Eaton at 4:17-22. An “aural response,” Eaton explains, is “a result obtained by applying a series of tests on the patient; one test may include sending audio test signals and measuring the response of the patient to those audio test signals.” Eaton at 9:20-26.

205. Eaton discloses an embodiment in which the device sends “audio test signals” to the hearing aid and receives aural responses from the patient to those

signals. Eaton at 11:17-24; *see also* Eaton at claim 6. The device then sends the aural responses (or an audiogram based on those responses) to a “programming fitting server,” which derives an “audiological parameter from the aural responses [or audiogram].” Eaton at 11:24-33. The patient-specific audiological parameter is then transmitted by the mobile device to the hearing aid which uses it to adjust audio signals to improve the user’s hearing. Eaton at 1:15-16, 11:33-12:4, claim 46 (“upgraded audiological software includes a piece of software to be executed on the hearing aid”).

2. The Enzmann-Eaton Combination

206. In view of Eaton, a person of ordinary skill in the art had reason to implement Enzmann’s earbud such that its amplification chart could be updated wirelessly. Enzmann explicitly recognizes that “[t]he user’s hearing characteristics,” as reflected in its amplification chart, “remain static unless the aided ear bud 200 is reprogrammed to compensate for additional hearing loss or increase and different users.” Enzmann at [0046]. Enzmann thus motivates a person of ordinary skill in the art to consider techniques for updating the amplification chart.

207. Eaton’s technique for updating a hearing aid is one such technique, and Eaton touts its technique as an improvement on the then-conventional technique for reprogramming hearing aids—*i.e.*, visiting an audiologist’s office—which was considered “laborious and time intensive.” Eaton at 1:17-25. A person of ordinary

skill in the art thus had reason to modify Enzmann's system to utilize Eaton's technique for wirelessly programming a hearing aid to a user's personal hearing characteristics.

208. In the Enzmann-Eaton combination, a user would utilize a mobile device, such as a phone, to send "audio test signals" to Enzmann's earbud and receive an aural response from the patient to those test signals. Eaton at 11:17-24. The mobile device would then send those aural responses to Eaton's "programming fitting server" which would process the responses to generate "audiological parameters...used to tailor an audiological therapy." Eaton at 11:31-32.

209. In an obvious implementation of Enzmann-Eaton, the "audiological parameters" would take the form of an updated version of Enzmann's amplification chart that reflects changes to the user's hearing profile (and corresponding changes to the amount of amplification needed to account for such changes). The audiological parameters, *i.e.*, updated amplification chart, would then be sent wirelessly to Enzmann's hearing aid for storage and subsequent use. Enzmann at [0043] ("memory device 310"), [0048] (explaining the amplification chart is "stored in EEPROM 310"), FIG.4.

210. A person of ordinary skill in the art would have had a reasonable expectation of success in achieving the proposed combination as modifying Enzmann to store and/or use an updated amplification chart requires only routine

software engineering. Indeed, Enzmann already suggests that its ear bud can be “reprogrammed,” but does not provide details on how that accomplished because such implementation-level details were well known to a person of ordinary skill. Enzmann at [0046].

3. Claims 24, 31, 33-35, 39-41, and 78-79

- a. Claim 24: A hearing enhancement apparatus as recited in claim 13, wherein, the at least one hearing characteristic of the user is wirelessly received and stored in the hearing enhancement apparatus.**

211. As I discussed above in VII.C.2, in the Enzmann-Eaton combination, an updated version of Enzmann’s amplification chart, *i.e.*, “*one hearing characteristic of the user*,” is received via a wireless connection with a mobile device and stored in memory on Enzmann’s hearing aid. Enzmann at [0043]; [0048]; FIG. 4; Eaton, 6:11-25; *see also* claim 13 (Ground 2A).

- b. Claim 31: A hearing enhancement apparatus as recited in claim 30, wherein the hearing enhancement apparatus allows the user to calibrate the user's hearing via a computing device.**

212. As I discussed above in VII.C.2, in the Enzmann-Eaton combination, the mobile device, which is a “*computing device*” that the user operates, sends audio test signals to Enzmann’s hearing aid and receives aural responses from the patient to those test signals. Eaton, at 11:17-24; *see also* claim 6; 5:11-16 (“diagnostics and adjustment is initiated by a patient”). Based on the patient’s aural responses, the

hearing aid is re-calibrated using an updated amplification chart that accounts for changes in the user's hearing.

- c. **Claim 33: A hearing enhancement apparatus as recited in claim 30, wherein at least a portion of the at least one hearing characteristic of the user is wirelessly received by and stored in the hearing enhancement apparatus.**

213. *Supra* claim 24; *see also* claim 30 (Ground 2A).

- d. **Claim 34: A hearing enhancement apparatus as recited in claim 33, wherein the hearing enhancement apparatus is a headset.**

214. *Supra* claim 33; *see also* claim 12 (Ground 2A).

- e. **Claim 35: A hearing enhancement apparatus as recited in claim 33, wherein the hearing enhancement apparatus is a computing device that is wearable.**

215. Enzmann's earbud—used in the Enzmann-Eaton combination—is a “*computing device that is wearable.*” Enzmann at FIG. 2 (depicting various computing electronics for the aided earbud); [0008].

- f. **Claim 39: A hearing enhancement apparatus as recited in claim 29, wherein at least a portion of the at least one hearing characteristic is wirelessly received by and stored in the hearing enhancement apparatus.**

216. *Supra* claim 24; *see also* claim 29 (Ground 2A).

- g. **Claim 40: A hearing enhancement apparatus as recited in claim 39, wherein the hearing enhancement apparatus is a headset.**

217. *Supra* claim 39; *see also* claim 12 (Ground 2A).

- h. Claim 41: A hearing enhancement apparatus as recited in claim 39, wherein the hearing enhancement apparatus is a computing device that is wearable.**

218. *Supra* claims 35 and 39.

- i. Claim 78: A hearing enhancement apparatus as recited in claim 77, wherein the hearing enhancement apparatus assists in measuring the user's hearing.**

219. As I discussed above in VII.C.1-2, Eaton's audiological parameters are determined by "sending audio test signals" to a hearing aid and "measuring the response of the patient to those audio test signals." Eaton at 9:19-26. When that technique is implemented with Enzmann's earbud, the earbud "*assists in measuring the user's hearing*" because it plays the audio test signals for the patient. *See also* claim 62 in Ground 2A.

- j. Claim 79: A hearing enhancement apparatus as recited in 62, wherein information regarding the at least one hearing characteristic of the user is wirelessly received and stored in the hearing enhancement apparatus.**

220. *Supra* claim 24; *see also* claim 62 (Ground 2A).

D. Ground 2C: Enzmann in View of Sauer Renders Claims 45 and 63-77 Obvious.

221. At a high-level, the claims discussed in this section require that claim 13's "*hearing enhancement apparatus*" include voice-control capabilities. As discussed below, adding such functionality to Enzmann's earbud would have been obvious in view of Sauer.

1. Sauer (EX1012)

222. Sauer discloses a voice-controlled hearing aid. Sauer at Title (“Voice-controlled hearing aid”); Abstract. Sauer explains that some hearing-aid users have difficulty adjusting a hearing aid’s physical controls, *e.g.*, a potentiometer (*i.e.*, knob) for controlling volume. Sauer at 1:16-50.

223. To address this problem, Sauer discloses the use of a “voice decoder” that recognizes certain “code words” the user utters and adjusts settings based on those words. Sauer at 3:5-26; *see also* Sauer at Abstract (“the control of a part that influences the transmission characteristic of the amplifier ensues in the hearing aid by recognizing and evaluating a code word spoken by the hearing aid user”); claim 1 (“A hearing aid comprising: ... a voice control circuit having means for receiving a spoken command, means for recognizing said spoken command as being spoken by said hearing-impaired person”); FIG. 1.

224. For example, “the hearing aid wearer can modify the volume gain of the hearing aid on the basis of stored code words and corresponding spoken instructions such as ‘softer’ and ‘louder.’” Sauer at 3:31-34; *see also* Sauer at claim 1 (“processor means for evaluating said spoken command and for converting said spoken command into an electrical control signal for setting at least one of the gain of said amplifier”). To capture words spoken by the user, Sauer’s system uses the hearing aid’s pre-existing microphone. Sauer at 4:19-23.

2. The Enzmann-Sauer Combination

225. As I explained in Ground 2A for limitation [8C], a person of ordinary skill in the art would have understood Enzmann's earbud includes means for controlling the earbud's volume despite Enzmann not explicitly describing such a mechanism. In view of Sauer, POSAs would have known that one suitable mechanism for controlling the volume on Enzmann's earbud would have been to use Sauer's voice decoder.

226. Sauer explicitly motivates the combination by touting the benefits of voice-controls. 1:15-58 (explaining that voice control improves the art by enabling “the operation, switching or control” of the hearing aid “without the necessity of physically touching switch means on the hearing aid and without the use of additional remote control devices”); Abstract (explaining that voice control “make[s] the operation, control and/or program selection of a hearing aid easier” and “make[s] manual operations and actuation means superfluous”). Moreover, using Sauer's voice-control technique would have been the simple substitution of one known element for controlling a hearing aid's volume (Sauer's voice control) for another (Enzmann's unidentified control) to obtain predictable results, *i.e.*, a hearing aid with volume that users can adjust. That Enzmann already includes a microphone for capturing the user's voice (Enzmann at [0033]) and a digital signal audio processor (Enzmann at [0031]), highlights its compatibility with Sauer's technique.

A person of ordinary skill in the art therefore had reason to modify Enzmann's earbud to utilize Sauer's technique for voice-controlled functionality, and a reasonable expectation of success in doing so as implementing Sauer's technique in Enzmann's earbud would have required mere routine engineering, *e.g.*, adding Sauer's voice decoder and code words to Enzmann's earbud.

227. In an obvious implementation of Enzmann-Sauer, Enzmann's earbud would be modified to include Sauer's voice decoder which would identify certain code words such as "softer" or "louder," the utterance of which would cause Enzmann to reduce or increase the earbud's volume.

3. Claims 45 and 63-77

- a. Claim 45: A hearing enhancement apparatus as recited in claim 29, wherein the apparatus includes a volume control that is configured to respond to a voice command of the user.**

228. As discussed immediately above in Section VII.D.2, in the Enzmann-Sauer combination, Enzmann's earbud "*includes a volume control*" in the form of Sauer's voice-decoder and code-word technique and that volume control "*is configured to respond to a voice command of the user,*" as claimed. *See also* claim 29 in Ground 2A.

- b. Claim 63: A hearing enhancement apparatus as recited in 62, wherein the apparatus comprises a volume control that is configured to respond to a voice command.**

229. *Supra* claim 45; *see also* claim 62 (Ground 2A).

- c. Claim 64: A hearing enhancement apparatus as recited in 62, wherein the apparatus is configured to recognize at least a voice command from the user and operate according to the voice command.**

230. *Supra* claim 45; *see also* claim 62 (Ground 2A).

- d. Claim 65: A hearing enhancement apparatus as recited in claim 64, wherein the at least one hearing characteristic of the user is identified via measuring the user's hearing at least across a plurality of frequencies.**

231. In the Enzmann-Sauer combination, Enzmann's earbud continues to use an amplification chart to modify the audio signal based on a user's unique hearing characteristics. *See* Ground 2A, limitation [1D] (discussing "*at least one hearing characteristic*" element).

232. As seen below in Figure 5, Enzmann's amplification chart "*is identified via measuring the user's hearing at least across a plurality of frequencies,*" as claimed. Enzmann at [0028] ("preprogrammed frequency mapping of the user's hearing characteristics"); [0046] ("frequency maps"). The "*plurality of frequencies*" is depicted as the X-axis below and the user's "hearing characteristic" (the dotted line) is measured across that plurality of frequencies:

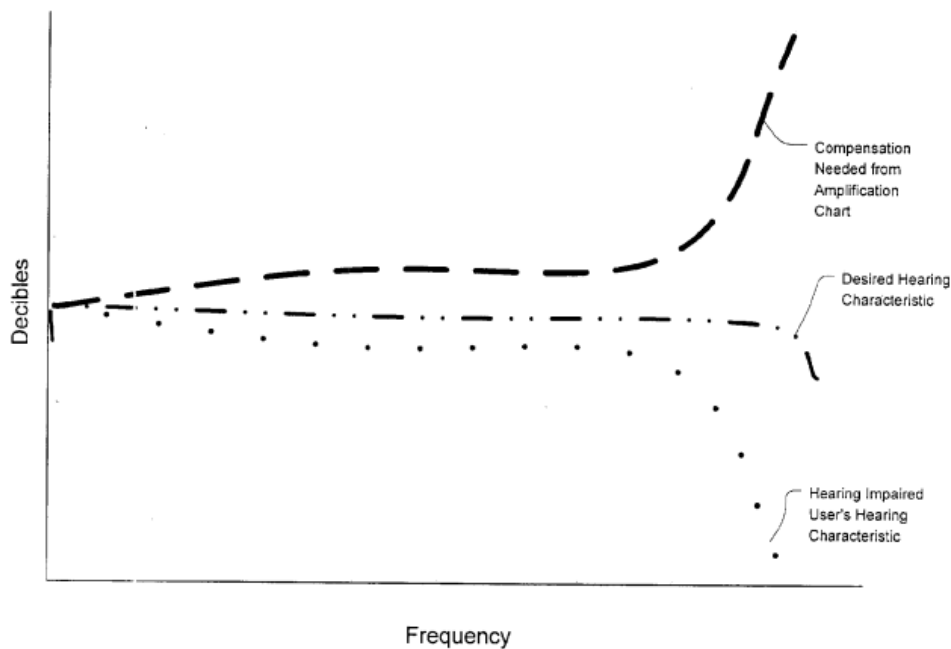


FIG. 5

- e. **Claim 66: A hearing enhancement apparatus as recited in claim 65, wherein the hearing enhancement apparatus is configured to alter a power level of the audio output signals so as to suppress at least a sound level associated with the environment of the apparatus so as to provide noise cancellation.**

233. In the Enzmann-Sauer combination, Enzmann's earbud continues to utilize Enzmann's noise-cancellation techniques. *Supra* Ground 2A (discussing claim 16). In Enzmann, "ambient noise" that the earbud's microphone captures is "typically **reduced in volume**" before being combined with the input audio signal from, *e.g.*, a cellular phone. Enzmann at [0040]; *see also* Enzmann at [0027],

[0046]-[0047]. The combined audio output signal is then played for the user. Enzmann at [0046]-[0047].

234. Enzmann's earbud therefore is configured to "*alter a power level of the audio output signals,*" i.e., the portion of the audio output that is ambient noise, "*so as to suppress at least a sound level associated with the environment of the apparatus so as to provide noise cancellation,*" as claimed.

- f. **Claim 67: A hearing enhancement apparatus as recited in claim 66 further comprising a microphone configured to receive audio sound at the environment of the apparatus for determining the sound level associated with the environment of the apparatus.**

235. *Supra* claim 66; *see also* claim 50 (Ground 2A).

- g. **Claim 68: A hearing enhancement apparatus as recited in claim 67, wherein the apparatus is configured to wirelessly couple to a cell phone.**

236. *Supra* claim 67; *see also* limitation [1A] (Ground 2A).

- h. **Claim 69: A hearing enhancement apparatus as recited in claim 68, wherein based on at least a preference of the user, the power of a first range of frequencies of the audio output signals is increased, and the power of a second range of frequencies of the audio output signals is not increased.**

237. As I discussed with respect to claim 48 (above) and in Ground 2A with respect to claim 8, Enzmann's amplification chart reflects a user's audio preferences as determined by, e.g., a hearing test performed by an audiologist. As reflected in Enzmann's Figure 5 (below), "*the power of a first range of frequencies of the audio*

output signals is increased,” i.e., the blue circle below where there is a delta between the user’s hearing characteristics (dotted line) and the desired hearing characteristics (dash and dotted line). In contrast, “the power of a second range of frequencies of the audio output signals is not increased,” i.e., the red circle below where there is a no delta between the user’s hearing characteristics (dotted line) and the desired hearing characteristics (dash and dotted line).

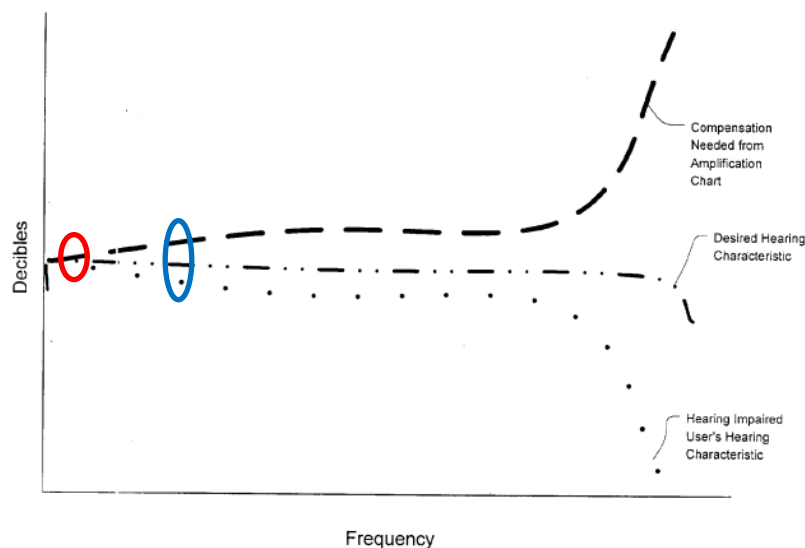


FIG. 5

238. If Patent Owner argues Enzmann-Sauer does not meet claim 69, then the claim would have been obvious over Enzmann-Sauer in view of a person of ordinary skill’s background knowledge. Specifically, a person of ordinary skill in the art understood that many hearing-impaired individuals suffer from slope loss, which requires signal amplification for high frequency audio but does not require

amplification at lower frequencies. That a person of ordinary skill in the art would have been aware of slope loss is confirmed by the prior art. *See, e.g.*, EX1011, [0002] (“Millions of Americans suffer from hearing loss. Most commonly, hearing loss is of one of four types. In slope loss, the ability to hear high frequencies is lost while the ability to hear sounds in the low frequencies is retained.”); EX1051 (filed in 1966), 6:45-49 (“Patty was tested and found to have the above loss pattern, commonly referred to as a ‘ski slope’ loss. In other words, she could hear low tones well enough to understand some speech but she was unable to reproduce sounds adequately to have intelligible speech.”), 2:31-33 (“The most common types of hearing deficiency are characterized by greater losses occurring in the upper frequencies of audible speech.”).

239. Given his or her knowledge of slope loss, a person of ordinary skill in the art would have expected that, for at least some individuals, Enzmann’s amplification chart would reflect no need for audio-signal compensation for a range of low-frequency signals and only a need for audio-signal compensation for a range of high-frequency signals, meeting claim 69. *See, e.g.*, EX1011 at [0035] (“Processor 326 transforms the signal to compensate for the user’s particular hearing loss. For example, if the user has a slope loss (i.e., can hear low frequencies but progressively loses high frequencies), the processor boosts the high frequencies.”); EX1051, 4:65-72 (“This then precisely sets each of the attenuator controls so that

the least attenuation, and therefore the most amplification will be provided where the control arms 20 are in their uppermost positions as demonstrated in FIG. 3, thereby permitting the most amplification in the frequencies most difficult to hear.”).

- i. **Claim 70: A hearing enhancement apparatus as recited in claim 64, wherein the hearing enhancement apparatus is configured to alter a power level of the audio output signals so as to suppress at least a sound level associated with the environment of the apparatus so as to provide noise cancellation.**

240. *Supra* claims 64, 66.

- j. **Claim 71: A hearing enhancement apparatus as recited in claim 70 further comprising a microphone configured to receive audio sound at the environment of the apparatus for determining the sound level associated with the environment of the apparatus.**

241. *Supra* claims 67, 70.

- k. **Claim 72: A hearing enhancement apparatus as recited in claim 71, wherein the apparatus is configured to wirelessly couple to a cell phone.**

242. *Supra* claims 68, 71.

- l. **Claim 73: A hearing enhancement apparatus as recited in claim 72, wherein based on at least a preference of the user, the power of a first range of frequencies of the audio output signals is increased, and the power of a second range of frequencies of the audio output signals is not increased.**

243. *Supra* claims 69, 72.

- m. **Claim 74: A hearing enhancement apparatus as recited in claim 73, wherein the at least one hearing characteristic of the user is identified via measuring the user's hearing at least across a plurality of frequencies.**

244. *Supra* claims 65, 73.

- n. **Claim 76: A hearing enhancement apparatus as recited in 62, wherein based on at least a preference of the user, the power of a first range of frequencies of the audio output signals is increased, and the power of a second range of frequencies of the audio output signals is not increased.**

245. *Supra* claims 62, 69.

- o. **Claim 77: A hearing enhancement apparatus as recited in 62, wherein the at least one hearing characteristic of the user is identified via measuring the user's hearing at least across a plurality of frequencies.**

246. *Supra* claims 62, 65.

E. Ground 2D: Enzmann in View of Hagen Renders Claim 51 Obvious.

247. In this section, I address claim 51 which limits the “*microphone...for receiving the audio sound in the environment of the apparatus*”—recited in claim 50²—to “*a directional microphone*.” Implementing Enzmann’s earbud such that its microphone is “*directional*” would have been obvious in view of Hagen for the reasons discussed below.

² Discussed in Ground 2A.

1. Hagen (EX1014)

248. Hagen discloses a hearing aid with a microphone system that a user can switch between a non-directional (or omni-directional) mode and a directional mode. Hagen at 1:10-17. As Hagen explains, “[a] non-directional hearing aid system allows the wearer to pickup sounds from any direction,” whereas a “directional hearing aid helps the wearer to hear the voice of the person he or she is having a conversation with, while reducing the miscellaneous crowd noise present within the room.” Hagen at 1:18-28.

249. Hagen teaches it would be desirable to allow a user to switch between a directional and non-directional mode. Hagen at 2:45-60. Hagen therefore discloses a “directional microphone system” (Hagen at 5:28-36) that, when a “manual[] switch” S1 (Hagen at 5:2-4) is open (non-directional mode), feeds signals from only one non-directional microphone (mic F) into hearing aid circuit to deliver non-directional sounds. Hagen at 5:28-50. When S1 is closed (directional mode), signals from mic F are summed with adjusted signals from a second non-directional microphone (mic B), which are inverted, phase-adjusted, and gain-adjusted. Hagen at 5:28-6:10. This summation achieves enhanced “directivity index” (Hagen at 1:53-67), where sounds from front of the horizontal “axis of directionality” (Hagen at 5:19-28) are emphasized as compared with all directions around. Hagen at 1:53-67, 6:61-7:4, Figs. 1-2.

250. Hagen in its background section, also teaches that “[t]ypical hearing aids either include a non-directional or directional hearing aid system.” Hagen at 1:18-20. Hagen further explains that directional hearing systems can be implemented using directional microphones: “Traditionally, directional hearing aids are implemented with a single microphone having inlets to cavities located in front and back of a diaphragm. Directionality with a single microphone is accomplished with an acoustic resistor placed across a hole in the back inlet of the microphone acting in combination with the compliance formed by the volume of air behind the diaphragm. This system is termed a first order pressure gradient directional microphone because the microphone output is a function of the pressure differential across the diaphragm.” Hagen at 1:29-38.

2. The Enzmann-Hagen Combination

251. In view of Hagen, a person of ordinary skill in the art would know that it was beneficial to allow a person using Enzmann’s earbud the option of switching its microphone from a directional mode to a non-directional mode. For example, when Enzmann’s earbud is operating as a hearing aid, it would be beneficial for the microphone to be directional so the user can better hear the person with whom he or she is speaking. Hagen at 1:18-28. Conversely, when the earbud is being used as a companion to a phone, the microphone can be switched to a non-directional mode

to better pickup (and thus cancel out or suppress) background sounds. Hagen at 1:18-28.

252. Hagen’s description of prior-art hearing aids also confirms that the use of directional microphones to improve a hearing-impaired person’s ability to hear a conversation was known such that the choice to use a directional microphone in Enzmann’s earbud would have been a routine design choice for POSAs. Hagen at 1:29-39. Hagen’s description is consistent with the background knowledge that a person of ordinary skill in the art would have possessed, *i.e.*, that the use of directional microphones with hearing aids was conventional. *See, e.g.*, EX1030 (filed in 1974), at 1:5-10 (“Head worn miniature hearing aids have been provided with a directionality feature in recent years so as to provide relatively greater amplification of sounds originating from sources in front of the person wearing the aid as compared with sounds originating generally behind the person.”); EX1031 at 1:21-44 (“The application of directional microphones to hearing aids is well known in the patent literature [citing references] as well as commercial practice [citing commercial products].”). A person of ordinary skill in the art thus would have considered implementing Enzmann’s earbud to include a directional microphone so as to better capture the voice of a person speaking to the earbud-wearer to be the obvious use of a known technique to improve similar devices in the same manner.

253. The conventional nature of directional microphones in hearing aids would have also given a person of ordinary skill in the art a reasonable expectation of success that he or she could implement Enzmann’s microphone as a directional microphone like the one that Hagen discloses.

254. In the Enzmann-Hagen combination, Enzmann’s earbud would include Hagen’s microphone system, and a user of Enzmann’s earbud would thus be able to switch Enzmann’s microphone into a directional microphone.

3. Claim 51

255. In the Enzmann-Hagen combination, Enzmann’s microphone would have—at least in certain modes of operation—been a “*directional microphone*.” See also Claim 50 in Ground 2A.

F. Ground 2E: Enzmann in View of Fretz Renders Claims 10 and 26 Obvious.

256. In this section, I address claims 10 and 26 which, respectively, limit the “*speaker*” of independent claims 1 and 13 to a “*directional speaker*.” Implementing Enzmann’s earbud such that its speaker is “*directional*” would have been obvious in view of Fretz for the reasons discussed below.

1. Fretz (EX1013)

257. Fretz discloses an open-ear hearing aid, meaning that the hearing aid leaves part of the user’s ear canal open. Fretz at Abstract; FIGS. 1, 5A, 5B. Fretz explains that hearing aids inserted into a user’s ear have known drawbacks including

the creation of an “occlusion effect” that results “in sounds which are both unnatural and uncomfortable for the user.” Fretz at 1:24-30, 3:1-5. Fretz discloses an open-ear hearing aid that keeps the user’s ear open, thereby preventing the occlusion effect. Fretz at 4:14-25, 14:25-15:2.

258. Fretz explains that with its design “there is a greater possibility of feedback than with conventional, sealed canal hearing aids. That is, with an open ear canal, sound emanates from the open canal with little attenuation. The microphone [] picks up sound from both distant sources and sound coming out of the ear canal. The sound coming out of the ear canal causes feedback.” Fretz at 12:12-16. To address this issue, Fretz teaches the use of a directional speaker (referred to as a “receiver”) which “can be designed so that sound is transmitted with higher amplitude toward the ear drum than it is in the other direction.” Fretz at 14:6-24; *see also* Fretz at 10:1-3 (“receiver... is an output device, such as a loudspeaker”).

2. The Enzmann-Fretz Combination

259. Fretz discloses an alternative design for Enzmann’s earbud, and Fretz explicitly motivates POSAs to utilize its design to avoid drawbacks with in-the-ear hearing aids like Enzmann’s earbud. Fretz at 1:24-30 (“The traditional approach for correcting hearing impairments has been to employ electronic ‘In-The-Ear’ (ITE) hearing aid devices inserted into the ear and ‘Behind-The-Ear’ (BTE) hearing aid devices attached behind the ear. Then, through various signal processing techniques,

the sounds to be delivered to the ear are rebuilt and supplemented to facilitate and optimize the hearing of the user throughout the frequency range. Such devices tend to block the ear canal so that little or no sounds - reach the ear in a natural, unaided manner.”), 3:1-5 (“Conventional hearing aid systems cause an additional problem known as the occlusion effect. The occlusion effect is the increased transmission of sound by bone conduction when the ear canal is blocked and air conduction is impeded, resulting in sounds which are both unnatural and uncomfortable for the user. In particular, the user’s voice sounds different than normal when the ear is blocked.”).

260. POSAs therefore had reason to implement Enzmann’s earbud using Fretz’s design, and a reasonable expectation of success in making the combination as it requires only routine engineering skill to incorporate Enzmann’s functionality into Fretz’s design. In the combination, Enzmann’s earbud would retain Enzmann’s functionality, but the earbud would use Fretz’s open-ear design, including its use of a directional speaker to reduce feedback.

3. Claims 10 and 26

261. In the Enzmann-Fretz combination, Enzmann’s earbud would have been implemented to include a “*directional speaker*” to reduce feedback thereby rendering claims 10 and 26 obvious. *See also* claims 1 and 13 (Ground 2A).

G. Ground 3A: Berger Anticipates and/or Renders Obvious Claims 1-8, 11-15, 18-20, 23, 25, 27-30, 46-48, 52, 62, 75-76, and 80.

1. Berger (EX1011)³

262. Berger discloses a system for integrating a hearing aid into various electronic devices, including a wireless headset. Berger at Abstract; [0041] (“a hearing aid component can be integrated into a headset”). The embodiment in which a hearing aid is integrated into a wireless headset is shown in Figure 6 below:

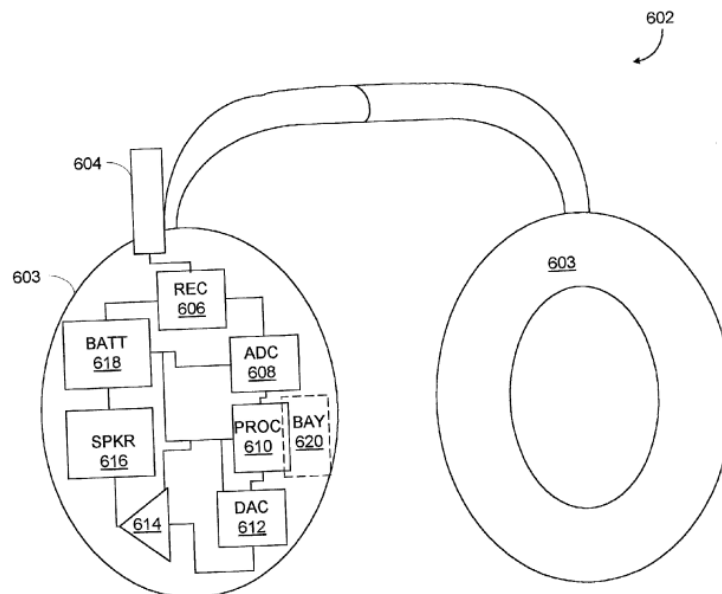


FIGURE 6

263. As shown above, Figure 6’s headset includes various electronic components including a receiver 606 and a processor 610. Berger at [0041]. The headset can be used with various electronic devices, including a television and/or

³ Citations in Ground 3A are to EX1011.

cellphone. Berger at [0008] (“Sound-producing devices compatible with the invention include wireless communications devices such as cellular telephones. In such uses, the hearing aid can be integrated with the earpiece, such as a headset or a handset.”); [0039] (“[W]ireless includes analog cellular, digital cellular, personal communication systems (PCS) and cordless phones, along with other wireless applications such as headsets for televisions, radios, hi-fi sound systems, home entertainment, movie theater seats, auditory loop systems, and other uses.”); [0041] (“Wireless headset 602 can be designed to be used with electronic devices including a television set, a computer system, or audio systems including home entertainment systems, radios, tapes, and compact discs.”).

264. Berger describes the functionality of its electronic components in the context of the handset shown in Figures 1 and 2A ([0017]-[0022]), but a person of ordinary skill in the art would have understood the components perform the same functionality in Figure 6’s headset. That is, processor 610 for the wireless headset embodiment performs the same functions as processor 210 for the wireless handset embodiment of Figure 2, etc.

265. The headset’s receiver “receives [a] digital wireless signal” picked up by antenna 604 and generates a digital audio signal that is transmitted to the processor. Berger at [0018]; *see also* Berger at [0041]. “A user’s [hearing] prescription is programmed into” the processor, which “transforms the [digital

audio] signal by applying a transfer function with more gain in the frequency ranges where the user has lost hearing.” Berger at [0019]; *see also* Berger at [0038]; [0041]. The modified signal is then transmitted to digital-to-analog converter 612 where it is converted to an analog signal, amplified by an amplifier 614, and output by speaker 616. Berger at [0019]; [0041].

266. As I discuss below, Berger anticipates and/or renders obvious many claims of the ’789 patent, including independent claims 1 and 13.

2. Claim 1

a. [1PRE]: “A hearing enhancement system for a user, comprising:”

267. Berger discloses a “system” that “integrates a hearing aid with devices,” including a wireless headset, and the system includes “a processor [that] transforms an electrical signal to compensate for a hearing impairment.” Berger at Abstract; *see also* Berger at [0041].

b. [1A]: “an audio system configured to receive input signals for broadcasting, and configured to up-convert the received input signals into up-converted signals to be wirelessly transmitted;”

268. Berger’s system includes “*an audio system configured to receive input signals for broadcasting*” such as a television or cellphone, each of which receives audio signals—*e.g.*, television or cellular signals—as inputs for broadcasting. Berger at [0008] (explaining that wireless headsets are used with cellular phones);

[0039], [0041] (“Wireless headset 602 can be designed to be used with electronic devices including a television set, a computer system, or audio systems including home entertainment systems, radios, tapes, and compact discs.”).

269. As Berger observes, a wireless headset needs “a receiver....because the incoming signal must be demodulated.” Berger at [0046]. Consistent with the explanation I provided above in paragraphs 129 to 134 of Ground 2A, a person of ordinary skill in the art would understand Berger’s observation to disclose that the incoming wireless signal the headset receives, *e.g.*, from a television or cellphone, has been modulated, *i.e.*, up-converted, for wireless transmission by the transmitting source, *e.g.*, the television or cellphone. *See, e.g.*, EX1027 at 3-4 (explaining that a modulator within the transmitter of a transmitting device up-converts, *i.e.*, modulates the signal information for transmission over a wireless transmission medium).

270. Berger thus discloses “*an audio system...configured to up-convert the received input signals into up-converted signals to be wirelessly transmitted.*”

c. [1B]: “wireless receiver configured to wirelessly receive the up-converted signals;”

271. As seen below, Berger’s headset includes “receiver 606” that receives the wireless signals sent by a phone, television, or other device to the headset. Berger at [0018] (“[A] wireless signal is picked up by handset antenna 104 and transmitted to integrated hearing aid device 106. A receiver 206 receives the digital

wireless signal picked up by antenna 104 and generates a digital audio signal.”); *see also* Berger at [0041].

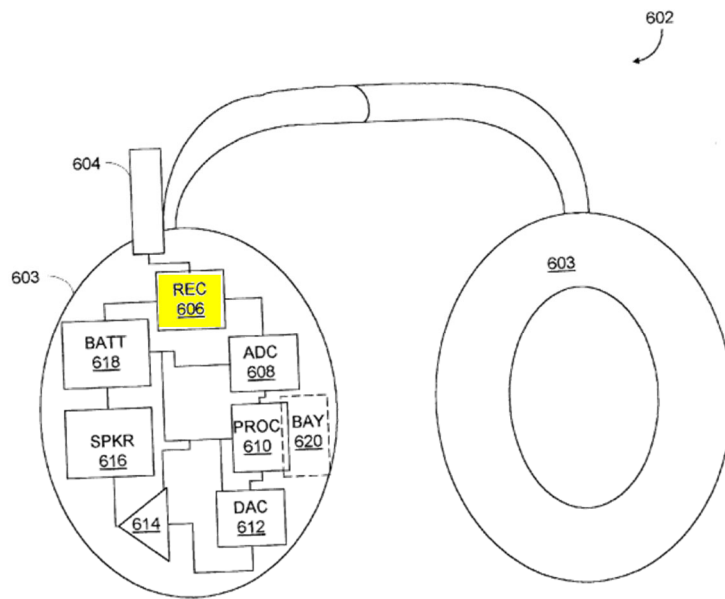


FIGURE 6

- d. [1C]: “a down-converter configured to down-convert the received up-converted signals into down-converted signals;”

272. For the reasons I discussed above in paragraphs 129 to 134 of Ground 2A, a person of ordinary skill in the art would have understood that Berger’s receiver is “a down-converter” that converts the received wireless signal to a down-converted signal for audio playback. Indeed, Berger explicitly teaches that the receiver “demodulate[s],” *i.e.*, down-converts, “the incoming signal.” Berger at [0046]; *see also* EX1027 at 3-4 (explaining that a demodulator within the receiver of a receiving

device down-converts, *i.e.*, demodulates, the signal information that has been transmitted over a wireless transmission medium).

- e. **[1D]: “a modifier configured to modify the down-converted signals into modified signals based on at least one hearing characteristic of the user to enhance the hearing of the user; and”**

273. Berger’s headset includes “*a modifier*” as claimed, *i.e.*, processor 610 (yellow highlighted in Berger’s Figure 6 below).

274. As Berger explains, the processor “transforms the [received audio] signal by applying a transfer function with more gain in the frequency ranges where the user has lost hearing.” Beger at [0021]; *see also* Berger at [0022] (explaining that multiple prescriptions can be programmed into the processor); [0003] (hearing aids “remedy a specific pattern of frequency loss specified by a user's prescription”); [0038] (“[T]he signal processing occurs in the processor of embodiments described above, for example, in a handset, wireless communications device, computer, or headphones.”).

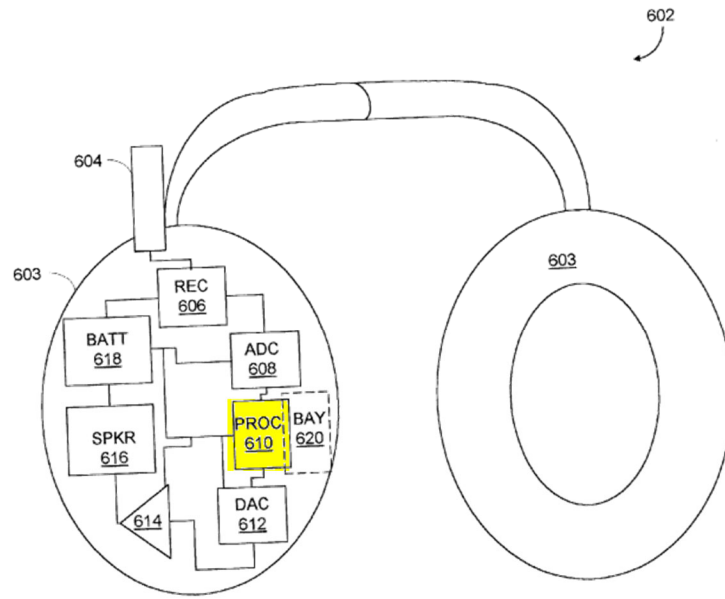


FIGURE 6

f. [1E]: “a speaker configured to generate audio output signals from the modified signals for the user.”

275. Berger’s headset includes speaker 616 (yellow highlighted in Figure 6 below) which outputs the wirelessly transmitted audio signals after those signals have been modified based on the user’s prescription. Berger at [0019] (“A user’s prescription is programmed into processor 210. Processor 210 transforms the signal by applying a transfer function with more gain in the frequency ranges where the user has lost hearing. The digital signal is then transmitted to a digital-to-analog converter (DAC) 212 where it is reconverted to analog. The signal then goes to an amplifier 214, where it is amplified and sent to a speaker 216. From speaker 216, the sound enters the user’s ear.”); *see also* Berger at [0041] (“wireless headset includes...a speaker 616”).

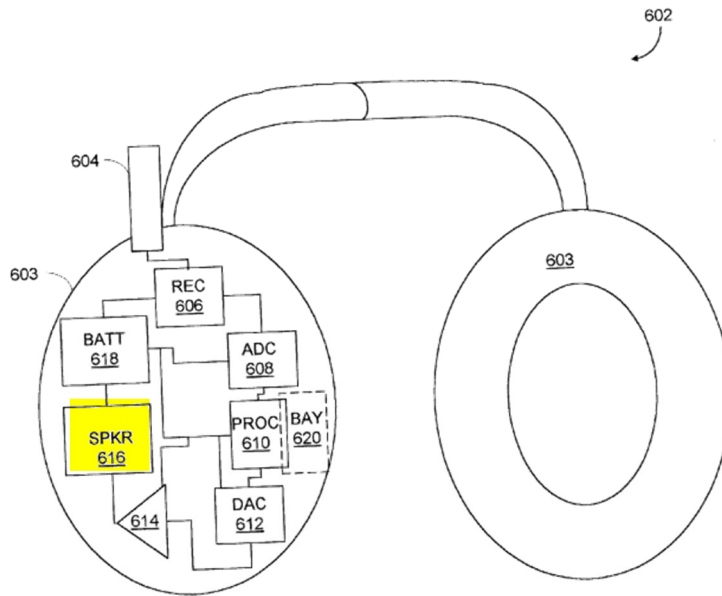


FIGURE 6

3. Dependent Claims 2-8 and 11-12

- a. **Claim 2: “A hearing enhancement system as recited in claim 1, wherein the up-converted signals are in the WiFi frequency band.”**

276. Berger does not state what wireless protocol its headset uses. However, as I explained above in Ground 2A with respect to claim 2, a person of ordinary skill in the art would have understood that one wireless protocol suitable for audio-signal transmissions was WiFi. Therefore, a person of ordinary skill in the art would have interpreted Berger to teach that its up-converted signals are transmitted in the WiFi frequency band.

277. Alternatively, at a minimum, a person of ordinary skill in the art would have considered implementing Berger’s wireless connection using WiFi to have

been the simple substitution of one known element (Berger's unidentified wireless protocol) for another (WiFi) to obtain predictable results (a wireless connection over which audio signals can be transmitted).

- b. Claim 3: “A hearing enhancement system as recited in claim 1, wherein the audio system is selected from the list consisting a television, a stereo system, a CD player and a radio.”**

278. *Supra* [1A] (explaining how Berger's wireless headphone receives audio signals from, *e.g.*, a television).

- c. Claim 4: “A hearing enhancement system as recited in claim 1, wherein the audio system is a phone.”**

279. *Supra* [1A] (explaining how Berger's wireless headphone receives audio signals from, *e.g.*, a phone).

280. If Patent Owner argues Berger does not disclose using its wireless headset with a phone, then doing so would have been obvious for at least two reasons.

281. First, Berger explicitly teaches that its invention is suitable for “sound-producing devices” includes “cellular telephones” and that “[i]n such uses, the hearing aid can be integrated with the earpiece, such as a **headset** or a handset.” Berger at [0008]; *see also* Berger at [0007] (“What is needed is an invention that allows hearing aid wearers to use electronic and telecommunication devices, such as wireless telephones ...”). Although I believe this disclosure is an explicit teaching

that Berger’s wireless headset is used with a cellular telephone, the disclosure—at a minimum—motivates a person of ordinary skill in the art to implement Berger such that its wireless headset is used with a cellular phone.

282. Second, apart from Berger’s explicit teachings, a person of ordinary skill in the art would have known that wireless headphones were commonly used with telephones by 2003. Indeed, EX1036 **defines** the word “headset” to mean “a set of headphones, typically with a microphone attached, used especially in telephone and radio **communication**.” Numerous other references confirm this basic understanding too:

- EX1032 at [0023]-[0025] (“The audio signal may be transmitted from the audio signal source (150) to the headset (100) by a wired connection (108) or a wireless link (107 or 110). ... The wireless link (107) may be, for example, a radio frequency or optical transmission. For wireless radio frequency communication, a radio antenna (109) would be provided on the headset (100) to receive the radio signal (107) from the audio signal source (150). ... The headset (100) of the present invention, can also be used to conduct a telephone conversation and, therefore, requires a microphone.”);
- EX1033 at [0003]-[0005] (stating that the “invention relates generally to cordless headset telephones, and more particularly to an ultralight headset telephone which includes features designed to enhance its ergonomics and comfort while providing broad telephone functionality,” and then in the “Description of the Related Art” section [i.e., the background section], disclosing that “[t]he basic cordless telephone headset is known. One such headset is shown, for example, in U.S. Pat. No. 5,113,428, issued May 12, 1992, of Robert Fitzgerald...,” followed by various other patented cordless telephone headsets and their designs);
- EX1034 at 2:15-51 (“Particularly, it is an object of the present invention to provide a method and apparatus for providing portable audio programming for the listening enjoyment of a user while preventing the user from missing

telephone calls. ... The apparatus may include headphones and a circuit on the headphones which receives wireless transmissions from both a phone base unit and an audio system. The circuit alerts a user of the headphones when a transmission received from the phone base unit indicates an incoming phone call. The apparatus of the present invention may also include a microphone on the headphones. The circuit can then transduce verbal utterances of the user with the microphone and transmit the utterances to the phone base unit to conduct a telephone call.”), FIG. 2 (illustrating an embodiment of the aforementioned “present invention,” including “a set of wireless headphones 101”);

- EX1035 at [0017] (“The headset 21 comprises two stereo earpieces 23 (right and left), each of which comprises a speaker 24 for stereo playback of music. The headset 21 also comprises a microphone 25, a headband 26 and an electronics module 27. The details of the electronics module, which comprises, among other things, a Bluetooth transceiver as a short-range radio transceiver for establishing a Bluetooth connection 29 between the headset 21 and the mobile telephone 22, will be described in greater detail in connection with Figure 3.”), FIG. 2.

283. Either because of Berger’s explicit motivation or because of his or her background knowledge that wireless headsets were commonly used with phones, a person of ordinary skill in the art would have been reason to implement Berger’s wireless headset such that the audio system with which it was wirelessly connected is a phone. This implementation would have been the obvious and simple combination of existing prior-art elements (a wireless headset and a cellular phone) according to known methods to yield a predictable result.

- d. Claim 5: “A hearing enhancement system as recited in claim 1, wherein the audio system receives the input signals from a microphone.”**

284. The audio signals that Berger’s headset receives from, *e.g.*, a phone are “*input signals from a microphone*,” *i.e.*, the microphone on the calling party’s phone.

- e. Claim 6: “A hearing enhancement system as recited in claim 1, wherein the down-converted signals are modified such that a portion of the audio output signals has an increased power to enhance the hearing of the user.”**

285. Berger explains that, based on a “user’s prescription,” Berger’s processor “transforms the [audio] signal by applying a transfer function with *more gain* in the frequency ranges where the user has lost hearing.” Berger at [0019]. Increasing the gain of audio signals increases the signals’ power in the frequency ranges where the gain has been increased.

- f. Claim 7: “A hearing enhancement system as recited in claim 6, wherein the portion with increased power is selected based on frequency, and wherein a higher frequency portion has increased power.”**

286. As I explained for claim 6, Berger uses the user’s prescription by applying “more gain in the frequency ranges where the user has lost hearing.” Berger at [0019]. Berger also explains that a common form of hearing loss is “slope loss” in which an individual loses “the ability to hear high frequencies.” Berger at [0002].

287. When the user's prescription programmed into processor 210 is for an individual with "slope loss," then "the processor boosts the high frequencies" where the user has lost hearing, but not the lower frequencies. Berger at [0035]; *see also* [0019]; claim 4 ("wherein said electrical signal is transformed to compensate for a slope hearing impairment").

g. Claim 8

(1) [8PRE]: "A hearing enhancement system as recited in claim 1,"

288. *Supra* [1PRE].

(2) [8A]: "wherein the at least one hearing characteristic of the user is determined via calibrating the user's hearing,"

289. The '789 patent explains that a user's hearing characteristic can be calibrated "by a third party, such as an audiologist." EX1001, 7:49-50.

290. A person of ordinary skill in the art would have understood that the "user's prescription" stored in Berger's processor and used to adjust Berger's audio signal was "*determined via calibrating the user's hearing*," *e.g.*, by an audiologist. A person of ordinary skill in the art would have known that a hearing-aid prescription details the specific amplification needed to restore a person's unique hearing loss, *i.e.*, at what frequencies amplification is needed, and that such a prescription is generated based on a doctor-administrated hearing exam or other form of hearing evaluation, *i.e.*, "*via calibrating the user's hearing*." The following exemplary

references corroborate my understanding of a person of ordinary skill's background knowledge:

- EX1055 at 1:16-41 (“The fitting process is generally carried out by a hearing professional, such as an audiologist, an ear, nose, and throat doctor, or a hearing aid dispenser. Hearing aid fitting is usually based on a number of diagnostic tests which are performed as part of, or prior to the fitting session. These diagnostic tests may include a threshold audiogram, and tests to establish the most comfortable (MCL) and uncomfortable (UCL) listening levels in different frequency bands. ... The result of these diagnostic tests is often a prescription for a hearing aid having an insertion gain (IG) which specifies the desired frequency dependent gain that a hearing aid delivers to provide maximum satisfaction for the hearing aid user.”);
- EX1056 at 3:60-4:7 (“The audiogram chart shows the results of a hearing threshold response or hearing acuity test performed by an audiologist or hearing aid dispenser using an audiometer. ... The operator varies the tones generated and inquires whether the patient can detect the generated tones at a variety of frequencies and amplitudes. The result of this process is that the hearing aid that the patient receives is not based on the patient's selected preference for a combination of electronic components. Rather, the components are usually selected from a prescription generated by the audiologist or hearing aid dispenser on the basis of the audiogram and/or the patient's response to the acuity tests.”);

- EX1057 (disclosing “an apparatus and method for customizing a frequency dependent signal amplification characteristic which matches and compensates for the deficiencies in the hearing response of a particular patient and which can be field programmed at the point of application based on the measured hearing characteristics of the patient and set in a programmable memory in the form of a patient prescription table (PPT),” (1:65-2:5) where the “patient prescription table (PPT)” is “taken directly from an audiologist's diagnostic audiogram to fully define the device behavior so as to optimally compensate for the patient’s hearing impairment).

291. Alternatively, if Patent Owner argues that Berger’s “user’s prescription” was not determined “*via calibrating the user’s hearing*,” then doing so would have been obvious because—as the references I discussed in the preceding paragraph demonstrate—mapping, *i.e.*, calibrating, a user’s hearing to determine at which audio frequencies the user has difficult hearing was the conventional manner by which hearing-aid prescriptions were generated.

(3) [8B]: “wherein the power of the audio output signals can be changed as a function of frequency, and”

292. As I explained for claim 6, based on a “user’s prescription,” Berger’s processor “transforms the [audio] signal by applying a transfer function with more **gain in the frequency ranges where the user has lost hearing.**” Berger at [0019]. The gain, *i.e.*, output power, of the signal is “*changed as a function of frequency*,”

i.e., whether the gain/power is changed depends on whether the frequency is a frequency at which the user has lost hearing.

(4) [8C]: “wherein the user can change the power of the audio output signals.”

293. As I explained in Ground 2A when discussing limitation [8C], a person of ordinary skill in the art would expect hearing-aid devices to have volume controls—indeed, the lack of such control would be very unexpected. A person of ordinary skill in the art would therefore have understood Berger to at least suggest that its headset had some form of volume control that allowed a user to adjust the headset’s volume.

294. Berger also discloses a smart-card bay into which a user may insert a card containing the user’s prescription to customize the prescription used for the hearing aid gain (power). *See, e.g.*, Berger at [0023]-[0024], [0041]; Figure 6 (depicting “bay 620”). “With prescriptions programmed into a smart card; use users can easily carry cards about with them and insert them into any compatible wireless telephone or other device.” Berger at [0026] “A particular advantage to the smart card approach is that a single user could have different smart cards that use different transfer functions based on the environments in which they will be used.” Berger at [0027]. Thus, a user can use the smart cards to change the transfer functions of the hearing compensation which, a POSA would understand, will change the power of the audio output signals

295. Alternatively, at a minimum, implementing Berger’s headset such that its volume could be adjusted by a user would have been a routine design choice that benefited patients by allowing them to adjust volume to comfortable levels. As I demonstrated with corroboration in Ground 2A at paragraphs 160 to 161, the use of volume controls on hearing-aid devices was commonplace as of 2003, and therefore using such a control on Berger’s hearing-aid headset would have been the obvious use of a known technique (user-adjustable volume control) to improve similar devices (Berger’s hearing-aid headset) to obtain a predictable result (a hearing-aid headset with volume that a user could alter).

h. Claim 11: “A hearing enhancement system as recited in claim 1, wherein the speaker is an ear speaker.”

296. As shown in Figure 6 below, Berger’s headset (including its speaker) is designed to fit over a user’s ear thereby delivering audio to the ear. The speaker thus “*is an ear speaker.*”

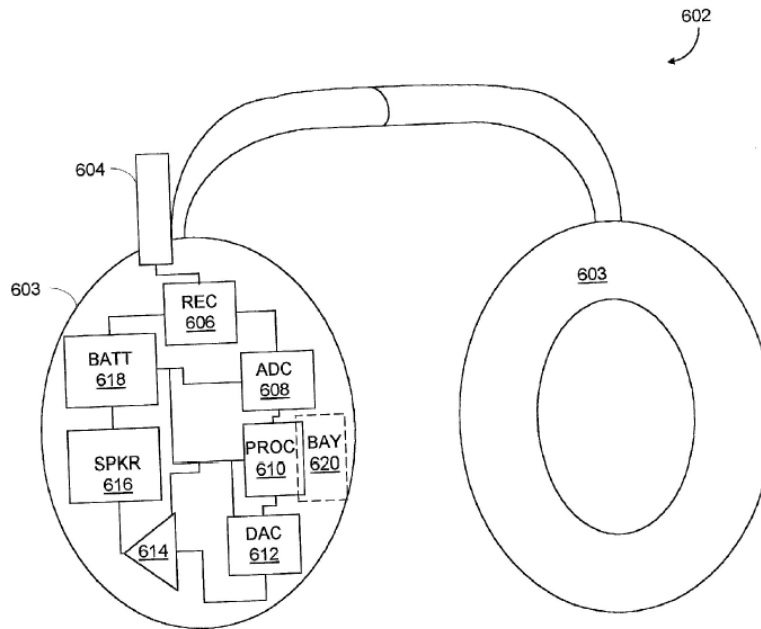


FIGURE 6

- i. **Claim 12: “A hearing enhancement system as recited in claim 1, wherein the speaker is in a headset.”**

297. As shown in Figure 6 below, Berger’s speaker is “*in*” Berger’s “*headset*”:

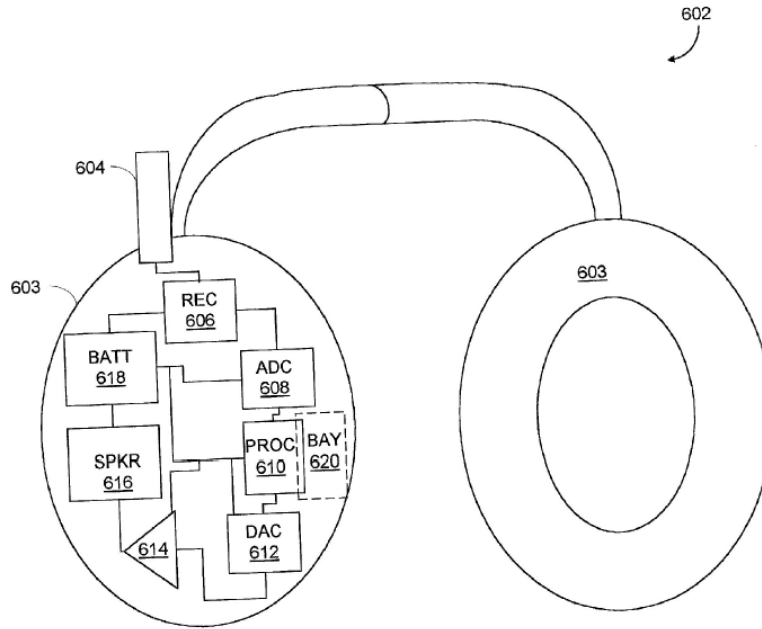


FIGURE 6

4. Independent Claim 13

298. Claim 13 is similar to claim 1 except claim 13 recites a “*hearing enhancement apparatus for a user*” rather than a “*hearing enhancement system for a user*.” As discussed for claim 1, Berger’s system includes a headset with a “*wireless receiver*,” “*down-converter*,” “*modifier*,” and “*speaker*” as recited in claim 13. [0041]; FIG. 6.

299. Berger’s headset meets claim 13’s “*hearing apparatus*,” and Berger anticipates (or renders obvious) claim 13 for the same reason it anticipates (or renders obvious) claim 1.

5. **Dependent Claims 14-15, 18-20, 23, 25, 27-30, 46-48, 52, 62, 75-76, and 80**

- a. **Claim 14: “A hearing enhancement apparatus as recited in claim 13, wherein the down-converted signals are modified such that a portion of the audio output signals has an increased power to enhance the hearing of the user.”**

300. *Supra* claim 6.

b. **Claim 15**

[15PRE]: A hearing enhancement apparatus as recited in claim 14,	<i>Supra</i> claim 14.
[15A]: wherein the portion with the increased power is selected based on frequency	<i>Supra</i> claim 7.
[15B]: wherein a higher frequency portion has increased power,	<i>Supra</i> claim 7.
[15C]: wherein the at least one hearing characteristic of the user is determined via calibrating the user's hearing,	<i>Supra</i> [8A]
[15D]: wherein the power of the audio output signals can be changed as a function of frequency, and,	<i>Supra</i> [8B]
[15E] wherein the user can change the power of the audio output signals.	<i>Supra</i> [8C]

- c. **Claim 18: “A hearing enhancement apparatus as recited in claim 14, wherein the portion with increased power is selected based on frequency, and wherein a higher frequency portion has increased power.”**

301. *Supra* claim 7.

- d. **Claim 19: “A hearing enhancement apparatus as recited in claim 13, wherein the up-converted signals are in the WiFi frequency band.”**

302. *Supra* claim 2.

- e. **Claim 20: “A hearing enhancement apparatus as recited in claim 13, wherein the at least one hearing characteristic of the user is determined via calibrating the user's hearing, wherein the power of the audio output signals can be changed as a function of frequency, and wherein the user can change the power of the audio output signals.”**

303. *Supra* claim [15C]-[15E].

- f. **Claim 23: “A hearing enhancement apparatus as recited in claim 13, wherein the apparatus is also configured to operate as at least a part of a phone.”**

304. *Supra* claim 4.

- g. **Claim 25: “A hearing enhancement apparatus as recited in claim 13, wherein, the at least one hearing characteristic of the user is retrieved from a portable media storage device while being physically in contact with the apparatus.”**

305. Berger discloses that the user's prescription “can be programmed into a ‘smart card’” (Berger at [0024]), and Berger's headset includes a “smart card bay

620 [that] allows insertion of a smart card” into the headset (Berger at [0041]). A person of ordinary skill in the art would have been familiar with smart cards and known that they are a form of “*portable media storage*” that needs to be physically connected to the headset for data on the card—*e.g.*, the user’s prescription—to be retrieved by the headset.

306. The smart-card bay 620 is seen in Figure 6 below:

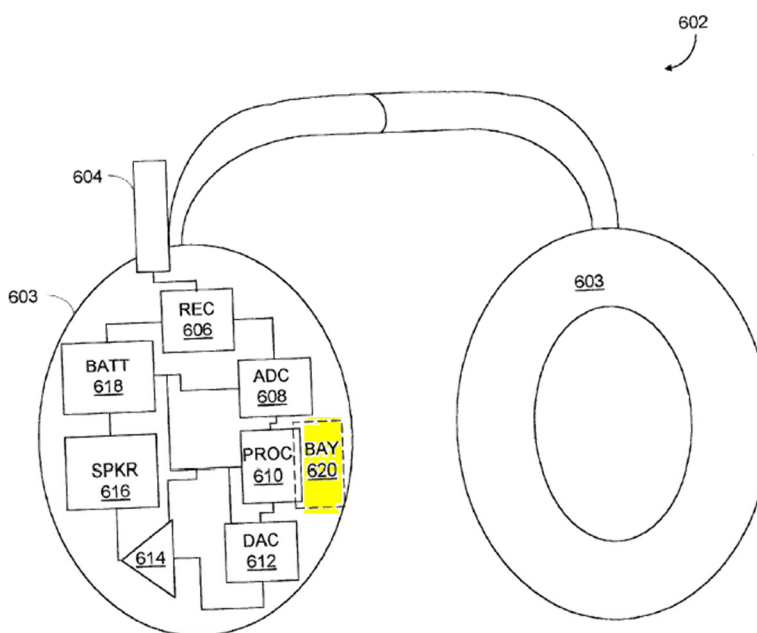


FIGURE 6

- h. Claim 27: “A hearing enhancement apparatus as recited in claim 13, wherein the speaker is an ear speaker.”**

307. *Supra* claim 11.

- i. Claim 28: “A hearing enhancement apparatus as recited in claim 13, wherein the speaker is in a headset.”**

308. *Supra* claim 12.

- j. **Claim 29: “A hearing enhancement apparatus as recited in claim 13, wherein the audio system is configured to operate as a phone, wherein the hearing enhancement apparatus is configured to operate in conjunction with or at least as a part of a mobile phone, wherein the speaker is an ear speaker, and wherein to enhance the hearing of the user, the modifier is configured to modify the down-converted signals into modified signals at one or more frequencies within the audio frequencies, with the one or more frequencies being determined by the at least one hearing characteristic of the user.”**

309. *Supra* claims 4, 6, 11, and 17.

- k. **Claim 30: “A hearing enhancement apparatus as recited in claim 29, wherein the at least one hearing characteristic of the user is determined via calibrating the user's hearing at least across the one or more frequencies to generate at least a portion of the hearing profile of the user, and wherein the hearing profile is stored in the hearing enhancement apparatus.”**

310. As I discussed above regarding limitation [8A], a person of ordinary skill in the art would have understood that the “user’s prescription” stored in Berger’s processor and used to adjust Berger’s audio signal was “*determined via calibrating the user's hearing,*” *e.g.*, by an audiologist testing the user’s hearing.

311. A person of ordinary skill in the art would also have understood that the “user’s prescription” was obtained by testing the user’s hearing “*across the one or more frequencies*” because that was the conventional (and logical) way to test a person’s hearing to generate a prescription—testing the full range of potential audio frequencies a user can be expected to encounter in life ensures the hearing aid is

programmed to assist the user across the full spectrum of sounds we encounter every day. The following exemplary prior-art references confirm my understanding of a person of ordinary skill's background knowledge:

- EX1037, 1:46-2:2 (disclosing that “it is highly desirable that hearing aids be individually fitted and prescribed so that each individual case will receive the hearing aid most suitable for it,” and for doing so, the invention “provides for the use of an accurately calibrated master hearing aid” for each user), 2:65-3:12 (explaining that Figures 1-3's audiograms each show a user's hearing ability **across various frequencies**), FIGS. 1-3;
- EX1055, 1:16-41 (“The fitting process is generally carried out by a hearing professional, such as an audiologist.... Hearing aid fitting is usually based on a number of diagnostic tests...administered using standard audiometers which present pure test tones and bands of noise **at different frequencies** and different amplitudes...to the test subject.... The test subject responds to the presentation sounds by indicating whether the sound is barely audible.... The result of these diagnostic tests is often a prescription for a hearing aid having an insertion gain (IG) which specifies the desired frequency dependent gain that a hearing aid delivers to provide maximum satisfaction for the hearing aid user”);
- EX1056, at 3:60-4:7 (“The audiogram chart shows the results of a hearing threshold response or hearing acuity test performed by an audiologist The operator varies the tones generated and inquires whether the patient can detect the generated tones **at a variety of frequencies** and amplitudes. The result of this process is that ... the [hearing aid] components are usually selected from a prescription generated by the audiologist”).

312. Alternatively, at a minimum, generating the user's hearing prescription by calibrating the user's hearing “*at least across the one or more frequencies*” would have been the use of a known technique to implement Berger's explicit teachings.

As the references I cited in the prior paragraph confirm, testing a user's hearing across a plurality of audio frequencies was how hearing-aid prescriptions were conventionally obtained. The use of such a known and conventional technique for obtaining Berger's hearing-aid prescription would have been obvious to a person of ordinary skill in the art.

- l. Claim 46: "A hearing enhancement apparatus as recited in claim 13, wherein the hearing enhancement apparatus is a headset."**

313. *Supra* claim 12.

- m. Claim 47: "A hearing enhancement apparatus as recited in claim 46, wherein the speaker is an ear speaker."**

314. *Supra* claim 11.

- n. Claim 48: "A hearing enhancement apparatus as recited in claim 47, wherein the audio output signals are changed in view of a preference of the user stored in the apparatus."**

315. Berger's processor is programmed with a user's prescription and modifies the audio signal based on that prescription, *e.g.*, increasing gain where the user has lost hearing. Berger at [0019], [0021]. A person of ordinary skill in the art would know that the user's prescription reflects an individual's "*preference*" because the prescription reflects the amount of gain that the user prefers to have applied to particular audio frequencies so that those frequencies can be adequately heard by the user. In other words, the amount of amplification that is needed to make

a particular audio frequency sufficiently audible to a specific user reflects that user's preference as some users may be satisfied with lower amplification than others.

316. Separately, Berger also discloses that multiple prescriptions can be programmed into the processor and a user can select between those multiple prescriptions. Bergar at [0022]; *see also* Berger at [0027] (“A particular advantage to the smart card approach is that a single user could have different smart cards that use different transfer functions based on the environments in which they will be used. For example, the requirements for a cellular telephone in a car, a wireless telephone in a noisy cafe, or a wireless telephone in a quiet place might be quite different.”). The user's decision to select one prescription over another reflects the user's preference and therefore resulting in the audio signals that the headset outputs being based on “*a preference of the user.*”

- o. Claim 52: “A hearing enhancement apparatus as recited in claim 46, wherein the audio output signals are changed in view of a preference of the user stored in the apparatus.”**

317. *Supra* claim 48.

- p. **Claim 62:** “A hearing enhancement apparatus as recited in claim 13, wherein at least a portion of the hearing enhancement apparatus is in a head-mounted electronic device.”

318. Berger’s headset (shown below in Figure 6) contains electronic circuits like a processor and is head-mounted, making the headset “*a head-mounted electronic device*”:

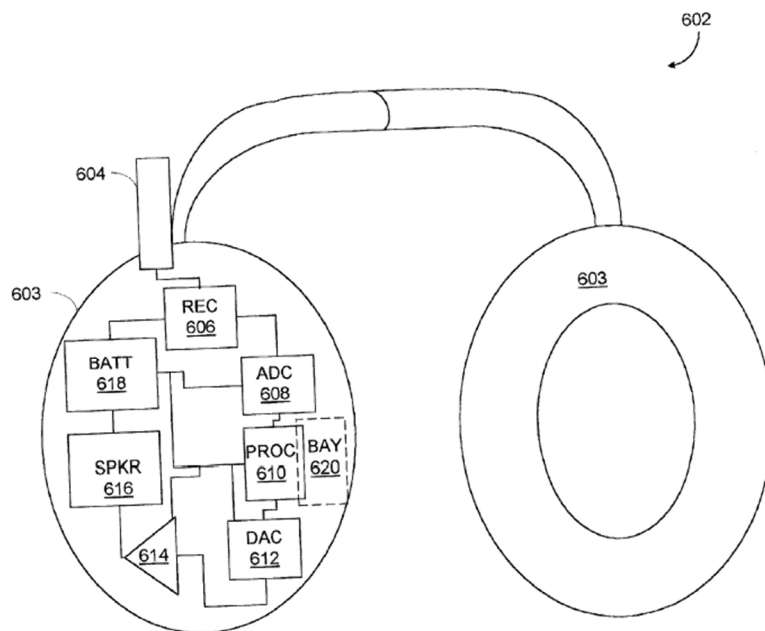


FIGURE 6

- q. **Claim 75:** “A hearing enhancement apparatus as recited in 62, wherein the apparatus is configured to wirelessly couple to a cell phone.”

319. *Supra* limitation [1A], claim 4.

- r. **Claim 76: “A hearing enhancement apparatus as recited in 62, wherein based on at least a preference of the user, the power of a first range of frequencies of the audio output signals is increased, and the power of a second range of frequencies of the audio output signals is not increased.”**

320. As I discussed above for claim 7, Berger explains that a common hearing impairment is “slope loss” wherein an individual has trouble hearing “high frequencies.” Berger at [0002]. When the prescription programmed into Berger’s processor—reflecting “*a preference of the user*”—is for an individual with “slope loss,” then “the processor boosts the high frequencies” that the user cannot hear, but does not boost low frequencies that the user can hear. Berger at [0035]; *see also* Berger at [0019] (“A user’s prescription is programmed into processor 210. Processor 210 transforms the signal by applying a transfer function with more gain in the frequency ranges where the user has lost hearing.”); claim 4 (“wherein said electrical signal is transformed to compensate for a slope hearing impairment”).

- s. **Claim 80: “A hearing enhancement apparatus as recited in 62, wherein information regarding the at least one hearing characteristic of the user is retrieved from a portable media storage device while the portable media storage device is physically and electrically connected to the apparatus.”**

321. *Supra* claim 25.

H. Ground 3B: Berger in View of Eaton Renders Claims 24, 31, 33-35, 39-41, and 77-79 Obvious.

322. The claims addressed in this section either directly or via dependency require the “*at least one hearing characteristic of the user*” recited in independent claim 13 be “*wirelessly received and stored in the hearing enhancement apparatus.*” These claims would have been obvious over Berger in view of Eaton for the reasons I discuss below.

1. Eaton

323. I discussed Eaton previously in Ground 2B. I incorporated that earlier discussion here as well.

2. The Berger-Eaton Combination

324. As I discussed in Ground 2B, Eaton discloses techniques for using mobile devices to test a patient’s hearing and wirelessly program a hearing aid based on that test. A person of ordinary skill in the art would have had reason to implement Berger’s headset such that the prescription programmed into Berger’s processor was updated wirelessly using Eaton’s technique.

325. Berger teaches that its processor is “preferably programmable, so that the programming **can be changed** if a user’s prescription changes.” Berger at [0023]. Berger also teaches that the prescriptions may be stored remotely (*e.g.*, a PBX) and selected using codes from among programmed prescriptions: “There are many ways various users can access different prescriptions. For example, each user

can be given a code whose entry will cause implementation of his own prescription. Implementation can be by PBX, in which centralized processors store prescription codes, for example allowing employees to enter codes that tailor signals to their prescription at any company telephone.” Berger at [0022]. Berger thus explicitly encourages a person of ordinary skill in the art to identify techniques for updating the prescription and/or loading prescriptions from a remote system, and Eaton’s wireless technique is one technique. Eaton also touts its technique as an improvement on the then-conventional technique for reprogramming hearing aids, which was considered “laborious and time intensive.” Eaton at 1:17-25. A person of ordinary skill in the art thus had reason to modify Berger’s system to utilize Eaton’s technique for wirelessly programming a hearing aid.

326. In the Berger-Eaton combination, a user would utilize a cellphone, to send “audio test signals” to Beger’s headset and receive an aural response from the patient to those test signals. Eaton, 11:17-24. The cellphone would then send those aural responses to Eaton’s “programming fitting server” which would process the responses to generate “audiological parameters...used to tailor an audiological therapy,” *e.g.*, to generate an update hearing prescription for the user. Eaton, 11:31-32. The updated hearing prescription would then be sent wirelessly to Berger’s headset where it would be programmed into the processor. Berger, [0019].

327. A person of ordinary skill in the art also would have had a reasonable expectation of success in implementing the above-described combination because Berger’s device is already capable of receiving data from a mobile phone and the user’s prescription would be (from the perspective of the headset) essentially the same whether it was loaded into the headset via a smart-card bay (as was the case in unmodified-Berger) or via a wireless transmission.

3. Claims 24, 31, 33-35, 39-41, and 77-79

- a. Claim 24: “A hearing enhancement apparatus as recited in claim 13, wherein, the at least one hearing characteristic of the user is wirelessly received and stored in the hearing enhancement apparatus.”**

328. As I discussed immediately above in Section VII.H.2, in the Berger-Eaton combination, an updated version of Berger’s prescription, *i.e.*, “*one hearing characteristic of the user*,” is received wirelessly from a phone and programmed into, *i.e.*, “*stored*,” Berger’s processor. Berger at [0019]; Eaton at 6:11-25; *see also* claim 13 (Ground 3A).

- b. Claim 31: “A hearing enhancement apparatus as recited in claim 30, wherein the hearing enhancement apparatus allows the user to calibrate the user’s hearing via a computing device.”**

329. As I discussed above in Section VII.H.2, in the Berger-Eaton combination, a cellphone, which is a “*computing device*” that the user operates, sends audio test signals to Berger’s headset and receives aural responses from the

user to those test signals. Eaton at 11:17-24; 5:11-16 (“such diagnostics and adjustment is initiated by a patient”), claim 6 (“deriving at least one audiological parameter by obtaining data about at least one aural response of the patient; and programming a hearing aid system based on the at least one audiological parameter by a mobile device so as to tailor an audiological therapy for the patient.”).

330. Based on the patient’s aural responses, the hearing aid is re-calibrated using an updated prescription that accounts for changes in the user’s hearing. The headset therefore “*allows the user to calibrate the user's hearing via a computing device.*”

- c. **Claim 33: “A hearing enhancement apparatus as recited in claim 30, wherein at least a portion of the at least one hearing characteristic of the user is wirelessly received by and stored in the hearing enhancement apparatus.”**

331. *Supra* claim 24; *see also* claim 30 (Ground 3A).

- d. **Claim 34: “A hearing enhancement apparatus as recited in claim 33, wherein the hearing enhancement apparatus is a headset.”**

332. *Supra* claim 33; *see also* claim 12 (Ground 3A).

- e. **Claim 35: “A hearing enhancement apparatus as recited in claim 33, wherein the hearing enhancement apparatus is a computing device that is wearable.”**

333. Berger’s headset—which is used in the Berger-Eaton combination—is a “*computing device that is wearable*.” Berger, FIG. 6 (depicting various computing electronics for the headset); *see also supra* claim 33.

- f. **Claim 39: “A hearing enhancement apparatus as recited in claim 29, wherein at least a portion of the at least one hearing characteristic is wirelessly received by and stored in the hearing enhancement apparatus.”**

334. *Supra* claim 24; *see also* claim 29 in Ground 3A.

- g. **Claim 40: “A hearing enhancement apparatus as recited in claim 39, wherein the hearing enhancement apparatus is a headset.”**

335. *Supra* claim 39; *see also* claim 12 in Ground 3A.

- h. **Claim 41: “A hearing enhancement apparatus as recited in claim 39, wherein the hearing enhancement apparatus is a computing device that is wearable.”**

336. *Supra* claims 35 and 39.

- i. **Claim 77: “A hearing enhancement apparatus as recited in 62, wherein the at least one hearing characteristic of the user is identified via measuring the user's hearing at least across a plurality of frequencies.”**

337. As I discussed above in Section VII.H.2, in the Berger-Eaton combination, the user’s hearing is measured using test signals to generate aural responses that “are formatted to form an audiogram before sending the information

the programming fitting server” (Eaton at 11:24-28) where the audiogram is used to update a user’s hearing prescription. As I discussed above in Ground 2A at paragraphs 155 to 157, audiograms were well known and a person of ordinary skill in the art would have understood that an audiogram depicts a user’s hearing profile “*across a plurality of frequencies*” and that the user’s prescription in Berger-Eaton is therefore “*identified via measuring the user's hearing at least across a plurality of frequencies.*”

j. Claim 78: “A hearing enhancement apparatus as recited in claim 77, wherein the hearing enhancement apparatus assists in measuring the user's hearing.”

338. As I discussed above in Section VII.H.2, Berger’s headset in Berger-Eaton “*assists in measuring the user’s hearing*” because it plays the audio test signals for the patient. *See also* claim 62 (Ground 3A).

k. Claim 79: “A hearing enhancement apparatus as recited in 62, wherein information regarding the at least one hearing characteristic of the user is wirelessly received and stored in the hearing enhancement apparatus.”

339. *Supra* claim 24; *see also* claim 62 (Ground 3A).

I. Ground 3C: Berger-Eaton in View of DeJaco Renders Claims 16-17, 22, 43-44, 49-50, 53-54, and 81-82 Obvious.

340. In this section, I analyze certain claims that recite adjusting audio based on “*the noise level of the environment of the apparatus.*” As described in the ’789 patent, such techniques include increasing “the gain of the system,” *i.e.*, volume, “so

as to ensure that the average power of the output audio signals is higher than the noise level by a certain degree.” EX1001, 9:14-17. As discussed below, the claims discussed in this Ground 3C would have been obvious over the Berger-Eaton combination from Ground 3B in view of DeJaco.

1. DeJaco (EX1015)

341. DeJaco discloses a cellphone that automatically increases the volume of its speaker “in response to an increase in the background noise level.” DeJaco at Abstract. DeJaco explains that when people use cellphones in noisy environments, they have difficulty hearing the calling party’s voice unless they increase the volume on the phone but that doing so manually “is inconvenient” and “may be dangerous,” *e.g.*, when driving. DeJaco at 2:14-20.

342. DeJaco discloses a processor that includes a “background noise level detection unit” and a “speaker gain look-up table.” DeJaco at 5:24-33. The detection unit determines “the background noise level from signals received from” a microphone on the cellphone, and “yield[s] a digital value representative of background noise level.” *Id.* Using the digital value and the speaker gain look-up table, DeJaco’s cellphone increases the gain of the speaker automatically. DeJaco at 7:3-24; FIG. 5.

2. The Berger-Eaton-DeJaco Combination

343. As I discussed in Ground 3A for limitation [1A] and claim 4, Berger's wireless headset is (or would have been) used with a cellphone. This would have been useful (and even legally required), for example, when a user is using the phone while driving because the user's hands would remain free for driving. EX1024, [0003] (explaining jurisdictions have enacted laws requiring "hands-free cellular devices" while driving).

344. DeJaco teaches that it can be "dangerous" for users to manually adjust the volume of a phone while driving. DeJaco at 2:14-20. DeJaco therefore gives a person of ordinary skill in the art reason—improved safety—to implement its technique for automatic-volume control in Berger's wireless headset to adjust the headset's volume automatically when, *e.g.*, driving a car.

345. In the Berger-Eaton-DeJaco combination, Berger's headset (as it is used in Berger-Eaton) would be modified to include DeJaco's "background noise level detection unit" and a "speaker gain look-up table." DeJaco at 7:3-24; FIG. 5. The headset would also include a microphone that would, among other things, capture background noise. Berger does not depict a microphone, but a person of ordinary skill in the art would have expected the headset to already include at least one microphone when the headset was used with a phone because the microphone would be needed to capture the user's voice for the telephone conversation. *See*,

e.g., EX1036 (defining “headset” as including “a microphone”); EX1058 at [0001] (explaining, as background, that headsets conventionally include “a speaker and a microphone”); EX1060 at 1:3-6 (defining “the term ‘headset’” to mean “a headphone, an earphone or any other **microphone** loudspeaker combination”). That microphone would also be capable of capturing background noise. *See, e.g.*, Enzmann at [0031] and [0033] (describing a single microphone on Enzmann’s earbud that captures audio, including “ambient noise” and “the user’s voice”).

346. Alternatively, adding a **separate** microphone to Berger’s headset that was positioned to capture background noise **specifically** would have been the use of a well-known technique (*i.e.*, the use of a microphone on a headset for background-noise detection) to improve a similar device. The existence of specific background-noise-detection microphones was well known in the art. *See, e.g.*, EX1024, [0005]-[0006] (describing prior-art headset that “employs a microphone to monitor external sound at the user’s ear”); *id.* at [0017]-[0020] (describing a “selective noise canceling headset” that “includes one or more microphones [] mounted on the earpieces [of the headset] to monitor the external sound at the user’s ear and generate a signal referred to herein as the ‘external audio signal.’”); EX1017 at Abstract (describing a headset with a microphone positioned so as to capture “ambient noise”); EX1059 at Abstract (describing a headset with two microphones, one for capturing voice audio, and one for capturing “background noise”); EX1060 at

Abstract, 11:11-14, and 17:6-11 (describing a headset with two microphones (elements 111 and 402), one for capturing the user's voice and the other for capturing environmental noise).

347. The Berger-Eaton-DeJaco headset would capture, *inter alia*, background noise with the headset's microphone(s) and adjust the volume of the headset's speaker utilizing DeJaco's detection unit and look-up table, *e.g.*, the volume would increase to overcome an increase in background noise. A person of ordinary skill in the art would have had a reasonable expectation of success in implementing the combination as the use of microphones in headsets was well known, and DeJaco's automatic-volume technique requires routine engineering skills to implement.

3. Claims 16-17, 22, 43-44, 49-50, 53-54, and 81-82

- a. Claim 16: "A hearing enhancement apparatus as recited in claim 15, wherein the down-converted signals are further modified based on the noise level of the environment of the apparatus."**

348. As I discussed immediately above in Section VII.I.2, in Berger-Eaton-DeJaco, Berger's headset utilizes DeJaco's automatic-volume technique which would change the gain of, *i.e.*, "*modif[y]*," the wireless signals transmitted by the phone to the headset, *i.e.*, "*the down-converted signals*." This modification to the signals would be "*based on the noise level of the environment of the apparatus*," *e.g.*, gain is increased when the noise level increases.

- b. **Claim 17: “A hearing enhancement apparatus as recited in claim 16, wherein the apparatus is also configured to operate as at least a part of a phone.”**

349. *Supra* claim 16; *see also* claim 4 (Ground 3A).

- c. **Claim 22: “A hearing enhancement apparatus as recited in claim 13, wherein the down-converted signals are further modified based on the noise level of the environment of the apparatus.”**

350. *Supra* claims 16-17; *see also* claim 4 (Ground 3A).

- d. **Claim 43: “A hearing enhancement apparatus as recited in claim 29, wherein the hearing enhancement apparatus is configured to alter a power level of the audio output signals based on a noise level of the environment of the apparatus.”**

351. As I discussed with claim 16, the Berger-Eaton-DeJaco headset adjusts volume, *i.e.*, “*a power level of the audio output signals*” to overcome background noise, *i.e.*, “*based on a noise level of the environment of the apparatus.*”

- e. **Claim 44: “A hearing enhancement apparatus as recited in claim 43, wherein the hearing enhancement apparatus is configured to increase the power of the audio output signals as the noise level increases, and wherein the hearing enhancement apparatus is configured not to further increase the power of the audio output signals if the noise level is beyond a certain predetermined threshold.”**

352. A person of ordinary skill in the art would have appreciated that increasing the volume of a headset’s speaker too much would become disturbing or

even harmful—this is why almost all conventional speaker systems include a maximum volume above which the speaker will not go.

353. Therefore, when implementing Berger-Eaton-DeJaco, a person of ordinary skill in the art would have naturally designed DeJaco’s “speaker gain look-up table” (DeJaco at FIG. 5) to have a maximum “gain level” for the speaker and a corresponding maximum “sound level,” *i.e.*, background noise, that would not be exceeded even if the detected background noise continued to increase above the maximum “sound level” such that the headset does “*not [] further increase the power of the audio output signals if the noise level is beyond a certain predetermined threshold.*” Indeed, DeJaco already suggests such an implementation as it sets a maximum “gain level” for its speaker. DeJaco at 4:7-11 (“FIG. 1 is a graph illustrating background noise levels and corresponding input voice levels for a cellular telephone operating in a changing noise environment; FIG. 2 is a graph illustrating the signal to noise level for the input voice and noise signals of FIG. 1”); 5:33-6:14 (discussing “maximum” noise level); FIGS. 1-2.

- f. **Claim 49: “A hearing enhancement apparatus as recited in claim 48, wherein the audio output signals are changed based on audio sound in the environment of the apparatus.”**

354. *Supra* claim 16; *see also* claim 48 (Ground 3A).

- g. Claim 50: “A hearing enhancement apparatus as recited in claim 49 further comprising a microphone at least for receiving the audio sound in the environment of the apparatus.”**

355. As I discussed above in Section VII.I.2, the Berger-Eaton-DeJaco combination adds a microphone to Berger’s headset to detect, *inter alia*, background noise in the user’s environment.

- h. Claim 53: “A hearing enhancement apparatus as recited in claim 46, wherein the audio output signals are changed based on audio sound in the environment of the apparatus.”**

356. *Supra* claim 16; *see also* claim 46 (Ground 3A).

- i. Claim 54: “A hearing enhancement apparatus as recited in claim 53 further comprising a microphone at least for receiving the audio sound in the environment of the apparatus.”**

357. *Supra* claim 50; *see also* claim 46 (Ground 3A).

- j. Claim 81: “A hearing enhancement apparatus as recited in 62, wherein the hearing enhancement apparatus is configured to alter a power level of the audio output signals so as to suppress at least a sound level associated with the environment of the apparatus so as to provide noise cancellation.”**

358. As I discussed above for claim 16, Berger-Eaton-DeJaco’s headset increases the speaker’s volume to overcome, *i.e.*, drown out, background noise. By drowning out, *i.e.*, suppressing, the background noise via increasing gain of the audio output, the headset “*is configured to alter a power level of the audio output*

signals so as to suppress at least a sound level associated with the environment of the apparatus so as to provide noise cancellation.” See also claim 62 (Ground 3A).

- k. Claim 82: “A hearing enhancement apparatus as recited in claim 81 further comprising a microphone configured to receive audio sound at the environment of the apparatus for determining the sound level associated with the environment of the apparatus.”**

359. *Supra* claims 50, 81.

J. Ground 3D: Berger-Eaton-DeJaco in View of Sauer Renders Claims 45 and 63-74.

360. At a high-level, the claims discussed in this section require that a claimed “*hearing enhancement apparatus*” include voice-control capabilities. As discussed below, adding such functionality to Berger’s headset (as used in Berger-DeJaco-Eaton) would have been obvious in view of Sauer.

1. Sauer

361. I discussed Sauer previously in Ground 2C. I incorporated that earlier discussion here as well.

2. The Berger-Eaton-DeJaco-Sauer Combination

362. For the same reasons that I discussed above in Ground 2C with respect to Enzmann in view of Sauer, a person of ordinary skill in the art would have had reason to implement the Berger-Eaton-DeJaco headset that I described in Ground 3C such that the headset used its microphone(s) not only to implement DeJaco’s automatic-volume control (and Berger’s telephone communication), but also to

provide a user with the convenient ability to control the headset's volume with a spoken command.

363. As with Ground 2C, Sauer explicitly motivates the combination by touting the benefits of voice-controls. 1:15-58; Abstract. Moreover, using Sauer's voice-control technique would have been the simple substitution of one known element for controlling a hearing aid's volume (Sauer's voice control) for another (Berger's unidentified control) to obtain predictable results, *i.e.*, a hearing aid with volume that users can adjust. That the Berger-Eaton-DeJaco headset includes a microphone for capturing the user's voice (*see* Ground 3C) highlights its compatibility with Sauer's technique. A person of ordinary skill in the art therefore had reason to modify the Berger-Eaton-DeJaco headset to utilize Sauer's technique for voice-controlled functionality, and a reasonable expectation of success in doing so as implementing Sauer's technique in the Berger-Eaton-DeJaco headset earbud would have required mere routine engineering, *e.g.*, adding Sauer's voice decoder and code words to the headset.

364. In an obvious implementation of Berger-Eaton-DeJaco-Sauer, the Berger-Eaton-DeJaco headset would be modified to include Sauer's voice decoder which would identify certain code words such as "softer" or "louder," the utterance of which would cause the headset to reduce or increase the headset's volume.

3. Claims 45 and 63-74

- a. **Claim 45: “A hearing enhancement apparatus as recited in claim 29, wherein the apparatus includes a volume control that is configured to respond to a voice command of the user.”**

365. As I discussed immediately above in Section VII.J.2, the Berger-Eaton-DeJaco-Sauer combination “*includes a volume control that is configured to respond to a voice command of the user.*”

- b. **Claim 63: “A hearing enhancement apparatus as recited in 62, wherein the apparatus comprises a volume control that is configured to respond to a voice command.”**

366. *Supra* claim 45; *see also* claim 62 (Ground 3A).

- c. **Claim 64: “A hearing enhancement apparatus as recited in 62, wherein the apparatus is configured to recognize at least a voice command from the user and operate according to the voice command.”**

367. *Supra* claim 45; *see also* claim 62 (Ground 3A).

- d. **Claim 65: “A hearing enhancement apparatus as recited in claim 64, wherein the at least one hearing characteristic of the user is identified via measuring the user's hearing at least across a plurality of frequencies.”**

368. *Supra* claim 64; *see also* claim 77 (Ground 3B).

- e. **Claim 66: “A hearing enhancement apparatus as recited in claim 65, wherein the hearing enhancement apparatus is configured to alter a power level of the audio output signals so as to suppress at least a sound level associated with the environment of the apparatus so as to provide noise cancellation.”**

369. As I discussed above for claim 16 in Ground 3C, Berger-Eaton-DeJaco’s headset increases the speaker’s volume to overcome, *i.e.*, drown out, background noise. The headset would do the same in the Berger-Eaton-DeJaco-Sauer combination. By drowning out, *i.e.*, suppressing, the background noise via increasing gain of the audio output, the headset “*is configured to alter a power level of the audio output signals so as to suppress at least a sound level associated with the environment of the apparatus so as to provide noise cancellation.*”

- f. **Claim 67: “A hearing enhancement apparatus as recited in claim 66 further comprising a microphone configured to receive audio sound at the environment of the apparatus for determining the sound level associated with the environment of the apparatus.”**

370. *Supra* claim 66; *see also* claim 50 (Ground 3C).

- g. **Claim 68: “A hearing enhancement apparatus as recited in claim 67, wherein the apparatus is configured to wirelessly couple to a cell phone.”**

371. The Berger-Eaton-DeJaco-Sauer headset “*is configured to wirelessly couple to a cell phone*” for the reasons I discussed above in Ground 3A for limitations [1A] and claim 4.

- h. **Claim 69: “A hearing enhancement apparatus as recited in claim 68, wherein based on at least a preference of the user, the power of a first range of frequencies of the audio output signals is increased, and the power of a second range of frequencies of the audio output signals is not increased.”**

372. *Supra* claim 67; *see also* claim 76 (Ground 3A).

- i. **Claim 70: “A hearing enhancement apparatus as recited in claim 64, wherein the hearing enhancement apparatus is configured to alter a power level of the audio output signals so as to suppress at least a sound level associated with the environment of the apparatus so as to provide noise cancellation.”**

373. *Supra* claims 64, 66.

- j. **Claim 71: “A hearing enhancement apparatus as recited in claim 70 further comprising a microphone configured to receive audio sound at the environment of the apparatus for determining the sound level associated with the environment of the apparatus.”**

374. *Supra* claim 71; *see also* claim 50 (Ground 3C).

- k. **Claim 72: “A hearing enhancement apparatus as recited in claim 71, wherein the apparatus is configured to wirelessly couple to a cell phone.”**

375. *Supra* claims 68, 71.

- l. **Claim 73: “A hearing enhancement apparatus as recited in claim 72, wherein based on at least a preference of the user, the power of a first range of frequencies of the audio output signals is increased, and the power of a second range of frequencies of the audio output signals is not increased.”**

376. *Supra* claim 72; *see also* claim 76 (Ground 3A).

- m. **Claim 74: “A hearing enhancement apparatus as recited in claim 73, wherein the at least one hearing characteristic of the user is identified via measuring the user's hearing at least across a plurality of frequencies.”**

377. *Supra* claim 73; *see also* claim 77 (Ground 3B).

K. Ground 3E: Berger in view of Willis Renders Claims 10 and 26 Obvious.

378. In this section, I address claims 10 and 26 which, respectively, limit the “*speaker*” of independent claims 1 and 13 to a “*directional speaker*.” Implementing Berger’s headset such that its speaker is “*directional*” would have been obvious in view of Willis for the reasons discussed below.

1. Willis (EX1016)

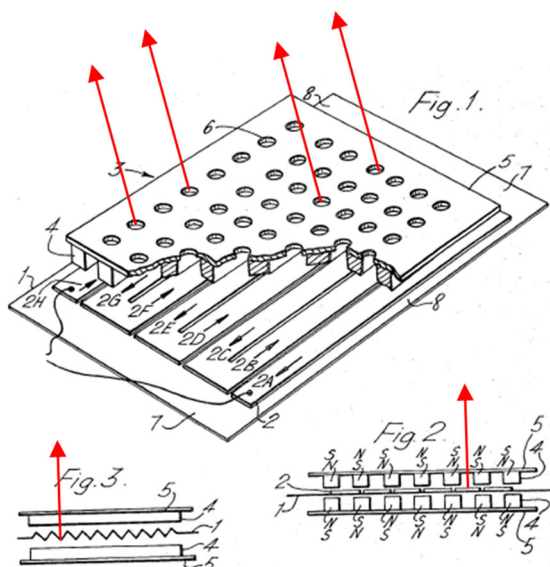
379. Willis discloses an audio-transducer, *i.e.*, speaker, that uses magnets to vibrate a diaphragm back-and-forth so that audio is output by the transducer in a particular direction. Willis at 3:17-23 (“The pattern of polarity of the magnets 4 is so arranged that the leakage flux between adjacent pairs of poles is in conformity with the direction of the current flow in the associated conductor portions 2A-2H and orthogonal thereto so that the net effect is for the whole diaphragm 1 to be uniformly attracted and repelled by the magnet unit or units 4.”), 3:44-47 (“It is well known that the higher frequencies from a physically large sound source tend to become beamed, so that small diameter tweeters are used to increase the spread.”); 4:16-20 (“Each earphone consists of a front portion F and a back portion B each of

which contains a **directional transducer** which **beams sound towards the adjacent ear 53L, 53R** from which it is separated by an air gap 54.”).

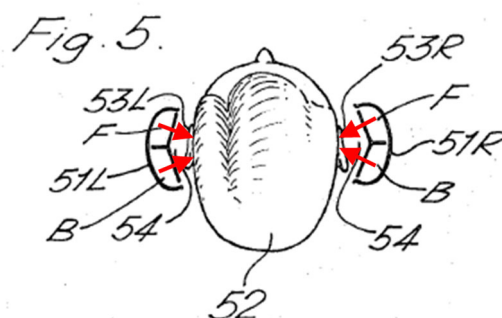
380. A person of ordinary skill would have understood that Willis’s transducer is designed to output audio signals in a directional manner, *i.e.*, to operate as a directional speaker. The transducer operates by inducing oscillations in a diaphragm 1 through the interaction of alternating current in conductor portions (2A–2H in Fig. 1) and magnetic flux from adjacent magnets 4. More specifically, the “pattern of polarity of the magnets 4” causes the diaphragm to be “uniformly attracted and repelled by the magnet unit or units 4” (Willis at 3:17–23). A person of ordinary skill in the art would have understood that this causes the diaphragm to oscillate back-and-forth along the axis perpendicular to the diaphragm’s plane (*i.e.*, up and down in Fig. 3), which is also the direction of the audio signals generated from such oscillation (annotated as red arrows in Figs. 1-3 below), thereby projecting the audio signals towards a particular direction, e.g., “towards the adjacent ear” (Willis at 4:16-20), as I annotated with red arrows in Fig. 5.

381. Below, I have added four arrows indicating the directions of audio signal beams in Fig. 5, because Willis discloses four “directional transducer[s]” in its Figure 5 earphone embodiment—one in each of “a front portion F and a back portion B” of the left/right earphone—each “directional transducer [] beams sound towards the adjacent ear 53L, 53R.” Willis at 4:16-20. Willis also states that high-

frequency signals from large sources “tend to become beamed” (Willis at 3:44–47), which a person of ordinary skill in the art would have understood as high directionality of audio signal propagation. Thus, Willis’s transducer outputs audio directionally by design.



Willis, Figs. 1-3 (annotated)



Willis, Fig. 5 (annotated)

382. Willis teaches that with its transducer, “satisfactory bass response is maintained with an air gap between the head and the transducer,” which advantageously “permit[s] the subject to hear external sounds such as door bells” and allows “for quadra-sonic reproduction.” Willis at 4:5-12; FIG. 5 (depicting headphones with an “air gap 54” between the speaker and the user's ear).

2. The Berger-Willis Combination

383. Willis discloses an alternative design for Berger’s headset, and Willis explicitly motivates POSAs to utilize its design to permit a user to hear external

sounds while also achieving quadra-sonic, *i.e.*, immersive, sound. Willis at 4:5-12. A person of ordinary skill in the art thus had reason to implement Berger's headset using Willis's directional-speaker and air-gap design, and the person of ordinary skill would have had a reasonable expectation of success in making the combination as it requires only routine mechanical design changes to Berger's headset and the use of a directional speaker, the use of which Willis confirms was well known.

384. In the Berger-Willis combination, Berger's headset would retain the functionality it has in Berger but would be implemented using Willis' design, including its use of a directional speaker.

3. Claims 10 and 26: "...wherein the speaker is a directional speaker."

385. In the Berger-Willis combination, Berger's headset would have been implemented to include a "*directional speaker*" so as to improve audio quality and/or permit a user to hear environmental noises thereby rendering claims 10 and 26 obvious. *See also* claims 1 and 13 (Ground 3A).

L. Ground 3F: Berger-Eaton-DeJaco in view of Miles Renders Claim 51 Obvious.

386. In this section, I address claim 51 which limits the "*microphone...for receiving the audio sound in the environment of the apparatus*"—recited in claim

50⁴—to “*a directional microphone.*” Implementing the Berger-Eaton-DeJaco (discussed in Ground 3C) headset such that its microphone is “*directional*” would have been obvious in view of Miles for the reasons discussed below.

1. Miles (EX1017)

387. Miles discloses a headphone with a directional microphone that is positioned on the top of the headphone so as to isolate the microphone from the user’s mouth and the headphone’s speakers. Miles at Abstract (“The system includes a directional microphone mounted on a headset/helmet, isolated from both voice and earphone output The microphone picks up the ambient noise”), 1:53-57 (similar), 2:16-18 (similar). The microphone is used to pick up ambient noise. Miles at 1:57-59.

2. The Berger-Eaton-DeJaco-Miles Combination

388. Miles would have motivated a person of ordinary skill in the art to implement the Berger-Eaton-DeJaco headset such that the microphone used to capture and measure the noise level in the user’s environment was a directional microphone positioned on the top of the headphone. Such a design would have ensured that the microphone better captured background noise by reducing the

⁴ Discussed in Ground 3C.

likelihood that the microphone captured the user's voice or sound from the headphone's speakers.

3. Claim 51: "A hearing enhancement apparatus as recited in claim 50, wherein the microphone is a directional microphone."

389. In the Berger-Eaton-DeJaco-Miles combination, Berger's headset as used in the Berger-Eaton-DeJaco combination of Ground 3C would have been implemented to include a "*directional microphone*" so as to improve DeJaco's automatic-volume-control functionality thereby rendering claim 51 obvious.

VIII. CONCLUSION

390. I declare that all statements made herein of my own knowledge are true, that all statements made on information and belief are believed to be true, and 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.

391. I declare under penalty of perjury that the foregoing is true and correct.

Dated: August 28, 2025

By: /s/ David V. Anderson
David V. Anderson, Ph.D.