

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

K/S HIMPP
Petitioner

v.

BRAGI GmbH
Patent Owner

Case IPR2023-01150

**DECLARATION OF SAYFE KIAEI, PH.D.
U.S. PATENT NO. 9,843,853
CHALLENGING CLAIMS 1-21**

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I, Sayfe Kiaei, declare as follows:

I. INTRODUCTION

1. My name is Dr. Sayfe Kiaei. I am a professor at Arizona State University. I have been retained as an expert in this proceeding by counsel for K/S HIMPP. I have been asked for my expert conclusions regarding the validity of claims 1-21 of U.S. Patent No. 9,843,853 (the “’853 Patent”) (Ex. 1001-USP853). For the reasons set forth below, it is my conclusion that claims 1-21 of the ’853 patent are invalid.

II. QUALIFICATIONS AND PROFESSIONAL EXPERIENCE

2. My qualifications are stated more fully in my curriculum vitae, which is attached as Exhibit A. Below is a summary of my education, work experience, and other qualifications.

3. I earned a Ph.D. in 1987 from Washington State University in Electrical, Computer, and Energy Engineering. From 1985 through 1987, while working toward my Ph.D., I worked with Boeing on the development of signal processing and control systems.

4. From 1987 through 1993, I was a tenured Professor at Oregon State University in the Electrical and Computer Engineering Department.

5. From 1993 to 2002, I was a Senior Member of Technical Staff with the Wireless Technology Center and Broadband Operations at Motorola Inc., where I

was responsible for the development of wireless system, cellular system, RF integrated circuits, GPS, and Digital Subscriber Lines (DSL) transceivers.

6. Since 2001 I have held the position of Motorola Endowed Chair Professor in Analog and Radio Frequency Integrated Circuitry at the School of Electrical, Computer, and Energy Engineering at Arizona State University in Tempe, Arizona. I am also the Director of the National Science Foundation Center, Connection One. Connection One is an industry/university cooperative research center with over thirty industrial members and five university members focused on developing communication systems, sensors, electronics, bio-electronics, and networking technologies.

7. At Arizona State University, I have developed and taught courses on Wireless and RF Transceivers, Electronics, VLSI, Analog IC design, RFIC, communications, and related areas. In my over thirty years of academic experience, I have taught university courses and done research in electronics, RF and wireless system, bio-electronics, networking, communication systems, and sensors.

8. I have graduated over 100 M.S. and Ph.D. students working under my supervision on their thesis, and many of them are professors in academia, or have senior positions in the industry. Currently, I have 8 M.S., Ph.D., and postdoc students working with me in my lab on research related to communication and networking systems, wireless systems, RF, and integrated circuits. My research is funded by

various sources, including industry, federal agencies including NSF, DARPA, ONR, DOE, and other, with an average total research funding of \$1M per year.

9. I have published over two hundred journal and conference papers covering topics such as wireless systems, power management, low-power electronics, sensors, radio frequency, integrated circuits (IC), filter design, and related areas. A list of my publications can be found in my CV, attached as Exhibit A. I also have over 10 patents and patent applications in electronics, RF, and low-power bio-electronics.

10. I am an IEEE Fellow, a distinction and the highest level of IEEE membership awarded by the IEEE directors to recognize a high level of demonstrated extraordinary accomplishments. The IEEE is the Institute of Electrical and Electronics Engineers, the world's largest association of technical professionals whose objectives include the educational and technical advancement of electrical and electronic engineering, telecommunications, computer engineering, and related disciplines. I am a member of the IEEE Circuits and Systems Society, IEEE Solid State Circuits Society, and IEEE Communication Society, IEEE RF and Microwave committees, IEEE International Symposium on Low Power Electronics and Design (ISLPED), IEEE Signal Processing Society, IEEE Fellow Selection Committee, and many other International Electrical Engineering societies. I was one of the key organizers to establish the IEEE Radio Frequency Integrated Circuits (RFIC)

symposium in 1995, and IEEE International Symposium on Low Power Electronics and Design (ISLPED) in 1997. I have been on the executive committee, and technical committee of RFIC and ISLPED for the last 16 years. The RFIC and ISLPED Symposia have grown and is now the premier international symposium in the world where the latest RF, low-power electronics, wireless, and bio-electronic circuits and components are presented.

11. I have received several awards including the Carter Best Teacher Award, the IEEE Darlington Award (which is given for the best technical paper on circuits and systems in the IEEE Circuits and Systems Society), and the Motorola 10X Rapid Design Cycle Reduction Award.

12. I have been one of the key organizers of the IEEE International Symposium on Low Power Electronics and Design (ISLPED) since 1997. I have published papers and organized sessions on techniques for low-power cellular phones at ISLPED. I have published a number of papers on the design and development of low-power RF, wireless transceivers, sensors, and low-power bio-electronics.

13. I have also been a consultant on various projects with Intel (designing 2G, 3G mobile telephone transceivers, Internet-of-Things (IOT), and sensors), Texas Instrument (developing 3G cellular and Bluetooth technologies), Sony Wireless (developing GPS technologies), Tektronics (designing wireless systems), and

various other consultancies. During my work in industry, I have designed and contributed to the design of many wireless systems for commercial products. Many of my designs are still in use today in products manufactured by the companies I have worked for, including Motorola, Intel, Sony, and more.

14. I am being compensated for my time at my ordinary hourly rate of \$475. My compensation is not dependent on the outcome of these proceedings or the content of my opinions. To the best of my knowledge, I have no financial interest in either party or in the outcome of this proceeding.

III. MATERIALS CONSIDERED

15. In preparing this declaration, I have reviewed the claims, specification, and file history of the '853 patent. I understand that the '853 patent issued on December 12, 2017, from U.S. Application No. 15/245,031, filed on August 23, 2016. The '853 patent states that it claims priority to U.S. Provisional Application No. 62/211,767, filed on August 29, 2015 (although I note that the provisional application number and the filing year are erroneously identified in the first paragraph of the '853 patent).

16. I have also reviewed and understand the references and exhibits cited in this Declaration, including the following:

Exhibit	Description
1001	U.S. Patent No. 9,843,853 (“’853 patent”)

Exhibit	Description
1003	U.S. Patent Application Publication No. 2015/0245126 (“Shaffer”)
1004	Certified English translation of DE Patent Application No. 102007039455 (“Hain”)
1005	U.S. Patent No. 8,265,315 (“Sorensen”)
1006	Certified English translation of EP Patent Application No. 1727395 (“Steinbrecher”)
1007	GB Patent Application No. 1254017 (“Brown”)
1008	File History for U.S. Patent No. 9,843,853 (“853 FH”)
1009	DE Patent Application No. 102007039455 (original German version of Hain)
1010	Affidavit of James Doing (Certificate of Translation for Hain)
1011	EP Patent Application No. 1727395 (original German version of Steinbrecher)
1012	Affidavit of James Doing (Certificate of Translation for Steinbrecher)
1013	U.S. Patent Application Publication No. 2013/0007484
1014	Colburn, “The Resilience of the Reed Relay,” IEEE Spectrum (August 28, 2015) [https://spectrum.ieee.org/the-resilience-of-the-reed-relay]
1015	U.S. Patent No. 2,264,746
1016	Hamlin Application Note AN104: Reed Switch and Reed Sensor Activation (2008) [https://www.sparkfun.com/datasheets/Components/Buttons/AN104.pdf]

IV. LEGAL PRINCIPLES

17. I am not an attorney. For the purposes of this declaration, I have been informed by HIMPP’s counsel about certain aspects of the law that are relevant to

my analysis, as stated in the following paragraphs. I have applied these legal principles in arriving at my conclusions expressed in this declaration.

18. I have been informed and understand that a patent claim is invalid if it would have been obvious to a person of ordinary skill in the art (“POSITA”) at the time of the alleged invention recited in the claims. This means that, even if all of the requirements of a claim are not found in a single prior art reference, the claim is not patentable if the differences between the subject matter in the prior art and the subject matter in the claim would have been obvious to a POSITA at the time of the alleged invention.

19. I have been informed and understand that a determination of whether a claim would have been obvious should be based upon several factors, including, among others: (1) the level of ordinary skill in the art at the time of the alleged invention; (2) the scope and content of the prior art; (3) the differences, if any, that existed between the claimed invention and the prior art; and (4) any objective considerations of nonobviousness.

20. I have been informed and understand that when determining any differences between the invention covered by the patent claims and the prior art, one should not look at the individual differences between the patent claims and the prior art in isolation, but rather consider the claimed invention as a whole and determine whether or not it would have been obvious in light of all of the prior art.

21. I have been informed and understand that a single reference can render a patent claim obvious if any differences between that reference and the claims would have been obvious to a POSITA. Alternatively, the teachings of two or more references may be combined in the same way as disclosed in the claims. I have been informed and understand that when deciding whether to combine the various items described in the prior art, the relevant question is whether the prior art combination would have been obvious to a POSITA at the time of the invention. I have been further informed that it can be important to identify a teaching, suggestion, or motivation, in either the prior art or the knowledge of persons skilled in the art, that would have prompted a person of ordinary skill in the relevant field to combine the elements in the prior art in the way the claimed invention does.

22. In determining whether a combination based on either a single reference or multiple references would have been obvious, it is appropriate to consider, among other factors:

- whether the teachings of the prior art references disclose known concepts combined in familiar ways, and when combined, would yield predictable results;
- whether a POSITA would implement a predictable variation, and would see the benefit of doing so;

- whether the claimed elements represent one of a limited number of known design choices, and would have a reasonable expectation of success by a POSITA;
- whether a POSITA would have recognized a reason to combine known elements in the manner described in the claim;
- whether there is some teaching or suggestion in the prior art to make the modification or combination of elements claimed in the patent; and
- whether the innovation applies a known technique that had been used to improve a similar device or method in a similar way.

23. I have been informed and understand that one of ordinary skill in the art has ordinary creativity, and is not an automaton. I have been informed and understand that in considering obviousness, it is important not to determine obviousness using the benefit of hindsight derived from the patent being considered. I have been informed and understand that a patent composed of several elements is not proved obvious merely by demonstrating that each of its elements was independently known in the prior art.

24. I have been informed and understand that to show a motivation to combine, one is not required to show how the references would be physically combined to render a claim obvious. The analysis is not focused on whether the features of one reference can be physically incorporated into the structure of another

reference, but rather whether a person of ordinary skill in the art would have been motivated to combine the teachings of the references to achieve the claimed invention. For example, a person of ordinary skill in the art would understand how predictable variations of known concepts could be combined and would recognize that where multiple tools were available in a “toolbox” of a POSITA, any tool could be chosen.

V. LEVEL OF ORDINARY SKILL IN THE ART

25. I have considered the '853 patent from the perspective of a POSITA at the time of the alleged invention. A person of ordinary skill in the art for the '853 patent would have had at least the equivalent of a bachelor's degree in electrical engineering and one to two years of experience in the field of wireless electronic devices and battery systems, particularly as those systems relate to wireless earpieces such as wireless headphones and hearing aids. This level of skill in the art is appropriate because many concepts of wireless electronic devices (such as wireless earpieces) and battery systems were well known and widely taught in undergraduate courses. Moreover, an additional two years of experience in the industry would give one of ordinary skill in the art experience with how such systems are implemented in the real world. Before August 29, 2015, which is the claimed priority date of the '853 patent, I would have qualified at least as a POSITA under this standard.

VI. OVERVIEW OF THE RELEVANT TECHNOLOGY AND THE '853 PATENT

A. Reed Switch

26. As I will explain in further detail below, one feature described in the '853 patent is the use of a “reed switch” within a wireless earpiece. *See* Ex-1001-USP853, 2:52-57 (“In one embodiment, a reed switch may be utilized in the wireless earpieces to activate and deactivate each of the wireless earpieces”). Accordingly, I briefly describe the well-known principle of operation of a reed switch here.

27. A reed switch is “an electrical switch operated by an applied magnetic field.” Ex-1001-USP853, 2:54-55. In particular, a reed switch turns on and off using the electromechanical mechanism illustrated below.

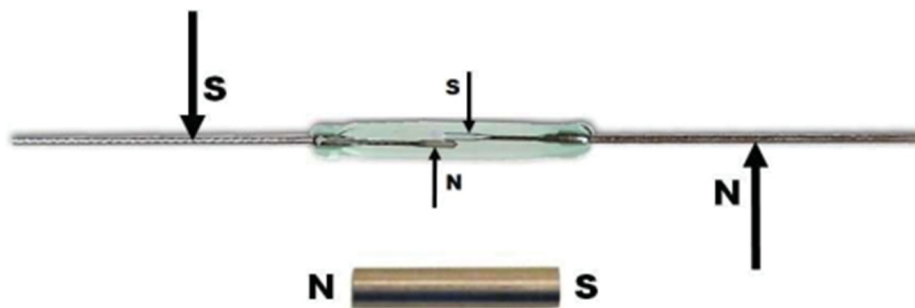


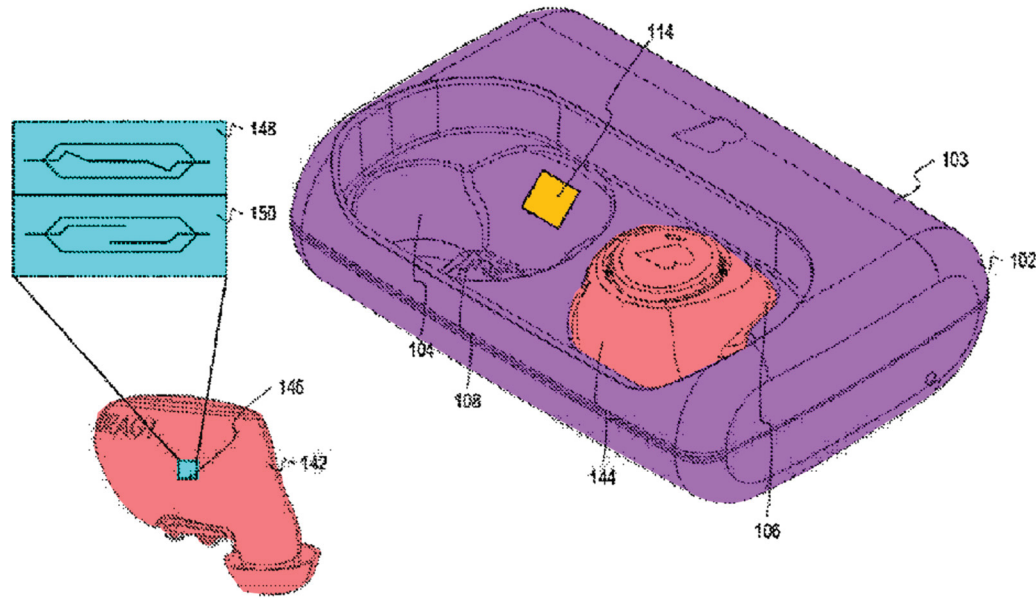
Figure 1 – Magnetic Induction

Ex-1016, 1-2 (“One way of thinking about the interaction is that the magnet induces magnetic poles into the metal parts of the reed switch and the resulting attraction between the electrical contacts causes the reed switch to activate”).

28. Reed switches were well-known long before the claimed priority date of the '835 patent. In fact, the reed switch (which is also called a reed contact or a reed relay) was invented in the 1920s, almost a century before the claimed priority date, and was in widespread use by the 1960s. *See* Ex-1014, 2-3; Ex-1015, claim 1. The particular use of a reed switch within a wireless earpiece, as described in the '853 patent, was also well-known, having been disclosed in printed publications as early as the 1970s. Ex-1007-Brown, 2:1-21 (“The hearing aid 10 includes ... a magnetically actuated reed relay switch 24”).

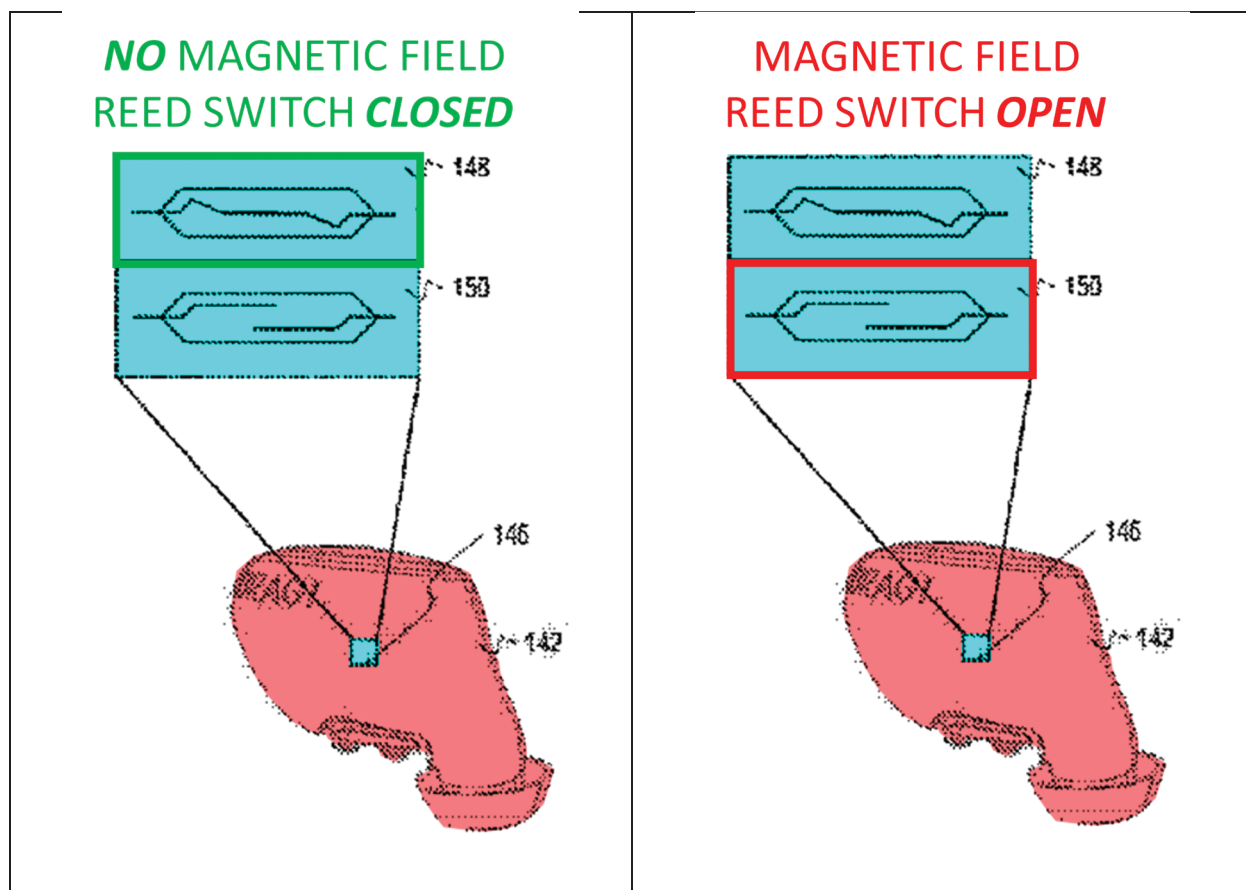
B. The Alleged Invention

29. The '853 patent describes a wireless earpiece system, and in particular describes techniques that purport to extend battery life when wireless earpieces are placed in a “smart” storage case. Ex-1001-USP853, 1:15-17 (“the present invention relates to wireless earpieces that manage and extend battery life”), 2:35-42 (“The illustrative embodiments provide a system, method, and wireless earpieces for managing and preserving battery life. The wireless earpieces may interact with a smart case to perform various actions. For example, the smart case may be utilized to preserve the battery life of the wireless earpieces by interacting with the wireless earpieces while in a low power mode or state.”). Figure 1 of the '853 patent is reproduced below.



Id., Figure 1. Figure 1 shows that wireless earpieces 142, 144 (red) can each incorporate a reed switch 146 (blue) that is used to detect a magnetic field applied by a magnet (orange) of the storage case (purple). *Id.*, 2:52-57 (“In one embodiment, a reed switch may be utilized in the wireless earpieces to activate and deactivate each of the wireless earpieces. The reed switch is an electrical switch operated by an applied magnetic field. The magnetic field may be provided by a magnet of the smart case thereby turning the wireless earpieces on and off.”), 5:31-37.

30. The operation of the reed switches within the earpieces is described in further detail below, with reference to the insets 148 and 150 in Figure 1.



Ex-1001-USP853, Figure 1. The left panel shows that the reed switch 146 (blue) is closed when a magnetic field is not applied to the earpieces, such as when the earpieces are in use. The reed switch 146 then opens when a magnetic field is applied to the earpieces, such as when the earpieces are placed into a storage case equipped with a permanent magnet, as shown in the right panel. *Id.*, 5:31-37 (“The wireless earpieces 142, 144 may each include a reed switch 146. The reed switch 146 may operate in a closed mode 148 when no magnetic field is present or in an open mode 150 when a magnetic field is present. The magnetic field may be supplied by one or more magnets of the smart case, such as magnet 114. As a result, the reed

switch 146 may be in the closed mode 148 when outside the smart case 102 and in the open mode 150 when in the smart case 102.”), Figure 5, 8:32-52.

31. In this manner, based on changes in the state of the reed switch 146, the earpieces can detect whether they are in use or have been placed into their storage case. In response, the earpieces can reduce their power consumption (e.g., by turning off or entering a low power mode) when placed into the storage case. Ex-1001-USP853, 4:27-33 (“In one embodiment, the interfaces 108, 110 may each include a magnet that activates the corresponding reed switch (i.e., reed switch 146 described below) to power off or initiate a low power mode (e.g., lower power state or mode) for one or both of the wireless earpieces 142, 144 when one or more of the wireless earpieces 142, 144 are placed within the receptacles 104, 106 [of the storage case].”), 8:53-9:14 (“If the magnetic field is not present, the wireless earpiece remains powered on as the reed switch remains closed (step 504).... [T]he wireless earpiece operates normally with the onboard battery powering the circuitry and components of the wireless earpiece.... If the magnetic field is determined to be present in step 502, the reed switch is opened by the magnetic field (step 508).... [T]he wireless earpiece may move to a low power mode in order to preserve battery life when in the reed switch is activated potentially indicating that the wireless earpiece is within the smart case.”), Figure 5.

32. In certain embodiments, the '853 patent refers to the earpiece storage case as a “smart” case that is equipped with logic circuitry to facilitate battery charging and other functionality of the wireless earpieces. Ex-1001-USP853, 2:37-51 (“The wireless earpieces may interact with a smart case to perform various actions. For example, the smart case may be utilized to preserve the battery life of the wireless earpieces by interacting with the wireless earpieces while in a low power mode or state. In addition, the smart cases may ensure that the wireless earpieces are charged to a desired level. Charging may be performed utilizing contact or wirelessly (e.g., inductive charging). The smart case may communicate with the wireless earpieces through physical interactions (e.g., magnetic contact points, physical switches, etc.) or through wireless connections, standards, or protocols (e.g., near field communications, Bluetooth, Wi-Fi, etc.). The wireless earpieces may upload, synchronize, or store biometric and performance data associated with the wireless earpieces and/or associated user to the smart case.”), 3:21-24, 3:28-43, 4:47-53, 5:9-25, 6:45-7:4, 7:39-54, 9:60-10:9, Figure 4.

C. Examination Of The '853 Patent At The U.S. Patent Office

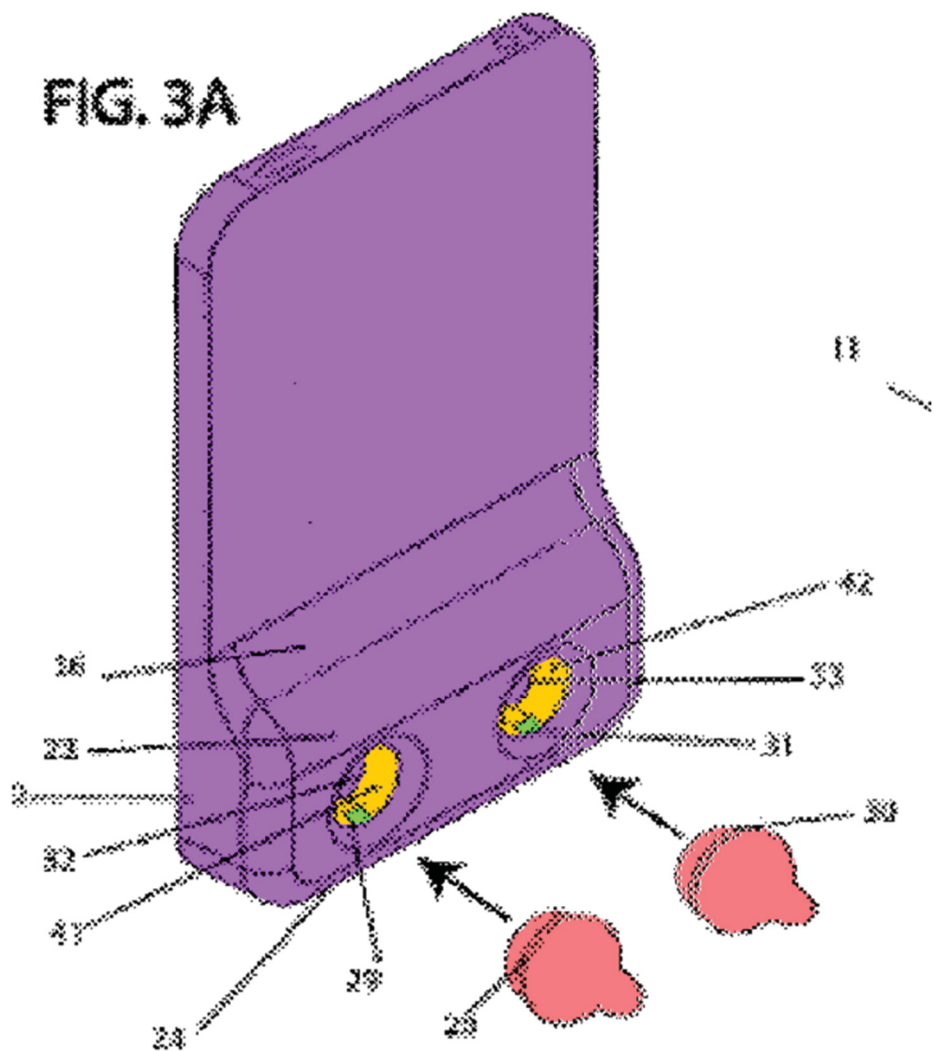
33. As stated on its cover page, the '853 patent was filed August 23, 2016, as U.S. Patent Application No. 15/245,031 and claims priority to U.S. Provisional Application No. 62/211,767 filed August 29, 2015.

34. The examiner allowed the '853 patent without issuing any rejections during examination. Namely, on May 2, 2017, the examiner issued a first office action notice of allowance, finding all of the claims as written allowable. Ex-1008-FH [PDF173] (5/2/2017 Notice of Allowance at 2). The applicant then filed a Request for Continued Examination (RCE), amending the claims to add Claim 21 and stating that Claim 21 was “similar to” allowed Claim 17 and identifying various minor changes in the claim language. *Id.* [PDF215] (8/2/2017 RCE Amendment at 7). The examiner again issued a notice of allowance that included Claim 21, stating that “the prior art on record does not teach the power related mode of operation (i.e., high power and low power modes) as required in independent claim 1.” *Id.* [PDF233] (8/16/2017 Notice of Allowance at 3). The examiner further stated that “[s]imilar reasoning applies to independent claims 10 and 21 for connecting and disconnecting from a battery when a magnetic field is detected.”

VII. OVERVIEW OF THE PRIOR ART

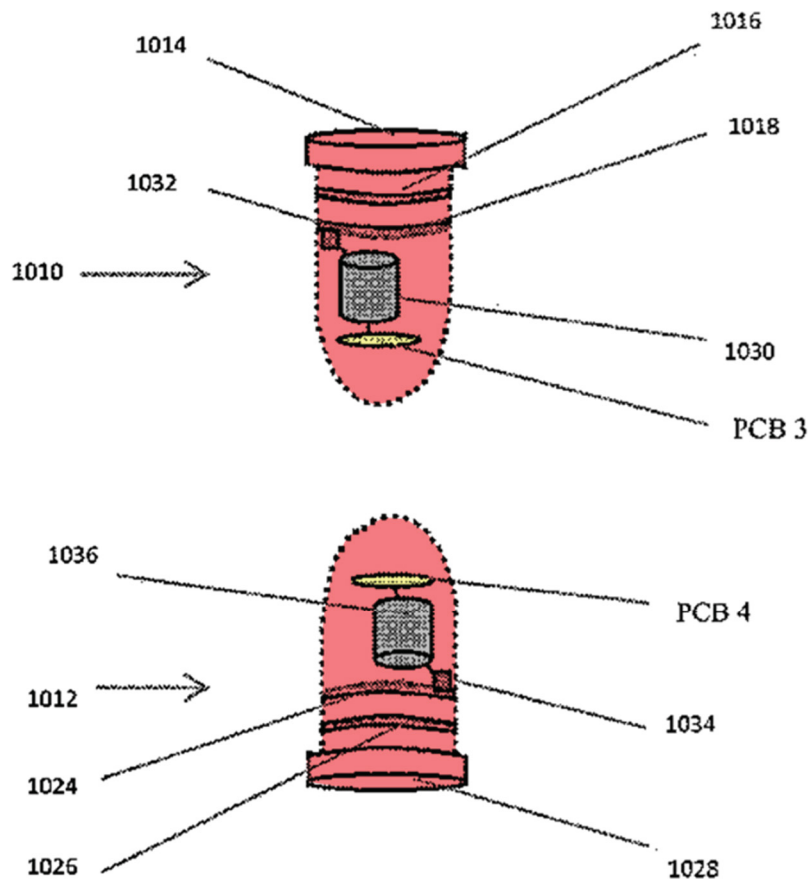
A. Shaffer

35. Shaffer discloses the same types of techniques as those described in the '853 patent, e.g., techniques for reducing the battery consumption of wireless earpieces when they are placed in a storage case. Figure 3A of Shaffer is reproduced below.



Ex-1003-Shaffer, Figure 3A. Figure 3A depicts a system that includes left and right wireless earpieces (referred to as wireless audio earbuds, red) and a storage case with a magnetic charging dock (referred to as a mobile device case 11, purple). *Id.*, ¶ 34 (“FIGS. 1-5 illustrate an embodiment of a mobile device case 11, which embeds a magnetic charging dock for two wireless audio earbuds in the rear of base portion 12”).

36. The internal circuitry of the wireless audio earbuds is depicted in Figure 10 of Shaffer, reproduced below.



Ex-1003-Shaffer, Figure 10. The wireless earbuds 1010 and 1012 (red) shown in Figure 10 are configured to automatically turn off when placed into the storage case. *Id.*, ¶ 62 (“FIG. 10 illustrates an embodiment in which the earbuds are equipped with features that enable them to automatically trigger on and off”). In one embodiment, Shaffer discloses that earbuds 1010 and 1012 detect when they are placed in the storage case using magnetic sensors, such that they automatically turn off or enter a

low power mode when the magnetic sensor indicates that they are in the storage case. *Id.*, ¶ 63 (“Each earbud may include one or more contact sensors, such as pressure sensors or magnetic sensors that detect when the earbud is in (or out of) the aperture [of the storage case] and which send a corresponding signal to the earbud PCBs. Firmware embedded within the earbud PCBs could cause a circuit that includes the rechargeable earbud batteries 930 and 934 [sic] to switch on or off, or return them to a low-energy consumption idle mode.”).

B. Hain, Brown, and Steinbrecher

37. As I will explain in further detail in my analysis of the Grounds, Hain, Brown, and Steinbrecher each disclose systems similar to the ’853 patent and the above-described system of Shaffer. Namely, each of these references discloses techniques for using a magnetic sensor to automatically reduce the battery consumption of wireless earpieces when placed in a storage case.

38. Hain, Brown, and Steinbrecher each further expressly disclose that the wireless earpieces use a reed switch to determine when the earpieces are placed in the storage case by detecting the presence or absence of a magnetic field. *See, e.g.*, Ex-1004-Hain, ¶ 18 (“[T]he status of reed contacts 6 and 16 can be queried.... From this, the corresponding hearing aid detects in a simple manner whether it is in the immediate vicinity of a magnet”), ¶ 22 (“If it is detected that both hearing aids are in a magnetic field at the same time, this is an indication that the hearing aids are

located in a storage box equipped with at least one permanent magnet. The hearing aids are then switched to a switch-off mode in which the hearing aids are largely switched off and only a residual power supply for the sensor device is maintained.”); Ex-1006-Steinbrecher, ¶ 19 (“A microswitch is preferably arranged in the hearing aid, which then controls an input of the charge controller when the hearing aid is placed in a storage case”), ¶ 20 (“In a particularly preferred embodiment, the microswitch is designed as a reed contact, which is actuated by a permanent magnet arranged in the storage case”); Ex-1007-Brown, 1:19-27 (“According to the invention there is provided a hearing aid comprising ... a switch controlling the flow of current from the [battery] cell to the amplifier [circuit], the switch being a reed [r]elay switch ... disposed for being rendered open circuit by a magnet outside the casing”).

VIII. ANALYSIS OF GROUNDS

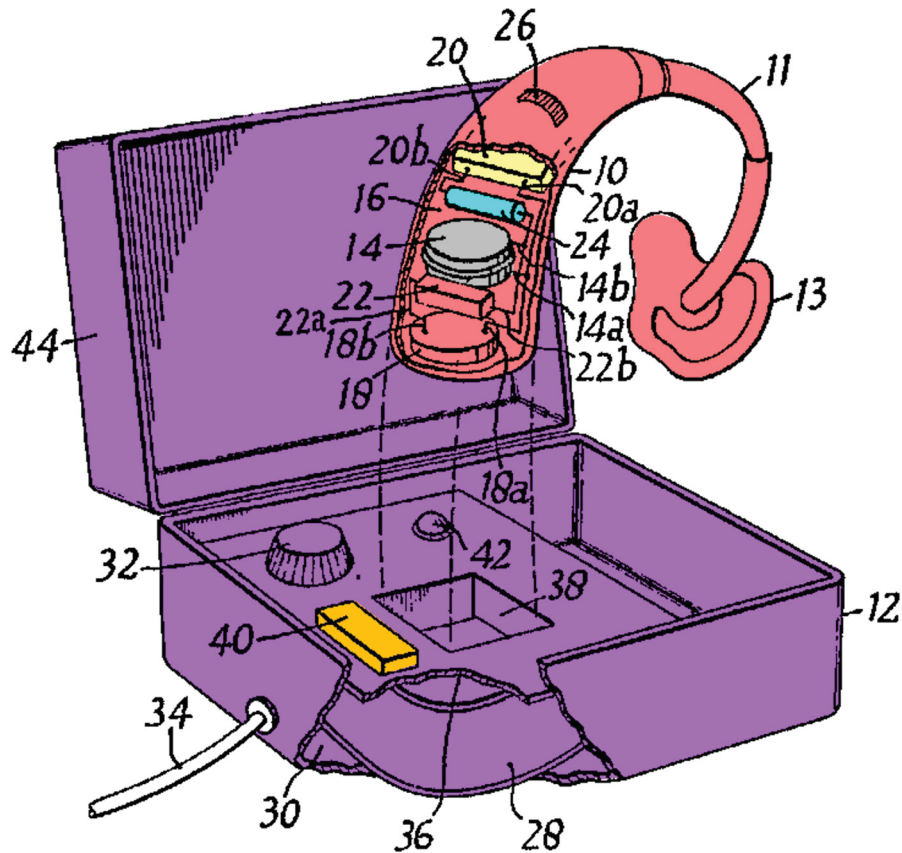
A. Ground 1

39. As I will explain in detail below, claims 10 and 14 are anticipated by Brown.

1. Claim 10

(a) [10Preamble] A wireless earpiece comprising:

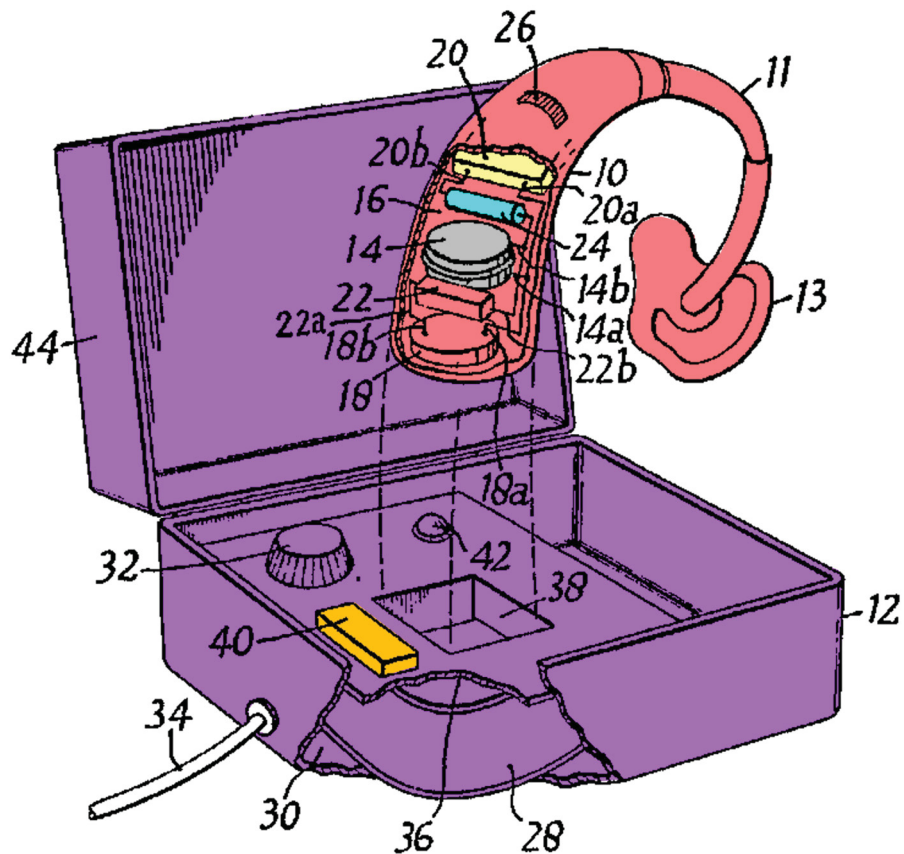
40. I have been informed and understand that, in general, there are circumstances where the preamble of a claim does not limit the scope of the claim, and there are circumstances where the preamble does limit the scope of the claim.



Ex-1007-Brown, Figure 1. Figure 1 depicts a hearing aid 10 (red) that is used as a wireless earpiece. *Id.*, 1:87-91 (“In Fig. 1 there is shown a miniature hearing aid 10 and a receptacle or case 10 for storing the hearing aid 10 when the aid is not in use”).

(b) [10A] circuitry operating the wireless earpiece;

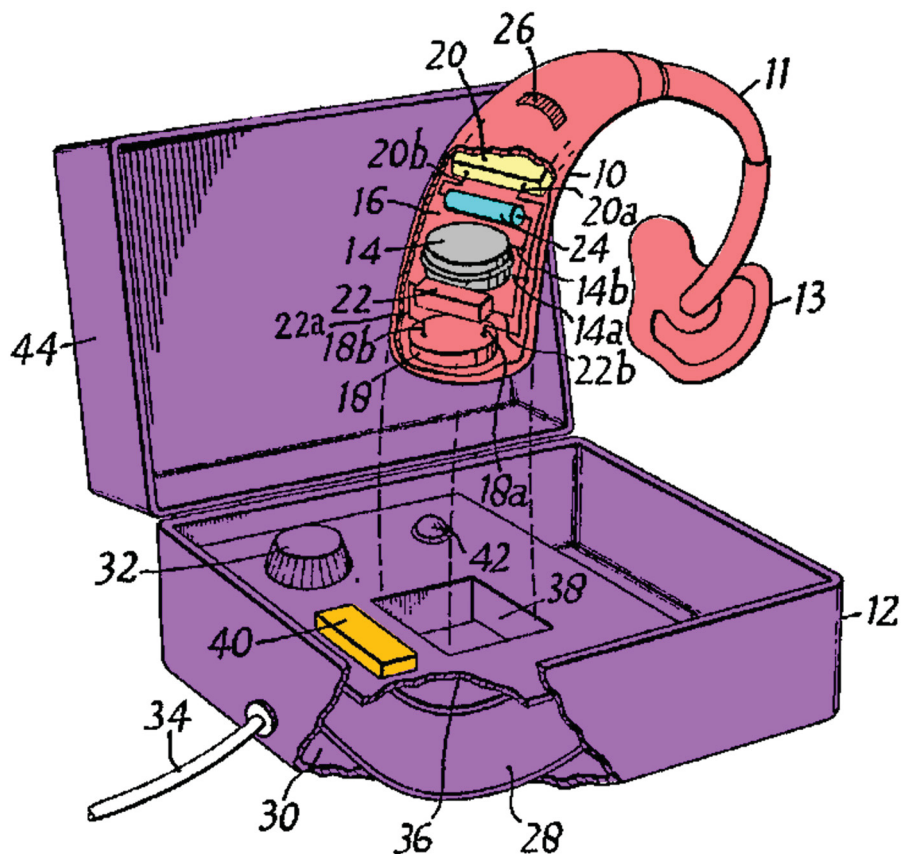
41. Brown discloses circuitry operating the wireless earpiece, as shown in Figure 1 below.



Ex-1007-Brown, Figure 1. Figure 1 shows that the hearing aid 11 (red) includes circuitry including an amplifier 20 (yellow) and other electronics that operate the hearing aid 11, e.g., by enabling the user to adjust the hearing aid volume. *Id.*, 2:1-21 (“The hearing aid 10 includes ... an amplifier 20 for the aid.... The amplifier, microphone, speaker, and a volume control 26, provided to enable the user of the hearing aid to adjust the volume to a convenient level, can be entirely conventional.”).

(c) [10B] a battery powering the circuitry of the wireless earpiece; and:

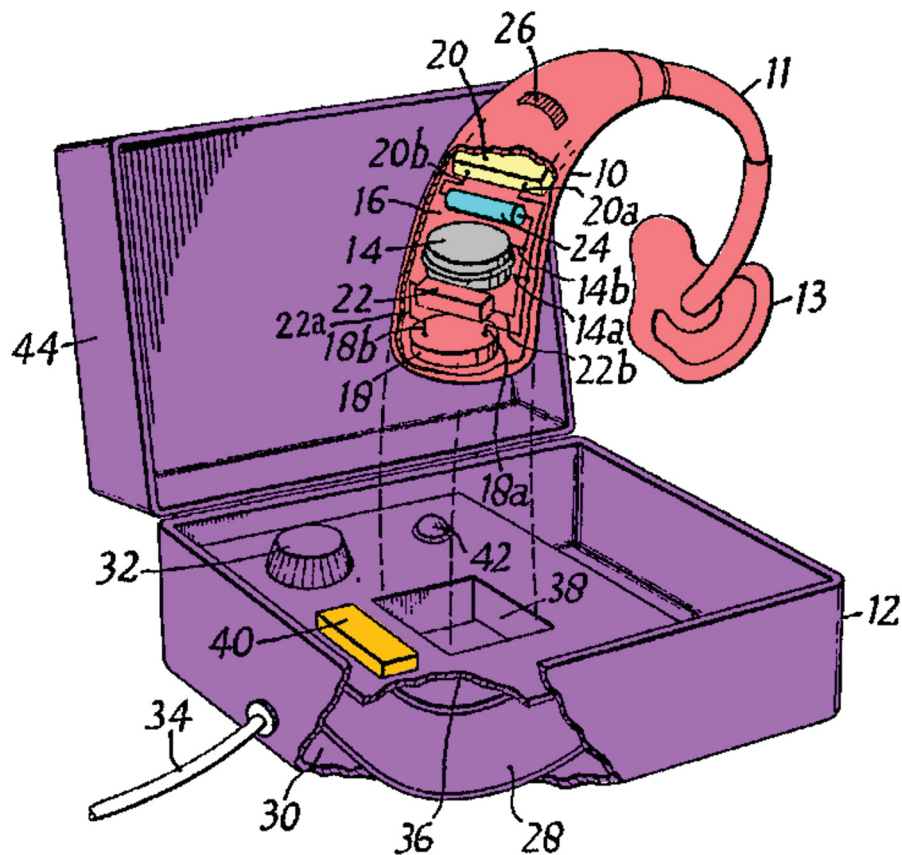
42. Brown discloses a battery powering the circuitry of the wireless earpiece, as shown in Figure 1 below.



Ex-1007-Brown, Figure 1. Figure 1 shows that the hearing aid 10 (red) includes an accumulator cell 14 (gray), which is a type of battery that powers the hearing aid circuitry (e.g., amplifier 20, yellow) to allow the hearing aid to operate normally. *Id.*, 2:1-21 (“The hearing aid 10 includes an accumulator cell 14), 2:49-52 (“In use, when the hearing aid is removed from the case 12 the switch 24 closes to connect the accumulator 14 to the amplifier 20 and the aid operates in the normal manner”).

- (d) [10C] a reed switch connecting the battery to the circuitry wherein the reed switch connects the circuitry to the battery when a magnetic field is not detected, and wherein the reed switch disconnects the circuitry from the battery when a magnetic field is detected

43. Brown discloses a reed switch connecting the battery to the circuitry when a magnetic field is not detected, and wherein the reed switch disconnects the circuitry from the battery when a magnetic field is detected, as shown in Figure 1 below.



Ex-1007-Brown, Figure 1. Figure 1 shows that the hearing aid 11 (red) includes a reed relay switch 24 (blue) that connects the accumulator 14 (battery, gray) to circuitry including amplifier 20 (yellow) under normal operation (e.g., when a

magnetic field is not detected). However, when hearing aid 11 (red) is placed into its storage case (purple) containing a magnet 40 (orange), the reed relay switch 24 (blue) detects the magnetic field of magnet 40 and disconnects the amplifier circuitry (yellow) from the battery (gray). *Id.*, 1:19-43, 2:1-21 (“The hearing aid 10 includes ... a magnetically actuated reed relay switch 24.... The switch 24 includes a permanent magnet (not shown) which, in use, biases the contacts closed to connect the accumulator 14 to the amplifier 20 [(i.e., when no externally applied magnetic field is detected)]”), 2:42-48 (“When the hearing aid is placed in the well [of the storage case] a magnet 40 effectively neutralizes the magnetic field provided by the magnet in the reed relay switch 24 and the switch contacts open to disconnect the accumulator 14 from the amplifier 20 [(i.e., when the externally applied magnetic field generated by magnet 40 is detected)]”), 2:56-62.

2. Claim 14: The wireless earpiece of claim 10, wherein the wireless earpiece alters a power level of the wireless earpiece in response to the reed switch detecting the magnetic field.

44. As I explained above for Element [10C], Brown discloses that the wireless earpiece (e.g., hearing aid 10) alters a power level of the wireless earpieces (e.g., disconnects the battery 14 from the circuitry 20) in response to the reed switch (reed relay switch 24) detecting the magnetic field. *See* Ex-1007-Brown, 2:42-48 (“When the hearing aid is placed in the well [of the storage case] a magnet 40 effectively neutralizes the magnetic field provided by the magnet in the reed relay

switch 24 and the switch contacts open to disconnect the accumulator 14 from the amplifier 20 [(i.e., power to the earpiece circuitry is cut off in response to reed switch 24 detecting the magnetic field generated by magnet 40)]”); *see also id.*, 1:19-43. 2:56-62.

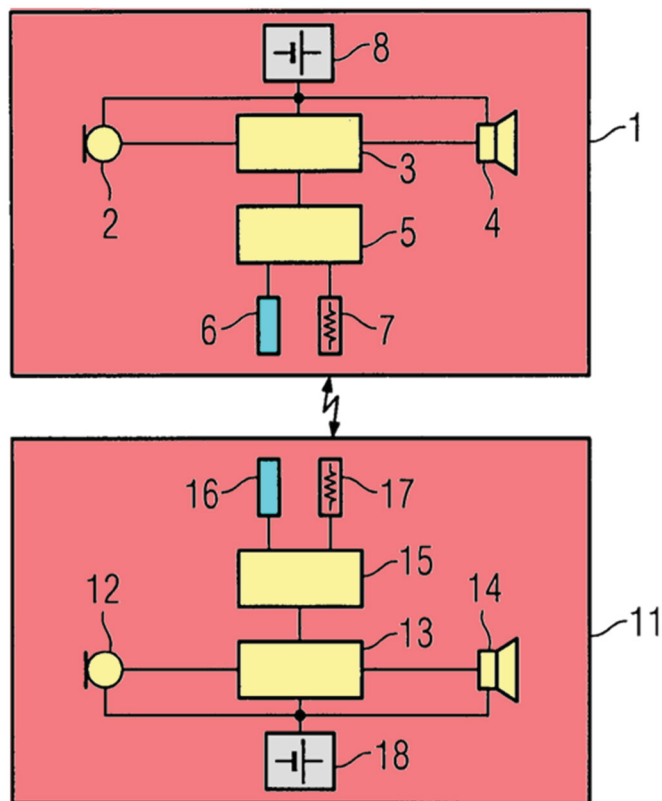
B. Ground 2

45. As I will explain in detail below, claims 1-3 and 5 are anticipated by Hain.

1. Claim 1

(a) [1Preamble] A method for managing wireless earpieces comprising:

46. Hain discloses the claimed method for managing wireless earpieces. An embodiment of Hain’s system is depicted in Figure 1, reproduced below.



Ex-1004-Hain, Figure 1. The system in Figure 1 includes two wireless earpieces (hearing aids 1 and 11, red). *see also id.*, ¶¶ 1 (“The invention relates to a hearing aid system having a first and a second hearing aid that can be worn on or in the ear of a user... wherein the hearing aid system also comprises means for wireless signal transmission between the hearing aids”), 13, 18, Claims 1 and 7. As I will explain below in further detail for Elements [1A]-[1B], the wireless earpieces are capable of automatically reducing their power consumption when placed into a storage case with embedded magnets. *Id.*, ¶¶ 11, 18, 19 (“However, if a magnetic field is detected simultaneously by both hearing aids 1 and 11, it can be concluded that both hearing aids are located in a storage box equipped with at least one corresponding magnet.

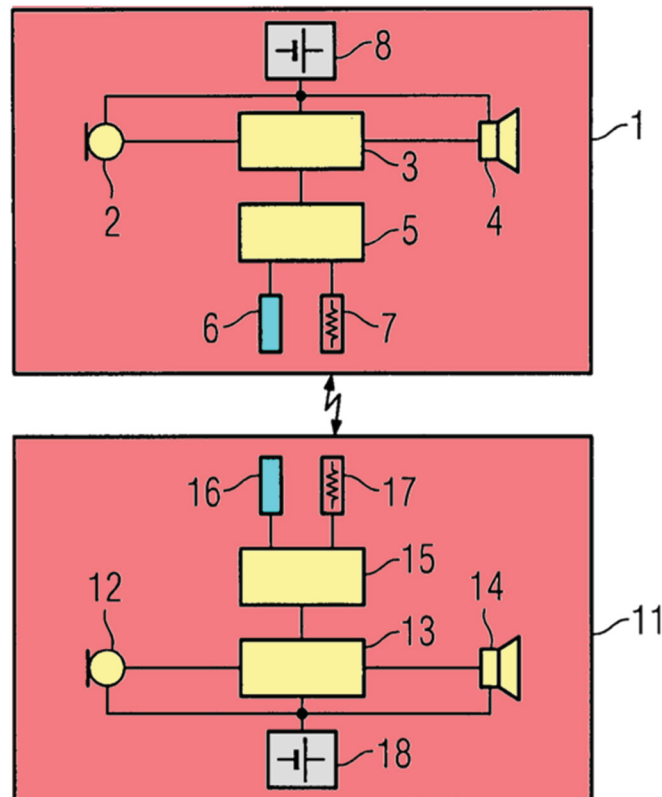
As soon as this situation is detected, the two hearing aids 1 and 11 switch off automatically. Advantageously, a residual power supply is maintained even in the switched-off state, by which the status of the reed contacts 6 and 16 can continue to be queried. As a result, the hearing aids 1 and 11 detect when they are being removed from the storage box. In this way, the hearing aids 1 and 11 can also be automatically switched on again.”), 21-22, Claims 1, 5-7, and 9. By carrying out these processes of detecting a magnetic field and reducing power consumption in an automated manner, Hain’s system carries out a method to manage hearing aids 1 and 11. *Id.*

(b) [1A] powering circuitry of the wireless earpieces utilizing a high power mode in response to detecting a magnetic field is not applied to one or more of the wireless earpieces; and

47. Hain discloses powering circuitry of the wireless earpieces (e.g., hearing aids 1 and 11) using a high power mode (e.g., “normal mode”) in response to detecting a magnetic field is not applied to one or more of the wireless earpieces. The ’853 patent describes embodiments of the “high power mode” as supporting the normal operation of the earpieces, e.g., when they are fully functional and operated using their on-board battery power. Ex-1001-USP853, 8:2-4 (“the reed switch 416 may initiate a self-power (or high power) mode when deactivated (e.g., closed) by the magnet 414 of the smart case 402”), 8:41-62 (“If the magnetic field is not present, the wireless earpiece remains powered on.... [T]he wireless earpiece operates

normally with the onboard battery powering the circuitry and components of the wireless earpiece.”).

48. A block diagram of Hain’s wireless earpieces (e.g., hearing aids 1 and 11, red) is shown in Figure 1, reproduced below.



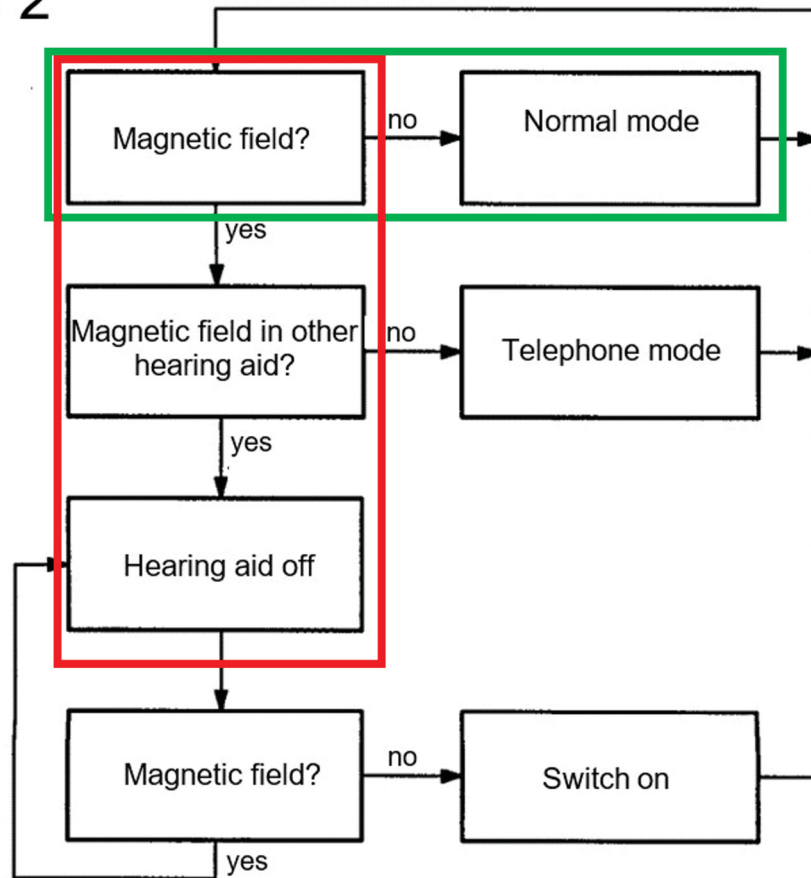
Ex-1004-Hain, Figure 1. Within hearing aid 1, a voltage source 8 (gray) powers circuitry (e.g., microphone 2, signal processing unit 3, receiver 4, and signal transmission and control unit 5, yellow), and similarly within hearing aid 11, a voltage source 18 (gray) powers circuitry (e.g., microphone 12, signal processing unit 13, receiver 14, and signal transmission and control unit 15). *Id.*, ¶¶ 1 (“The invention relates to a hearing aid system having a first and a second hearing aid that

can be worn on or in the ear of a user, each of which has an input converter for receiving an input signal and converting it into an electrical input signal, a signal processing unit for processing and amplifying the electrical input signal and outputting an electrical output signal, and an output converter for converting the electrical output signal into an output signal that can be perceived by the user as an acoustic signal, wherein the hearing aid system also comprises means for wireless signal transmission between the hearing aids”), 8 (“A hearing aid also comprises a voltage source (battery or accumulator) for supplying voltage to the electronic components”), 18, 20, Claims 1 and 7.

49. A POSITA would have recognized the earpiece circuitry shown in Figure 1 as being powered using what the ’853 patent calls the “high power mode” during the earpieces’ normal operation (e.g., when the earpieces are not in their storage case, which Hain refers to as a “storage box”). For example, the earpiece circuitry is fully functional and powered using voltage sources 8 and 18 when the earpieces are not in their storage box. *Id.*, ¶¶ 19 (“As a result, the hearing aids 1 and 11 detect when they are being removed from the storage box. In this way, the hearing aids 1 and 11 can also be automatically switched on again.”), 11, 21, 22.

50. A flow diagram identifying the circumstances under which the earpiece circuitry is powered normally (i.e., using a high power mode) is shown Figure 2, reproduced below.

FIG 2



Ex-1004-Hain, Figure 2. The green path of the flow diagram shows that when a magnetic field is not applied to the earpieces, the system detects that the earpieces are out of their storage box, so the earpieces are automatically powered on and operate in their normal mode (i.e., “high power mode”) *Id.*, ¶¶ 21 (“Fig. 2 shows a flow chart for automatically detecting the hearing situation “telephoning” and for automatically switching off two hearing aids of a hearing aid system according to the invention. In this case, a hearing aid of a relevant hearing aid system monitors permanently or cyclically for the presence of an external magnetic field. For as long as no magnetic field is detected, the hearing aid is in ‘normal operation.’”), 22 (“If

it is detected that both hearing aids are in a magnetic field at the same time, this is an indication that the hearing aids are located in a storage box equipped with at least one permanent magnet. The hearing aids are then switched to a switch-off mode in which the hearing aids are largely switched off and only a residual power supply for the sensor device is maintained.”), 10, 11, 13, 18, 19, Claims 1, 2, 5-7, and 9.

(c) [1B] altering the power sent to the circuitry of the wireless earpieces to a low power mode in response to detecting a magnetic field is applied to one or more of the wireless earpieces.

51. Hain discloses altering the power sent to the circuitry of the wireless earpieces (e.g., hearing aids 10 and 11) to a low power mode (e.g., residual power state) in response to detecting a magnetic field is applied to one or more of the wireless earpieces. In comparison to the high-power mode, the '853 patent describes embodiments of the low-power mode as supporting reduced functionality of the earpieces, e.g., functionality that is limited to battery charging, monitoring sensors, and other residual functions. Ex-1001-USP853, 4:27-33 (“the interfaces 108, 110 may each include a magnet that activates the corresponding reed switch (i.e., reed switch 146 described below) to power off or initiate a low power mode (e.g., lower power state or mode) for one or both of the wireless earpieces 142, 144”), 5:27-30 (“the low power mode allows charging of the wireless earpieces 142, 144”), 10:10-15 (“During any of steps 508-510, the wireless earpiece may enter a power saver or

low power mode. During the power saver mode the wireless earpiece may utilize minimal power to maintain functionality and alert status of the wireless earpiece.”).

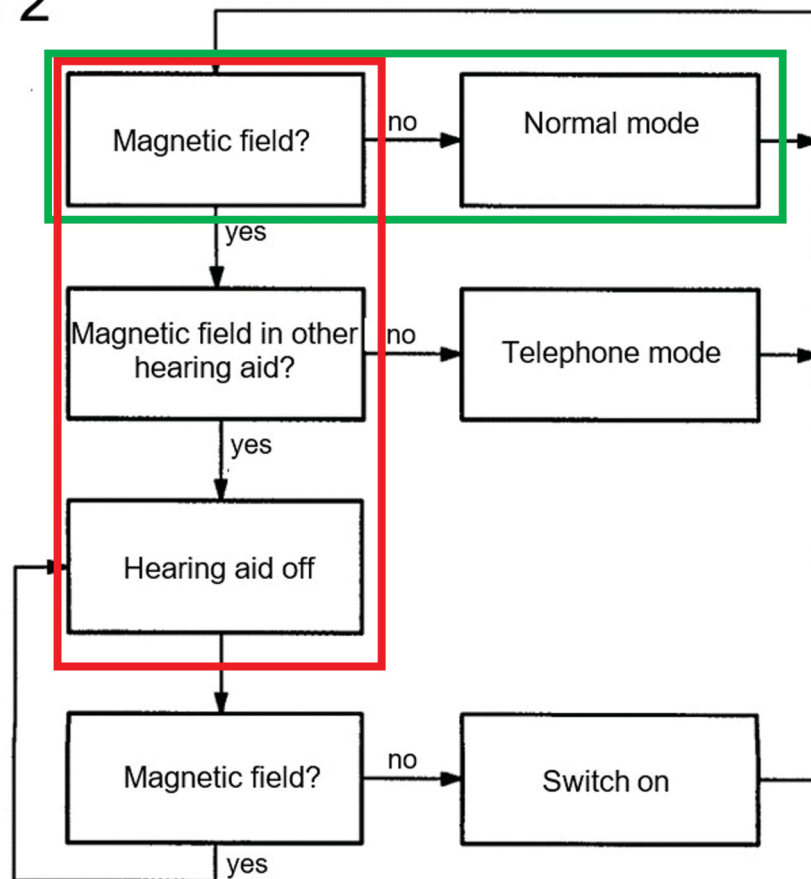
52. A POSITA would have recognized Hain’s earpiece circuitry (*see* Element [1A]) as being powered using what the ’853 patent calls the “low power mode” when the earpieces are placed in their storage case (e.g., “storage box”). For example, Hain teaches that when the earpieces are in their storage case, they enter a residual power state in which their functionality is limited to residual functionality including:

- The ability to recharge the earpieces; Ex-1004-Hain, ¶ 20 (“The hearing aids 1 and 11 are not only automatically switched off when stored in the storage box; rather, they are also recharged.”); and
- The ability to monitor sensors of the earpieces so that they can detect when they are removed from the storage case and transition back to the normal mode. Ex-1004-Hain, ¶ 19 (“Advantageously, a residual power supply is maintained even in the switched-off state, by which the status of the reed contacts 6 and 16 can continue to be queried. As a result, the hearing aids 1 and 11 detect when they are being removed from the storage box. In this way, the hearing aids 1 and 11 can also be automatically switched on again. This eliminates the need for manually operated on-and-off switches.”).

These capabilities match those of the “low-power mode” described in the ’853 patent.

53. A flow diagram identifying the circumstances under which power sent to the earpiece circuitry is reduced to the residual power state (i.e., low power mode) is shown Figure 2, reproduced below.

FIG 2



Ex-1004-Hain, Figure 2. The red path of the flow diagram shows that when a magnetic field is applied to both earpieces, the system determines that earpieces are in their storage box, so the earpieces automatically transition to their switched off state (i.e., “low power mode”). *Id.*, ¶¶ 21 (“Fig. 2 shows a flow chart for

automatically detecting the hearing situation “telephoning” and for automatically switching off two hearing aids of a hearing aid system according to the invention. In this case, a hearing aid of a relevant hearing aid system monitors permanently or cyclically for the presence of an external magnetic field. For as long as no magnetic field is detected, the hearing aid is in ‘normal operation.’”), 22 (“If it is detected that both hearing aids are in a magnetic field at the same time, this is an indication that the hearing aids are located in a storage box equipped with at least one permanent magnet. The hearing aids are then switched to a switch-off mode in which the hearing aids are largely switched off and only a residual power supply for the sensor device is maintained.”), 10, 11, 13, 18, 19, Claims 1, 2, 5-7, and 9.

**2. Claim 2: The method of claim 1 further comprising:
operating the wireless earpieces utilizing an onboard
battery in response to detecting the magnetic field is not
applied to one or more of the wireless earpieces.**

54. As I explained previously for Element [1A], Hain discloses that the wireless earpieces are operated using an onboard battery (e.g., voltage sources 8 and 18) in response to detecting the magnetic field is not applied to one or more of the wireless earpieces. *See* Section VIII.B.1(b); *see also* Ex-1004-Hain, Figure 1, ¶¶ 8 (“A hearing aid also comprises a voltage source (battery or accumulator) for supplying voltage to the electronic components”), 18, 20, Claims 1 and 7.

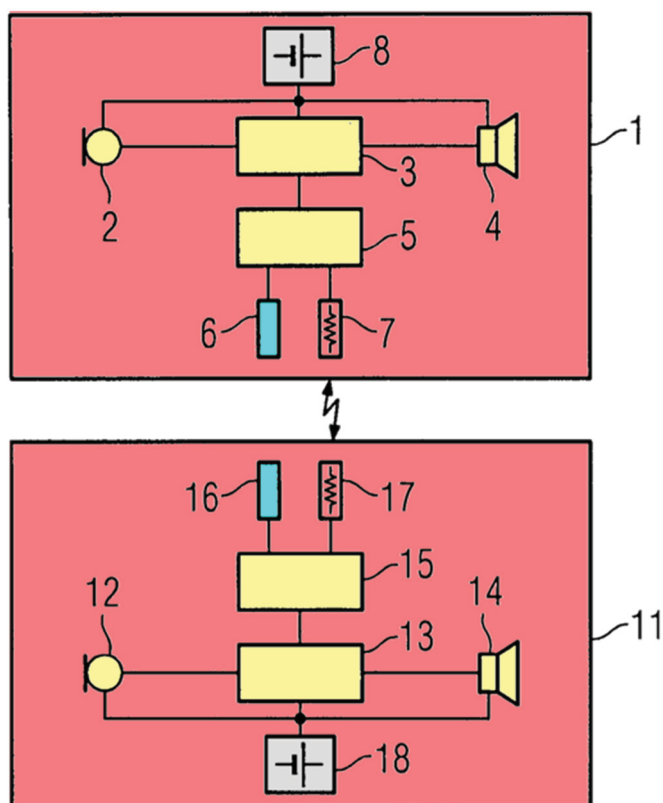
**3. Claim 3: The method of claim 1 further comprising:
charging an onboard battery of the wireless earpieces in
response to detecting a magnetic field is applied to the
wireless earpieces.**

55. As I explained previously for Element [1B], Hain discloses that an onboard battery (e.g., voltage sources 8 and 18) of the wireless earpieces is charged in response to detecting the magnetic field is applied to the wireless earpieces. *See* Section VIII.B.1(c); *see also* Ex-1004-Hain, ¶ 20 (“The voltage sources 8 and 18 for supplying voltage to the hearing aids 1 and 11 are preferably rechargeable, and the storage box for the hearing aids 1 and 11 is advantageously designed as a charging device for the voltage sources 8 and 18 at the same time. The hearing aids 1 and 11 are not only automatically switched off when stored in the storage box; rather, they are also recharged.”), Claim 6.

**4. Claim 5: The method of claim 1, wherein the magnetic field
is detected by a reed switch of the wireless earpieces.**

56. As I explained previously for Elements [1A]-[1B], Hain discloses determining whether wireless earpieces (e.g., hearing aids 1 and 11) are in their storage case by detecting whether a magnetic field is applied to the wireless earpieces. Hain further discloses that the magnetic field is detected by a reed switch (e.g., reed contacts 6 and 16) of the wireless earpieces.

57. A block diagram of Hain’s hearing aids 1 and 11 (i.e., wireless earpieces) is shown in Figure 1 below.



Ex-1004-Hain, Figure 1. Figure 1 shows that the wireless earpieces include reed contacts 6 and 16 (i.e., reed switches, blue) that are used to detect whether a magnetic field is applied to the earpieces and thereby determine whether the earpieces are in their storage case. *Id.*, ¶ 18 (“[T]he status of reed contacts 6 and 16 can be queried.... From this, the corresponding hearing aid detects in a simple manner whether it is in the immediate vicinity of a magnet”), 19 (“if a magnetic field is detected simultaneously by both hearing aids 1 and 11, it can be concluded that both hearing aids are located in a storage box equipped with at least one corresponding magnet”), 21-22.

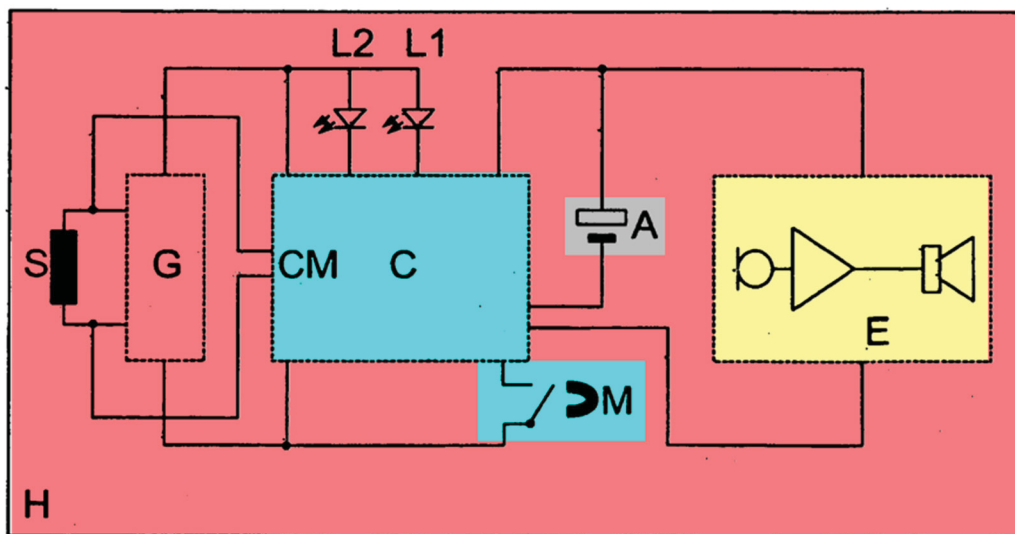
C. Ground 3

58. As I will explain in detail below, claims 10 and 21 are anticipated by Steinbrecher.

1. Claim 10

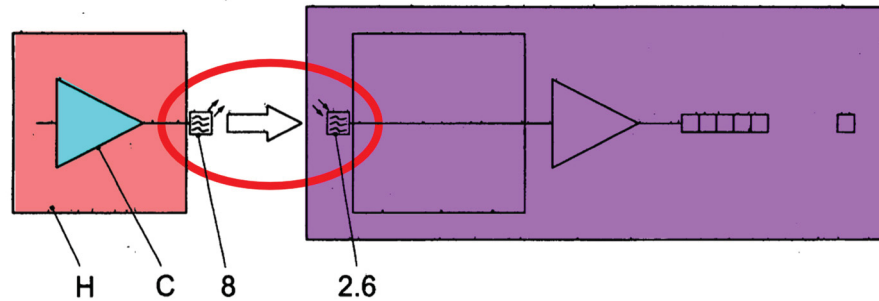
(a) [10Preamble] A wireless earpiece comprising:

59. Steinbrecher discloses a wireless earpiece system that includes at least one wireless earpiece (e.g., hearing aid H, red), as shown in Figure 2 below.



Ex-1006-Steinbrecher, Figure 2; *see also id.*, ¶ 25 (“The function of the second circuit arrangement 4 arranged in the hearing aid H with the charge controller C is explained in Fig. 2. The hearing aid H is supplied with energy via the energy receiving device in the form of the secondary coil S and rectified with the rectifier G. The hearing aid H also contains hearing aid’s electronics E, the battery A, the secondary coil S, and the charge controller C”).

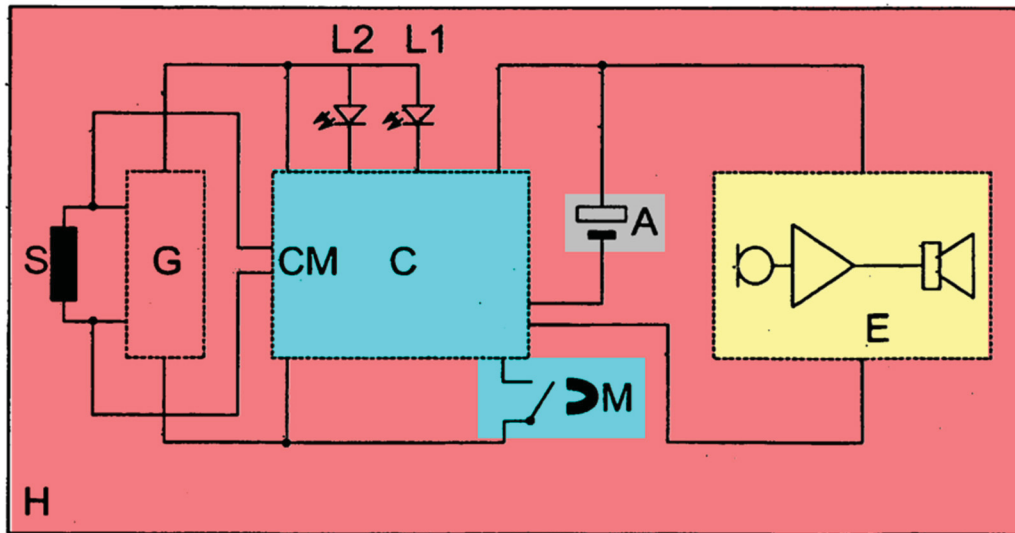
60. Figure 4 of Steinbrecher, reproduced below, depicts wireless communications between an RF transmitter 8 of hearing aid H (red) and an RF receiver 2.6 within a charging shell 1 (purple).



Ex-1006-Steinbrecher, Figure 4; *see also id.* ¶ 27 (“Fig. 4 shows an embodiment in which the signals are ... transmitted from the hearing aid H to the charging shell 1 ... by electromagnetic waves, for example by means of Bluetooth transmission. For this purpose, a miniaturized RF transmitter 8 is arranged on the hearing aid, whose transmission signals are modulated by the charge controller C. To receive the signals, the charging shell 1 is equipped with an RF receiver 9, which receives the electromagnetic signals and transmits them to the signal processing device 6.”).

(b) [10A] circuitry operating the wireless earpiece;

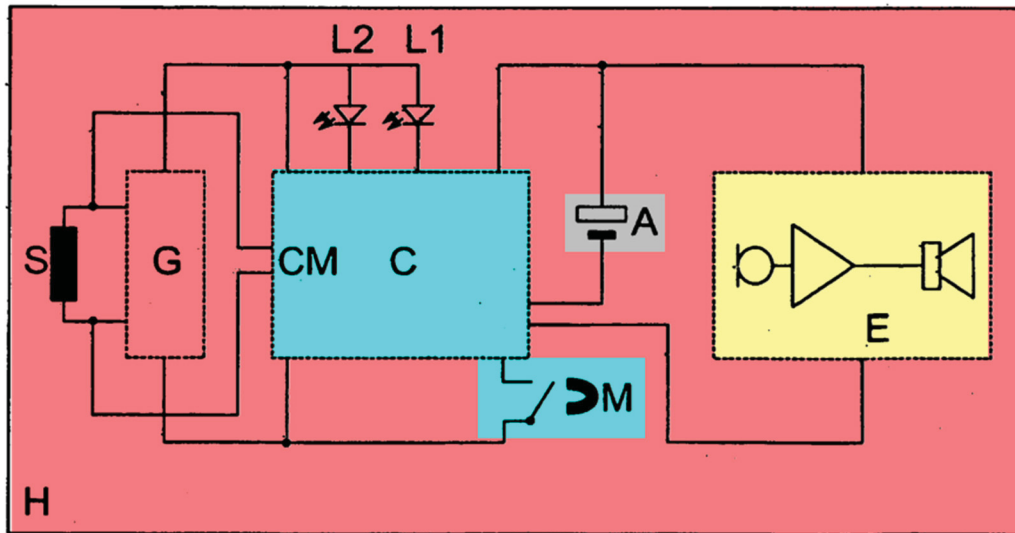
61. Steinbrecher’s wireless earpiece (e.g., hearing aid H, red) includes circuitry (e.g., electronics E, yellow) operating the wireless earpiece, as shown in Figure 2 below.



Ex-1006-Steinbrecher, Figure 2. For example, the circuitry shown in Figure 2 includes electronics E (yellow), which controls the audio output of the hearing aid H—namely, a POSITA would have understood the sequence of circular, triangular, and speaker-shaped symbols shown in the yellow box to depict circuitry comprising a microphone, amplifier, and speaker, respectively. *See id.*, ¶¶ 18-19, 25 (“The hearing aid H also contains hearing aid’s electronics E, the battery A, the secondary coil S, and the charge controller C”).

(c) [10B] a battery powering the circuitry of the wireless earpiece; and:

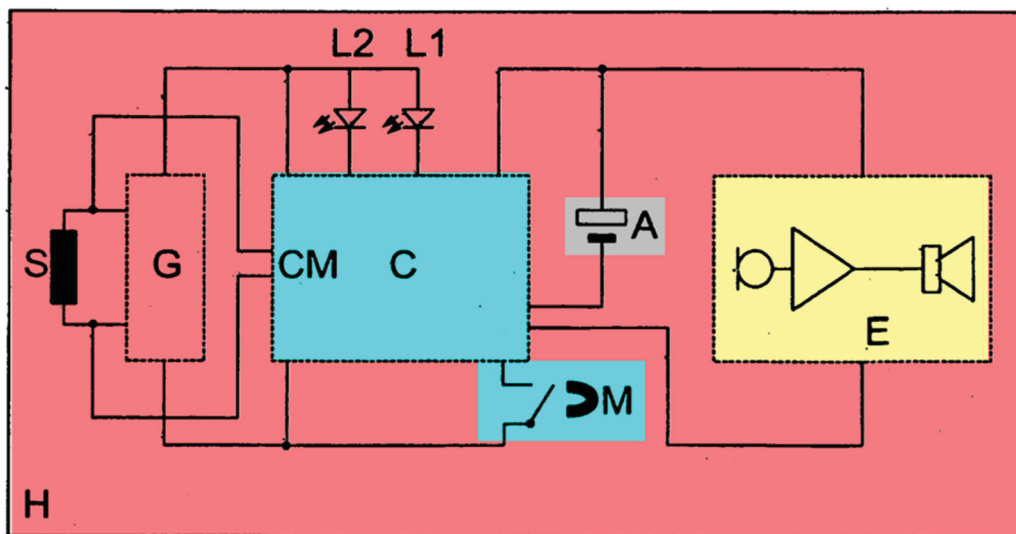
62. As shown in Figure 2 below, Steinbrecher’s wireless earpiece (e.g., hearing aid H, red) includes a battery (e.g., battery A, gray) powering the circuitry (e.g., electronics E, yellow) of the wireless earpiece.



Ex-1006-Steinbrecher, Figure 2; *see also id.*, ¶ 25 (“The hearing aid H also contains hearing aid’s electronics E, the battery A, the secondary coil S, and the charge controller C”). Based on the circuit configuration shown in Figure 2, a POSITA would have understood battery A to operate as a power supply for electronics E, with the top plate of battery A providing a supply voltage driving the circuitry of electronics E. *Id.*, ¶¶ 18, 19 (“A microswitch is preferably arranged in the hearing aid, which then controls an input of the charge controller when the hearing aid is placed in a storage case. In this case, the charge controller separates the hearing aid’s electronics from the battery, so that no current is consumed and no feedback whistling occurs.”), 25 (“When placed in a storage case, the microswitch configured as a reed contact is actuated by means of a built-in permanent magnet, which controls an input of the charging controller, whereupon the latter disconnects the electrical connection between the battery and the hearing aid’s electronics.”).

- (d) [10C] a reed switch connecting the battery to the circuitry wherein the reed switch connects the circuitry to the battery when a magnetic field is not detected, and wherein the reed switch disconnects the circuitry from the battery when a magnetic field is detected

63. Steinbrecher's wireless earpiece (e.g., hearing aid H, red) includes a switch (e.g., a microswitch M, blue, coupled to charge controller C) that, in a preferred embodiment, is implemented as a reed switch.



Ex-1006-Steinbrecher, Figure 2; *see also id.* ¶¶ 20 (“In a particularly preferred embodiment, the microswitch is designed as a reed contact, which is actuated by a permanent magnet arranged in the storage case.”), 25 (“When placed in a storage case, the microswitch configured as a reed contact is actuated by means of a built-in permanent magnet, which controls an input of the charging controller, whereupon the latter disconnects the electrical connection between the battery and the hearing aid’s electronics.”).

64. Steinbrecher also discloses that the reed switch (e.g., microswitch M) connects the battery (e.g., battery A, gray) to the circuitry (e.g., electronics E, yellow). Ex-1006-Steinbrecher, Figure 2; *see also id.*, ¶ 25 (“The hearing aid H also contains hearing aid’s electronics E, the battery A, the secondary coil S, and the charge controller C”). In particular, a POSITA would have understood microswitch M to connect battery A to electronics E because based on the state of microswitch M, the circuit formed by battery A and electronics E is made or broken using charge controller C. *Id.*, ¶¶ 18, 19 (“A microswitch is preferably arranged in the hearing aid, which then controls an input of the charge controller when the hearing aid is placed in a storage case. In this case, the charge controller separates the hearing aid’s electronics from the battery, so that no current is consumed and no feedback whistling occurs.”), 25 (“When placed in a storage case, the microswitch configured as a reed contact is actuated by means of a built-in permanent magnet, which controls an input of the charging controller, whereupon the latter disconnects the electrical connection between the battery and the hearing aid’s electronics.”).

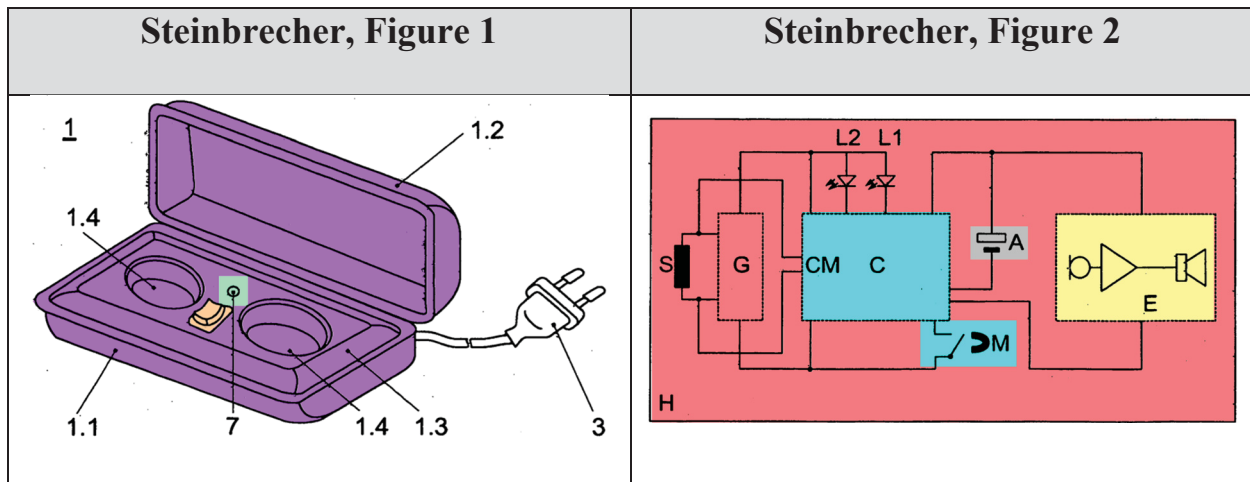
65. Steinbrecher further discloses that the reed switch (e.g., microswitch M) connects the circuitry (e.g., electronics E) to the battery (e.g., battery A) when a magnetic field is not detected and disconnects the circuitry from the battery when a magnetic field is detected. For example, Steinbrecher teaches that the switch is actuated by a built-in magnet of the storage case to automatically power on and off

the circuitry (e.g., electronics E) when the hearing aid is placed in its case. Ex-1006-Steinbrecher, ¶¶ 18, 19 (“A microswitch is preferably arranged in the hearing aid, which then controls an input of the charge controller when the hearing aid is placed in a storage case. In this case, the charge controller separates the hearing aid’s electronics from the battery, so that no current is consumed and no feedback whistling occurs.”), 25 (“When placed in a storage case, the microswitch configured as a reed contact is actuated by means of a built-in permanent magnet, which controls an input of the charging controller, whereupon the latter disconnects the electrical connection between the battery and the hearing aid’s electronics.”).

2. Claim 21

(a) [21Preamble] A system comprising:

66. Steinbrecher discloses a wireless earpiece system. For example, Steinbrecher’s system includes one or more wireless earpieces (e.g., hearing aid H, red) and a case (e.g., charging shell 1, purple) for storing and charging the earpieces, as shown in Figures 1 and 2 reproduced below.



Ex-1006-Steinbrecher, ¶¶ 24 (“The charging shell 1 shown in Fig. 1 has a housing bottom part 1.1 and a lid 1.2. In the housing bottom part 1.1, an intermediate floor 1.3, preferably made of a plastic that can be drawn, is inserted, in which two receiving recesses 1.4 for one hearing aid H each are incorporated.”), 25 (“The function of the second circuit arrangement 4 arranged in the hearing aid H with the charge controller C is explained in Fig. 2. The hearing aid H is supplied with energy via the energy receiving device in the form of the secondary coil S and rectified with the rectifier G. The hearing aid H also contains hearing aid’s electronics E, the battery A, the secondary coil S, and the charge controller C”).

(b) [21A] a first wireless earpiece, comprising:

67. As I explained above for Element [10Preamble], Steinbrecher’s system includes a first wireless earpiece. *See also* Element [21Preamble].

(c) [21B] circuitry operating the first wireless earpiece;

68. As I explained above for Element [10A], Steinbrecher discloses circuitry operating the first wireless earpiece.

(d) [21C] a battery powering the circuitry of the first wireless earpiece; and

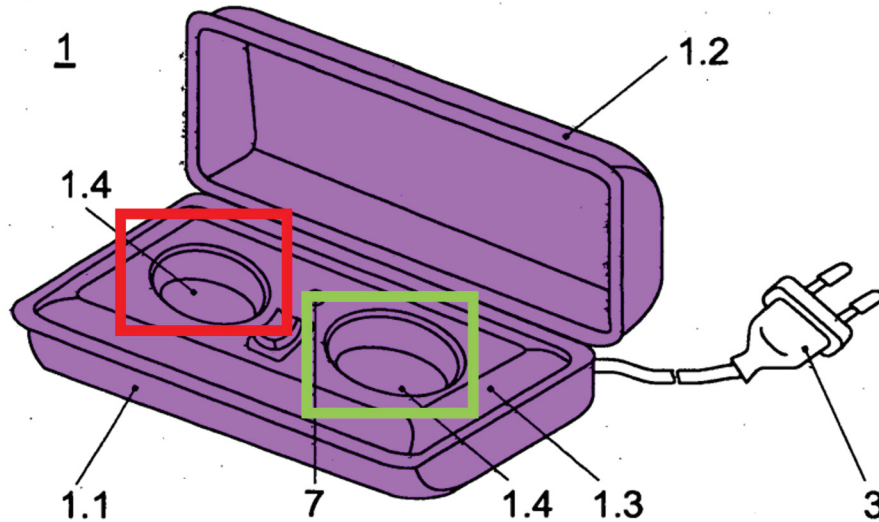
69. As I explained above for Element [10B], Steinbrecher discloses a battery powering the circuitry of the first wireless earpiece.

(e) [21D] a switch connecting the battery to the circuitry, wherein the switch connects the circuitry to the battery when a magnetic field is not detected, and wherein the switch disconnects the circuitry from the battery when a magnetic field is detected;

70. As I explained above for Elements [10B]-[10C], Steinbrecher discloses a switch (e.g., microswitch M implemented as a reed contact) connecting the battery to the circuitry, wherein the switch connects the circuitry to the battery when a magnetic field is not detected, and wherein the switch disconnects the circuitry from the battery when a magnetic field is detected.

(f) [21E] a smart case for charging the first wireless earpiece and a second wireless earpiece, the smart case comprising:

71. Steinbrecher's system includes a storage case (e.g., charging shell 1, purple) with a pair of recesses 1.4 for charging the first wireless earpiece (red box) and a second wireless earpiece (green box), as shown in Figure 1 below.



Ex-1006-Steinbrecher, Figure 1; *see also id.*, ¶¶ 24 (“The charging shell 1 shown in Fig. 1 has a housing bottom part 1.1 and a lid 1.2. In the housing bottom part 1.1, an intermediate floor 1.3, preferably made of a plastic that can be drawn, is inserted, in which two receiving recesses 1.4 for one hearing aid H each are incorporated.”), 25 (“After the hearing aid H has been inserted into the charging shell, the charge controller C is activated. Activation is indicated with the aid of light-emitting diodes L1, L2. The charge controller C has a control output with which the charge process can be started and ended”).

72. A POSITA would have understood Steinbrecher’s charging shell 1 to be a “smart case” given that it includes intelligent controls, including a signal processing device that receives and displays information associated with battery A. Ex-1006-Steinbrecher, ¶¶ 7 (“The charging shell comprises a first circuit arrangement, which is used in order to transmit energy and receive and process

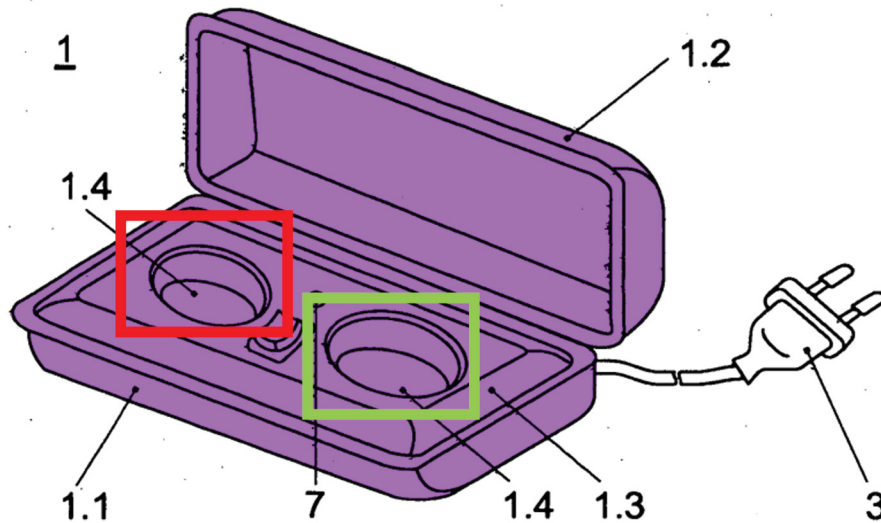
signals. For this purpose, it contains at least one energy transmission device and one signal processing device.”), 8 (“In addition, the number of charging cycles already completed is monitored, and this number or the number of remaining charging cycles and the current state of charge are processed in a suitable form as signals and transmitted from a modulator output via a suitable signal path to a demodulator input of the signal processing device, so that this information can be made available for the user at the charging shell.”), 24 (“An output device 7 [of the charging shell] is used in order to display the state of charge or information about the remaining life expectancy of a battery A in a hearing aid H that may have been inserted”), 25 (“The charge controller C has a modulator output CM, which is connected to the secondary coil in order to feed it modulated signals in order to transmit the state of charge and the number of charging cycles completed to the charging shell 1.”).

(g) [21F] a smart case housing:

73. Steinbrecher’s smart case (e.g., charging shell 1) includes a smart case housing. *See, e.g.*, Ex-1006-Steinbrecher, ¶ 24 (“The charging shell 1 shown in Fig. 1 has a housing bottom part 1.1 and a lid 1.2.”).

- (h) [21G] a first receptacle for receiving the first wireless earpiece disposed within the smart case housing;
- (i) [21H] a second receptacle for receiving the second wireless earpiece disposed within the smart case housing;

74. Referring to Figure 1 below, Steinbrecher discloses a first receptacle (e.g., first receiving recess 1.4 identified by the red box) for receiving the first wireless earpiece disposed within the smart case housing and a second receptacle (e.g., second receiving recess 1.4 identified by the green box) for receiving the second wireless earpiece disposed within the smart case housing.

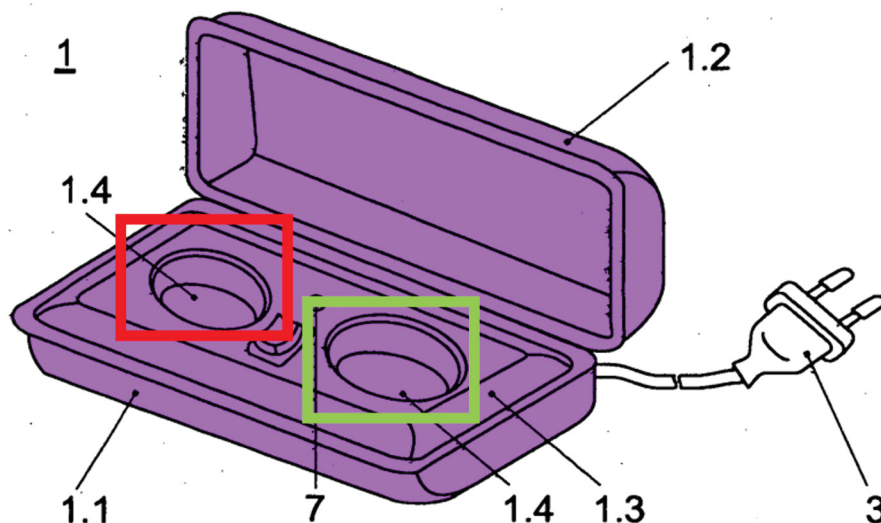


Ex-1006-Steinbrecher, Figure 1. Figure 1 shows that the first receptacle (red box) and a second receptacle (green box) are for receiving first and second earpieces, respectively, and are each disposed within the smart case housing. *See also id.* ¶ 24 (“The charging shell 1 shown in Fig. 1 has a housing bottom part 1.1 and a lid 1.2. In the housing bottom part 1.1, an intermediate floor 1.3, preferably made of a plastic

that can be drawn, is inserted, in which two receiving recesses 1.4 for one hearing aid H each are incorporated.”).

- (j) [21I] a first interface associated with the first receptacle for electrically connecting the smart case to the first earpiece;
- (k) [21J] a second interface associated with the second receptacle for electrically connecting the smart case to the second earpiece;

75. Referring to Figure 1 below, Steinbrecher discloses a first interface associated with the first receptacle (e.g., first receiving recess 1.4 identified by the red box) for electrically connecting the smart case to the first earpiece and a second interface associated with the second receptacle (e.g., second receiving recess 1.4 identified by the green box) for electrically connecting the smart case to the second earpiece.



Ex-1006-Steinbrecher, Figure 1. Recesses 1.4 used to electrically connect charging shell 1 to a pair of wireless earpieces (e.g., hearing devices). *See id.* ¶ 7 (“In the

procedure according to the invention for contactless loading of a accumulator battery in a hearing device, the hearing device is located in a charging shell during the charge process”). For example, recesses 1.4 each include energy transmission devices and signal processing devices, which are the same types of interfaces for electrically connecting the charging shell to the hearing devices as those described in the ’853 patent. *Id.* (“The charging shell comprises a first circuit arrangement, which is used in order to transmit energy and receive and process signals. For this purpose, it contains at least one¹ energy transmission device and one signal processing device”), 9 (“The energy transmission preferably takes place inductively from a primary coil arranged in the first circuit arrangement to a secondary coil arranged in the second circuit arrangement”); *cf.* Ex-1001-USP853, 4:11-26 (describing embodiments of “interfaces” that use “inductive chargers” and/or “[w]ireless charging”), 6:42-44 (“the interface 411 may include a wireless inductor for charging the wireless earpieces 401 without a physical connection”).

¹ Because two receptacles for wireless earpieces are shown in the charging shell of Figure 1, a POSITA would have understood this embodiment to include at least *two* energy transmission devices and signal processing devices, i.e., at least one for each receptacle.

- (I) [21K] an intelligent control disposed within the smart case housing and operatively connected to the first interface and the second interface.

76. As I explained above for Element [21E], Steinbrecher's charging shell 1 is a smart case that includes intelligent controls (e.g., signal processing devices) disposed within the smart case housing. Ex-1006-Steinbrecher, ¶ 7 ("The charging shell comprises a first circuit arrangement, which is used in order to transmit energy and receive and process signals. For this purpose, it contains at least one energy transmission device and one signal processing device.").

77. Moreover, Steinbrecher discloses that the intelligent controls (e.g., signal processing devices) are operatively coupled to the first and second interfaces (e.g., energy transmission devices). Namely, Steinbrecher discloses that the signal processing devices within the charging shell receive data (e.g., charge state information) from the wireless earpieces via a "signal path." Ex-1006-Steinbrecher, ¶¶ 8 ("In addition, the number of charging cycles already completed is monitored, and this number or the number of remaining charging cycles and the current state of charge are processed in a suitable form as signals and transmitted from a modulator output via a suitable signal path to a demodulator input of the signal processing device, so that this information can be made available for the user at the charging shell."), 24. Steinbrecher further discloses that the "signal path" includes the energy transmission devices, in which case the signal processing devices are operatively

coupled to the energy transmission devices via the signal path. *Id.* ¶¶ 9 (energy transmission devices include “secondary coil” within the charging shell), 25 (secondary coil is part of the signal path that the charge state information takes to reach the signal processing device: “The charge controller C has a modulator output CM, which is connected to the secondary coil [(energy transmission device)] in order to feed it modulated signals in order to transmit the state of charge and the number of charging cycles completed to the charging shell 1.”).

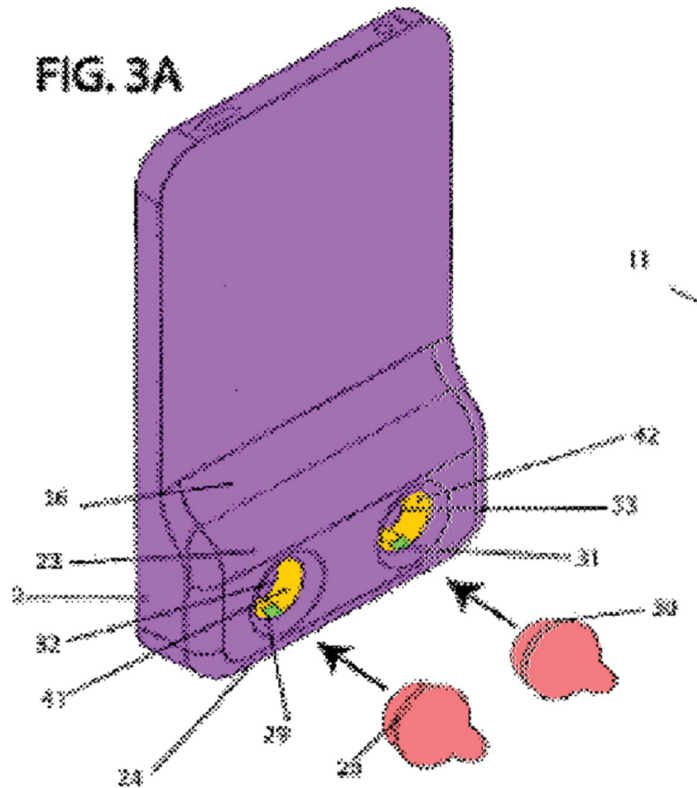
D. Ground 4

78. As I will explain in detail below, claims 1-7 and 9 would have been obvious over the teachings of Shaffer in view of Hain.

1. Claim 1

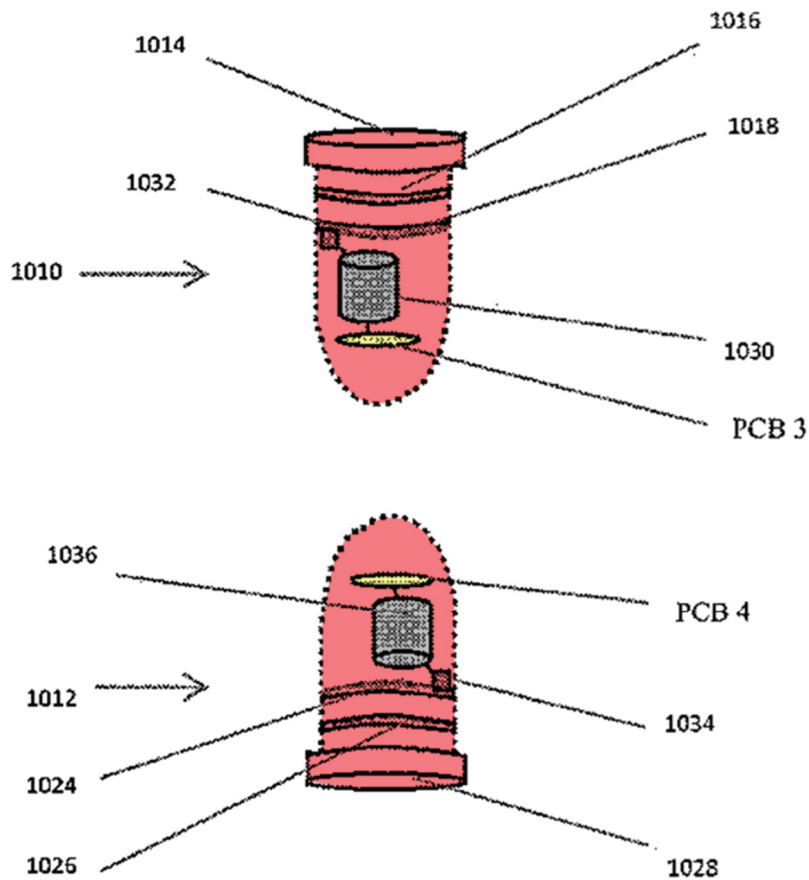
(a) [1Preamble] A method for managing wireless earpieces comprising:

79. Even if the preamble of claim 1 is limiting, Shaffer discloses the claimed method for managing wireless earpieces. An embodiment of Shaffer’s system is shown in Figure 3A, reproduced below.



Ex-1003-Shaffer, Figure 3A. The system above includes a pair of wireless earpieces (referred to as wireless audio earbuds, red) and a storage case (e.g., case 11, purple) with embedded magnetic charging docks. *Id.*, ¶ 34 (“FIGS. 1-5 illustrate an embodiment of a mobile device case 11, which embeds a magnetic charging dock for two wireless audio earbuds in the rear of base portion 12”), ¶ 32 (“The term ‘earbud’ refers to a device designed to fit within the ear of a human, and which emits audio signals that the earbud receives from a mobile electronic device. Examples of earbuds include in-ear headphones, hearing aids and the like.”).

80. Further details regarding the internal circuitry of the wireless earbuds are depicted and described with reference to Figure 10, reproduced below.



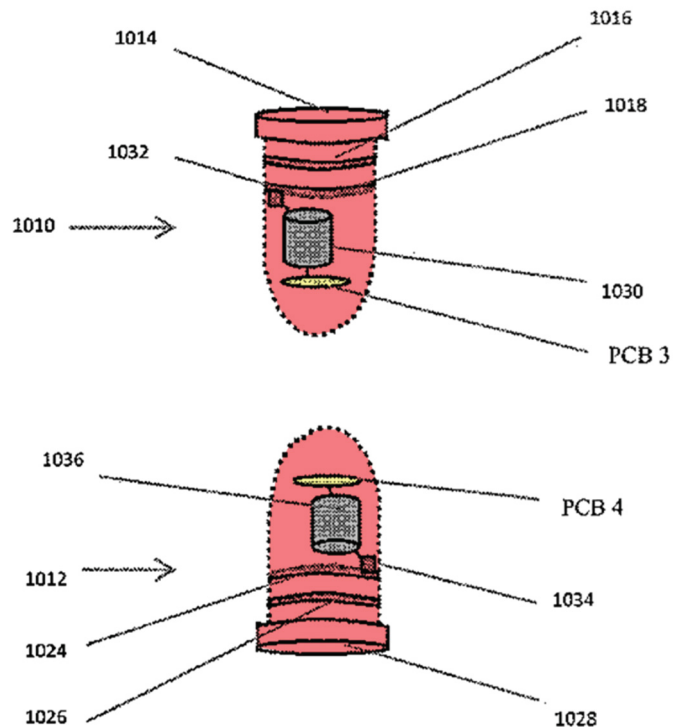
Ex-1003-Shaffer, Figure 10. As I will explain in further detail for Elements [1A]-[1B], Figure 10 depicts an embodiment of the wireless earbuds (e.g., wireless earbuds 1010 and 1012, red) capable of automatically reducing their power consumption when placed into the storage case of Figure 3A. *Id.*, ¶¶ 62, 63 (“Each earbud may include one or more contact sensors, such as pressure sensors or magnetic sensors that detect when the earbud is in (or out of) the aperture [of the storage case] and which send a corresponding signal to the earbud PCBs. Firmware embedded within the earbud PCBs could cause a circuit that includes the

rechargeable earbud batteries 930 and 934 to switch on or off, or return them to a low-energy consumption idle mode.”). By carrying out these processes of detecting the presence of a magnetic field and reducing power consumption in an automated manner, Shaffer’s system carries out a method to manage earbuds 1010 and 1012. *Id.*, ¶¶ 11, 62-63.

(b) [1A] powering circuitry of the wireless earpieces utilizing a high power mode in response to detecting a magnetic field is not applied to one or more of the wireless earpieces; and

81. Shaffer in view of Hain discloses powering circuitry of the wireless earpieces (e.g., Shaffer’s earbuds 1010 and 1012) utilizing a high power mode (e.g., “on” state) in response to detecting a magnetic field is not applied to one or more of the wireless earpieces.

82. A diagram of Shaffer’s earbuds 1010 and 1012 (i.e., wireless earpieces) is shown in Figure 10 below.



Ex-1003-Shaffer, Figure 10. Shaffer discloses that earbuds 1010 and 1012 (red) include PCB circuitry 3 and 4 (yellow) that, under normal operating conditions (e.g., when the earbuds are not in their case), is fully functional and powered using onboard batteries 1030 and 1036 (gray). *Id.*, ¶¶ 62-63 (“[E]arbuds 1010 and 1012 include earbud rechargeable batteries 1030 and 1036.... These components may be connected to printed circuit boards PCB 3 and PCB 4 within the earbuds.”). A POSITA therefore would have recognized Shaffer’s earbuds as being powered using what the ’853 patent calls the “high power mode” during the earpieces’ normal operation (e.g., when the earpieces are not in their storage case).

83. Shaffer further discloses that the earpieces include magnetic sensors to detect when the earpieces are not in their storage case, such that the earpiece circuitry is powered on (i.e., uses a “high power mode”) in response to the output of the magnetic sensor. Ex-1003-Shaffer, ¶¶ 62, 63 (“[Earbuds 1010 and 1012] may contain encoded firmware or other programming instructions to automatically trigger on when the earbuds are removed from the earbud apertures, and turn off upon return to the apertures [of the storage case]. Each earbud may include one or more contact sensors, such as pressure sensors or magnetic sensors that detect when the earbud is in (or out of) the aperture [of the storage case] and which send a corresponding signal to the earbud PCBs.”), 11 (“Optionally, each earbud may include one or more sensors that detect when the earbud is within or outside of an earbud receiving aperture; and programming that causes the earbud to receive the output of the one or more sensors and use the output to: (1) activate the earbud when the earbud is removed from an earbud receiving aperture; and (2) power down the earbud when the earbud is placed within an earbud receiving aperture”).

84. Shaffer does not expressly describe the implementation details of the magnetic sensor; however, as I explained above for Ground 2, Hain discloses an implementation of a magnetic sensor (e.g., reed contacts 6 and 16) that determines whether an earbud is in its storage case by detecting whether a magnetic field is applied to the earpieces. *See* Sections VIII.B.1(b-c) and VIII.B.4.

(i) Motivation to combine

85. A POSITA would have been motivated to modify Shaffer in view of Hain and would have done so with a reasonable expectation of success. As I explained above, Shaffer discloses using a magnetic sensor to detect whether earbuds are in their storage case and vary the power sent to the earbuds accordingly, and Hain provides implementation details of the magnetic sensor including the use of a reed switch (reed contacts 6 and 16) to detect the presence of a magnetic field. Accordingly, the modification would simply involve using Hain's magnetic sensor (which includes reed contacts 6 and 16) to implement Shaffer's teachings.

86. Hain discloses a well-known implementation of a magnetic sensor (e.g., a reed switch) that is suitable for Shaffer's purpose of detecting whether the earpieces are in their storage case—in fact, Hain uses the magnetic sensor for the same purpose as Shaffer. Ex-1003-Shaffer, ¶ 63 (“Each earbud may include one or more contact sensors, such as pressure sensors or magnetic sensors that detect when the earbud is in (or out of) the aperture [of the magnetic storage case] and which send a corresponding signal to the earbud PCBs”); Ex-1004-Hain, ¶¶ 10, 11 (“If, for example, there is a permanent magnet in a storage box for the hearing aid in question, a corresponding sensor device can also determine here that the hearing aid is located in the storage box”), 18 (“If the reed contacts 6 or 16 are in the immediate vicinity of a magnetic field whose field strength exceeds a certain threshold value, the reed

contacts 6 or 16 close. From this, the corresponding hearing aid detects in a simple manner whether it is in the immediate vicinity of a magnet.”).

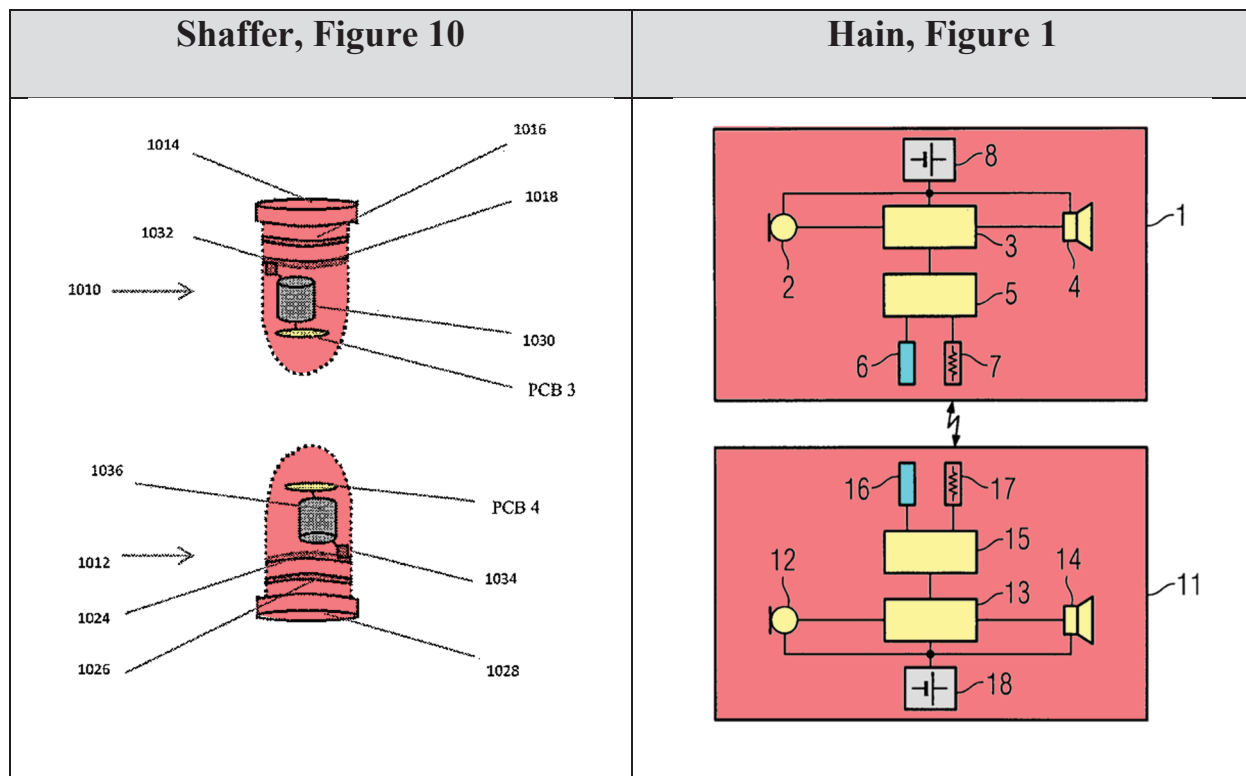
87. Moreover, Shaffer and Hain both describe similar wireless earpiece systems (e.g., systems including hearing aids or other types of earbuds), and more particularly both describe ways to reduce the power consumption of the wireless earpieces when placed into a magnetic storage case. *See, e.g.*, Ex-1003-Shaffer, ¶¶ 2 (“This patent document relates to a mobile device case that serves as an electrical charger and storage dock for rechargeable wireless audio earbuds”), 32 (“Examples of earbuds include in-ear headphones, hearing aids and the like”), 46, 62, 63 (“[The earbuds] may contain encoded firmware or other programming instructions to automatically trigger on when the earbuds are removed from the earbud apertures [of the magnetic storage case], and turn off upon return to the apertures”); Ex-1004-Hain, ¶¶ 6 (“The problem addressed by the present invention is to provide a simply implementable and reliable automatic switching off of the [hearing aid] devices in a hearing aid system”), 11 (“Furthermore, it is desirable for hearing aids to switch off automatically immediately after use. This can also be achieved with a sensor device for detecting an external magnetic field. If, for example, there is a permanent magnet in a storage box for the hearing aid in question, a corresponding sensor device can also determine here that the hearing aid is located in the storage box, so that the hearing aid is switched off automatically.”). In fact, as I explained above (*see*

Sections VIII.B.1(b-c) and VIII.D.1(b)), both Shaffer and Hain further describe using the same approach to detect whether the earpieces are in their storage case, namely, by equipping the earpieces with magnetic sensors to detect the presence or absence of a magnetic field applied by a magnetic storage case.

88. The benefits of reed switch-based magnetic sensors were well-known (*see* Section VI.A), as further evidenced by Hain’s express disclosure that its reed switch-based approach is “simply implementable and reliable” and requires “[o]nly a single magnetic field sensor ... in each hearing aid.” Ex-1004-Hain, ¶¶ 6, 23; *see also id.*, ¶ 10 (“In addition, the hearing aids according to the invention comprise a respective sensor device, by means of which magnetic fields in which the hearing aids are located and which exceed a specific field strength can be detected. The sensor devices are designed in a particularly simple manner as reed contacts.”), 18.

89. A POSITA would have had a reasonable expectation of success in applying Hain’s teachings to Shaffer’s system given that Hain’s teachings simply fill in routine implementation details of Shaffer’s magnetic sensors. Ex-1003-Shaffer, ¶ 63 (“Each earbud may include one or more contact sensors, such as pressure sensors or magnetic sensors that detect when the earbud is in (or out of) the aperture [of the magnetic storage case] and which send a corresponding signal to the earbud PCBs”); Ex-1004-Hain, ¶ 10 (“The sensor devices are designed in a particularly simple manner as reed contacts”). The modified system—in which the

magnetic sensors in Shaffer's earpieces (red) are implemented using Hain's reed contacts 6 and 16 (blue)—is shown below.



In the modified teachings of Shaffer, reed switches (e.g., Hain's reed contacts 6 and 16 (blue)) would be used to detect the presence or absence of a magnetic field applied to Shaffer's earpieces 1010 and 1012 (red), which is the same purpose for which they are used in Hain's hearing aids 1 and 11 (red). Thus, the modification does not involve any additional complexity or technical challenges.

- (c) [1B] altering the power sent to the circuitry of the wireless earpieces to a low power mode in response to detecting a magnetic field is applied to one or more of the wireless earpieces.

90. Shaffer in view of Hain discloses altering the power sent to the circuitry of the wireless earpieces (e.g., Shaffer's earbuds 1010 and 1012) to a low power mode (e.g., "low-energy consumption idle mode") in response to detecting a magnetic field is applied to one or more of the wireless earpieces.

91. For example, Shaffer teaches that earbuds 1010 and 1012 automatically transition to a "low-energy consumption idle mode" when they are placed in a storage case. Ex-1003-Shaffer, ¶ 63 ("[PCB circuitry] may contain encoded firmware or other programming instructions to automatically trigger on when the earbuds are removed from the earbud apertures, and turn off upon return to the apertures.... Each earbud may include one or more contact sensors, such as pressure sensors or magnetic sensors that detect when the earbud is in (or out of) the aperture and which send a corresponding signal to the earbud PCBs. Firmware embedded within the earbud PCBs could cause a circuit that includes the rechargeable earbud batteries 930 and 934 [sic] to switch on or off, or return them to a low-energy consumption idle mode."). Even in the low power mode, however, the earpieces maintain at least the ability to be charged and to monitor their sensors so that they are able to automatically turn back on when removed from the case. *Id.*, ¶¶ 40 ("A user may insert a rechargeable earbud into each of the earbud apertures 32 and 33

[of the storage case] to provide electrical charge via the earbud electrical contacts 29 and 31”), 63 (“[Earbuds 1010 and 1012] may contain encoded firmware or other programming instructions to automatically trigger on when the earbuds are removed from the earbud apertures [of the storage case]”).

92. More generally, a POSITA would have been aware of a wide range of power modes used by portable electronics (like wireless earpieces) at the time of the ’853 patent. Varying the level of power sent to the electronics was routinely used to achieve a desired balance between functionality and power consumption at a given point in time. *See, e.g.*, Ex-1013, ¶ 3 (“To reduce power consumption (and extend battery life), portable wireless devices ... may toggle between an active-power state [e.g., a high-power mode] and a low-power state [e.g., a low-power mode] (also known as a standby mode, sleep mode, suspend mode, or the like). When switched to the low-power state ... power consumption is reduced by reducing and/or eliminating power to all unneeded portions of the platform and devices. In many situations it is desirable for one or more applications/services executing on the portable wireless device to maintain connectivity and presence so that the platform or end-user can always be reached.”); *see also* Section VIII.B.1(c) (describing Hain’s low-power mode that uses a “residual power supply”). Accordingly, even if the Patent Owner contends that the claimed low-power mode requires a specific level of residual functionality that is not disclosed by Shaffer or Hain, it would have been

obvious to a POSITA to modify the power modes disclosed by Shaffer and Hain as a routine aspect of the design and implementation of the wireless earpiece system. Such variations would have been obvious to try given that wireless electronics were routinely operated in different power modes, and there are a limited number of circuits and subsystems in the earpieces that could be powered on or off in a given power mode. A POSITA would have implemented a particular desired level of functionality with a reasonable expectation of success given that the system of Shaffer and Hain already has the capability to power some, but not all, of the components of the wireless earpieces (as demonstrated by the residual functionality of the low-power “off” or “idle” modes described above), such that selecting a particular combination of components to keep operational would not have resulted in any additional complexity.

93. As I explained above for Element [1A], Shaffer further discloses that the earpieces include magnetic sensors to detect when the earpieces are in their storage case, such that the earpiece circuitry is powered down (i.e., transitions to a “low power mode”) in response to the output of the magnetic sensor. Ex-1003-Shaffer, ¶¶ 62, 63 (“[Earbuds 1010 and 1012] may contain encoded firmware or other programming instructions to automatically trigger on when the earbuds are removed from the earbud apertures, and turn off upon return to the apertures [of the storage case]. Each earbud may include one or more contact sensors, such as

pressure sensors or magnetic sensors that detect when the earbud is in (or out of) the aperture [of the storage case] and which send a corresponding signal to the earbud PCBs.... Firmware embedded within the earbud PCBs could cause a circuit that includes the rechargeable earbud batteries 930 and 934 to switch on or off, or return them to a low-energy consumption idle mode”), 11 (“Optionally, each earbud may include one or more sensors that detect when the earbud is within or outside of an earbud receiving aperture; and programming that causes the earbud to receive the output of the one or more sensors and use the output to: (1) activate the earbud when the earbud is removed from an earbud receiving aperture; and (2) power down the earbud when the earbud is placed within an earbud receiving aperture”).

94. As I explained above for Element [1A], Shaffer does not expressly describe the implementation details of the magnetic sensor; however, Hain discloses an implementation of a magnetic sensor (e.g., reed contacts 6 and 16) that determines whether an earbud is in its storage case by detecting whether a magnetic field is applied to the earpieces. *See* Sections VIII.B.1(b-c), VIII.B.4, VIII.D.1(b). A POSITA would have been motivated to modify Shaffer in view of Hain as described for Element [1A].

**2. Claim 2: The method of claim 1 further comprising:
operating the wireless earpieces utilizing an onboard
battery in response to detecting the magnetic field is not
applied to one or more of the wireless earpieces.**

95. As I explained previously for Element [1A], Shaffer in view of Hain discloses powering the wireless earpieces using a high-power mode in response to detecting the magnetic field is not applied to one or more of the wireless earpieces. Shaffer further discloses when the earpieces are in the high-power mode, the earpieces are operated using an onboard battery. *See* Section VIII.D.1(b); *see also* Ex-1003-Shaffer, Figure 10, ¶¶ 62-63 (“[E]arbuds 1010 and 1012 include earbud rechargeable batteries 1030 and 1036.... These components may be connected to printed circuit boards PCB 3 and PCB 4 within the earbuds.”); Ex-1004-Hain, Figure 1, ¶¶ 8 (“A hearing aid also comprises a voltage source (battery or accumulator) for supplying voltage to the electronic components”), 18, 20, Claims 1 and 7.

**3. Claim 3: The method of claim 1 further comprising:
charging an onboard battery of the wireless earpieces in
response to detecting a magnetic field is applied to the
wireless earpieces.**

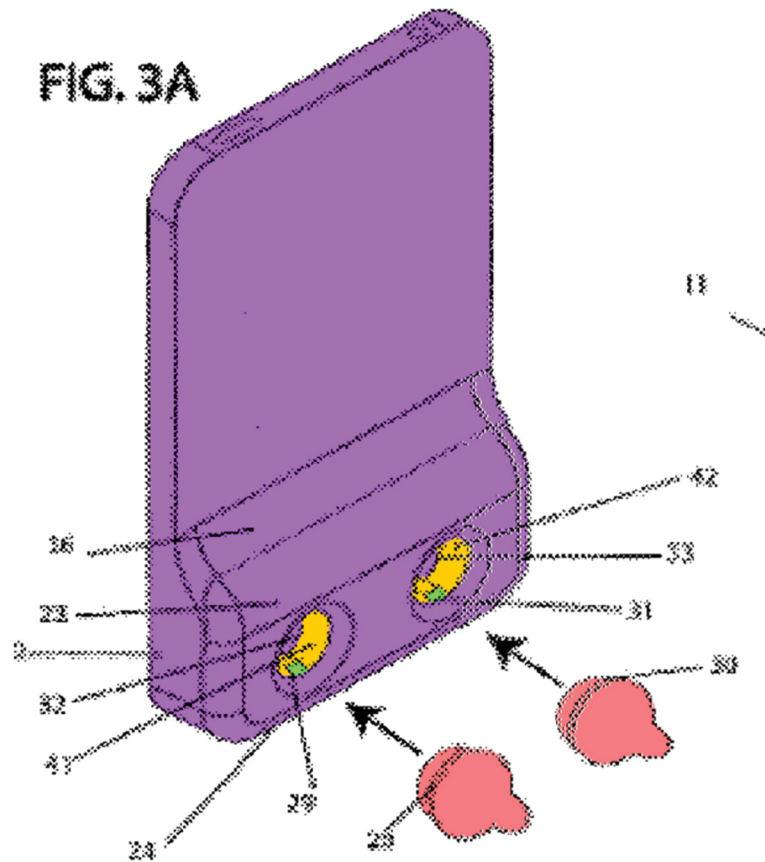
96. As I explained previously for Element [1B], Shaffer in view of Hain discloses powering the wireless earpieces (e.g., earbuds 1010 and 1012) using a low-power mode in response to detecting a magnetic field is applied to the wireless earpieces. Shaffer further discloses when the earpieces are in the low-power mode, an onboard battery (e.g., batteries 1030 and 1034) of the wireless earpieces is

charged. *See* Section VIII.D.1(c); *see also* Ex-1003-Shaffer, ¶¶ 62 (“[E]arbuds 1010 and 1012 include earbud rechargeable batteries 1030 and 1036”), 40 (“A user may insert a rechargeable earbud into each of the earbud apertures 32 and 33 [of the storage case] to provide electrical charge via the earbud electrical contacts 29 and 31”), Figure 10.

4. Claim 4: The method of claim 1, wherein the magnetic field is applied by a magnet of a smart case configured to receive the wireless earpieces.

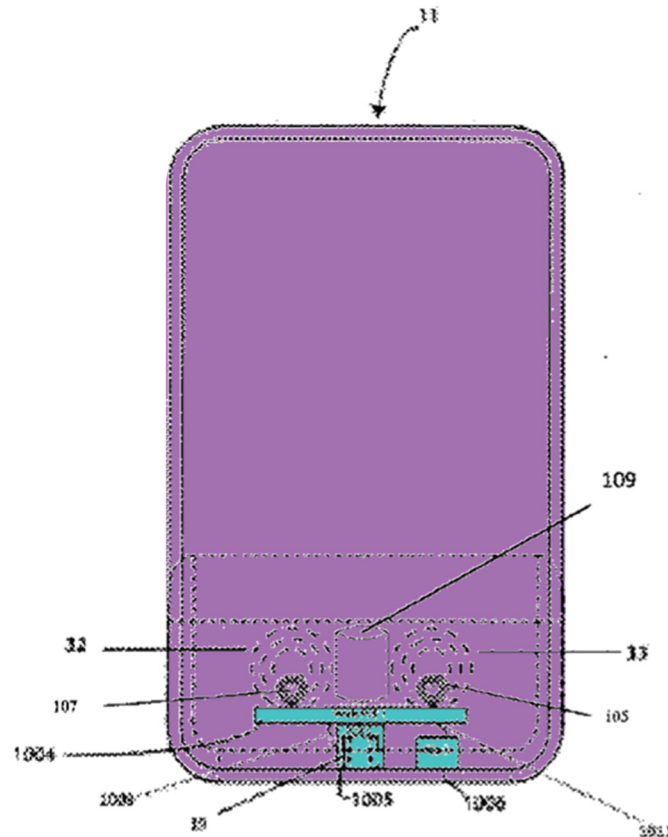
97. Shaffer discloses that the magnetic field is applied by a magnet of a smart case (e.g., storage case) configured to receive the wireless earpieces (e.g., earbuds 1010 and 1012).

98. In particular, Shaffer discloses that the magnetic field is applied by a magnet. Figure 3A of Shaffer, reproduced below, depicts a pair of earbuds (red) and their corresponding storage case 11 (purple).



Ex-1003-Shaffer, Figure 3A. As shown above, case 11 (purple) includes magnetic strips 41 and 42 (orange). *Id.*, ¶¶ 42 (storage case includes “aperture magnetic contact strips 41 and 42”). Due their placement within the apertures of the storage case, the magnetic strips 41 and 42 apply a magnetic field to the earpieces when the earpieces (e.g., earbuds 1010 and 1012 shown in Figure 10) are placed into the apertures of the storage case. *See, e.g., id.*, ¶¶ 43, 46, 58, 62 (explaining how earbuds 1010 and 1012 interact with the magnetic fields applied by the magnets of the storage case).

99. Moreover, the magnetic field is applied by a magnet of a smart case. For example, Figure 4 of Shaffer (reproduced below) shows details of the circuitry within case 11.

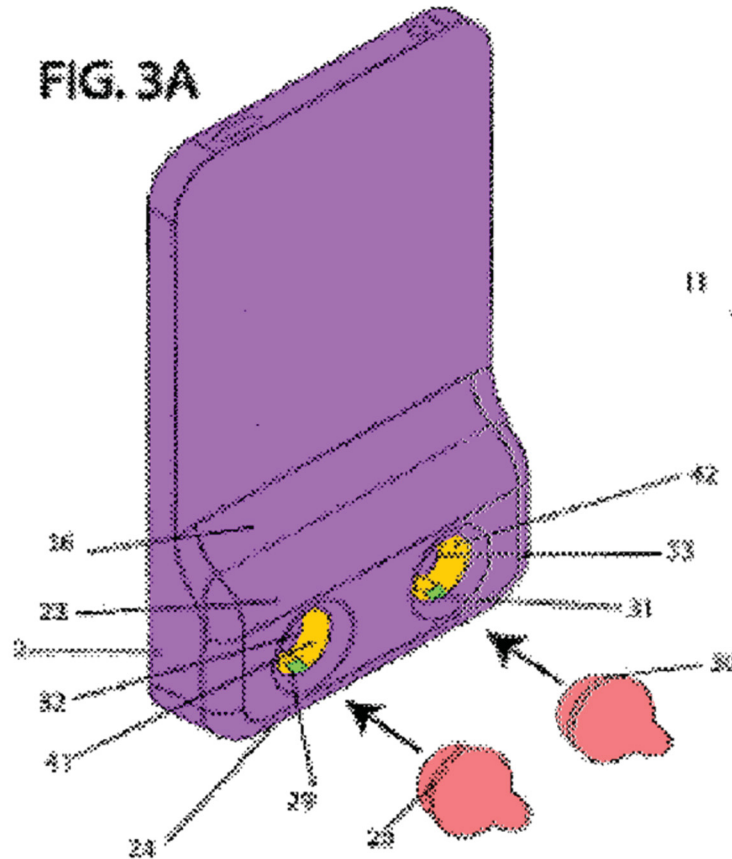


Ex-1003-Shaffer, Figure 4. Within case 11 (purple), Figure 4 shows that there are multiple intelligent controls represented by printed circuit boards 1004, 1005, and 1006 (teal). *Id.*, ¶ 48 (“FIG. 4 shows a view of the case 11 illustrating an example embodiment of its internal electrical components. As shown in the figure, there may be three (or any number of) printed circuit boards (or ‘PCBs’), the main PCB1 1004, PCB2 1005, and PCB3 1006.”). Shaffer explains that circuits contained on printed

circuit boards 1004, 1005, and 1006 are used to control the operation and functionality of the storage case—illustrative management functions include authentication, battery charging, and data connectivity. *Id.* (“PCB1 1004 is the main PCB in the example shown, and it may contain such items as a controller, firmware, an authentication chip, and a battery charging circuit. PCB2 1005 may contain a case connector, such as a 30-pin connector, Lightning connector or other connector. PCB3 1006 may contain the USB connector.”). Other management functions include automatically distributing battery charge among the onboard batteries of the storage case, the wireless earbuds, and a mobile device connected to the storage case. Ex-1003-Shaffer, ¶ 57 (“Main PCB1 1004 may contain any firmware or other software needed to appropriately balance the charge directed to rechargeable batteries 39 and 27 and case rechargeable battery 109, and the charge exchanged between all three rechargeable batteries and a mobile device connected to case 11.”). These control circuits and management functions offer the same “smart” capabilities as the ’853 patent’s case. *See, e.g.,* Ex-1001-USP853, 6:45-56 (“The logic engine 406 is the logic that controls the operation and functionality of the smart case 402. The logic engine 406 may include circuitry, chips, and other digital logic. The logic engine 406 may also include programs, scripts, and instructions that may be implemented to operate the logic engine 406. The logic engine 406 may represent

hardware, software, firmware, or any combination thereof”), 2:41-42 (“the smart cases may ensure that the wireless earpieces are charged to a desired level”).

100. In addition, the smart case is configured to receive the wireless earpieces. For example, Figure 3A of Shaffer is again reproduced below.



Ex-1003-Shaffer, Figure 3A. Figure 3A shows that case 11 (purple) receives a pair of wireless earpieces (red) via corresponding “earbud receiving apertures.” *Id.*, ¶¶ 40 (“The case also may include any number of earbud receiving apertures 32 and 33. Although the example shown illustrates two apertures, the device may include a single aperture, or more than two apertures, depending on the number of earbuds

that are desired to be charged. A user may insert a rechargeable earbud into each of the earbud apertures 32 and 33 to provide electrical charge via the earbud electrical contacts 29 and 31”), 41-43. This arrangement ensures that the earpieces (e.g., earbuds 1010 and 1012) are “securely retained” in the apertures of the case. *Id.*, ¶ 62 (“The earbuds are outfitted with magnetic rings 1016 and 1026 that allow a connection with magnetized earbud aperture rings to ensure the earbuds remain securely retained within earbud apertures (e.g., 834 and 830 of FIG. 8) [of the storage case] which may also contain magnetic elements”).

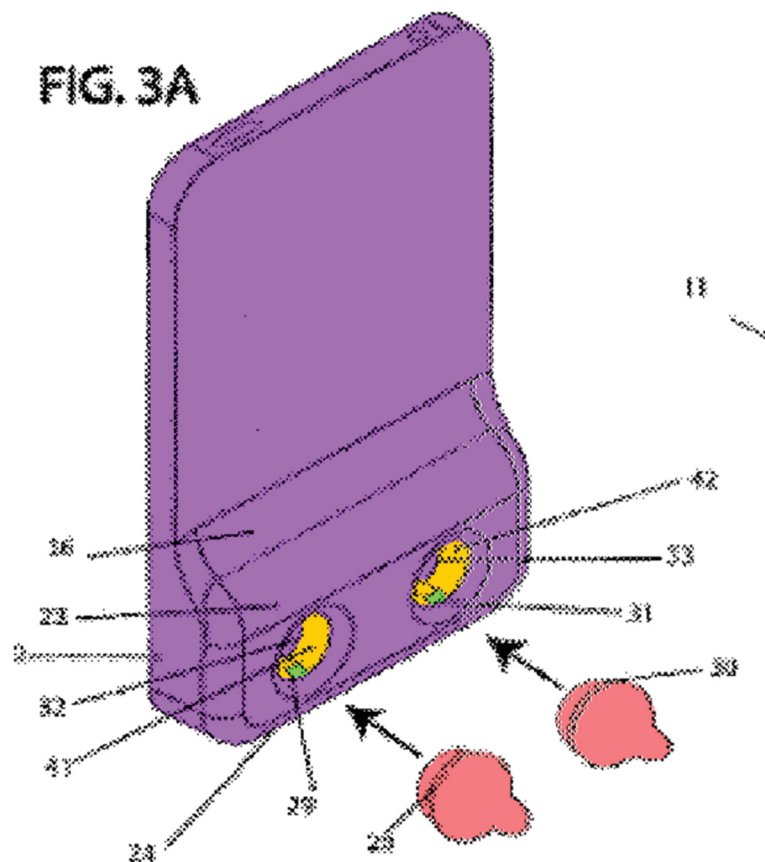
5. Claim 5: The method of claim 1, wherein the magnetic field is detected by a reed switch of the wireless earpieces.

101. As I explained above for Elements [1A]-[1B] and for Claim 5 (Ground 2), Hain discloses that the magnetic field is detected by a reed switch (e.g., reed contacts 6 and 16) of the wireless earpieces. *See also* Ex-1004-Hain, Figure 1, ¶¶ 4, 10-11, 18-19, Claim 2. The principle of operation of a reed switch, including how it detects a magnetic field, is further explained in Section VI.A. Moreover, a POSITA would have been motivated to modify Shaffer in view of Hain as described for Elements [1A]-[1B]. *See* Section VIII.D.1(b).

6. **Claim 6: The method of claim 1, further comprising:
coupling the wireless earpieces to interfaces of a smart case,
wherein the smart case applies a magnetic field to one or
more of the wireless earpieces.**

102. Shaffer discloses coupling the wireless earpieces (e.g., earbuds 1010 and 1012) to interfaces of a smart case (e.g., storage case), wherein the smart case applies a magnetic field to one or more of the wireless earpieces.

103. Figure 3A of Shaffer, reproduced below, depicts a pair of wireless earpieces (red) and a corresponding storage case 11 (purple).



Ex-1003-Shaffer, Figure 3A. Shaffer explains that a user can insert the earpieces into apertures of the storage case and thereby couple the earpieces to interfaces (e.g.,

electrical contacts 29 and 31, green) within the apertures. *Id.*, ¶¶ 39, 40 (“A user may insert a rechargeable earbud into each of the earbud apertures 32 and 33 to provide electrical charge via the earbud electrical contacts 29 and 31”), 42, 47, 56-58. In addition to electrical contacts, Shaffer discloses other types of interfaces for coupling to the earpieces, e.g., using inductive chargers or magnetic strips. *Id.*, ¶¶ 53 (“earbuds 34 and 35 may receive power from earbud apertures 32 and 33 via an induction charging unit”), 54-56, 42 (“In certain embodiments, the aperture magnetic contact strips 41 and 42 may also serve as electrical contacts, delivering charge directly to the earbud magnetic contact strips from the plug without the need for additional prongs or leaders”)

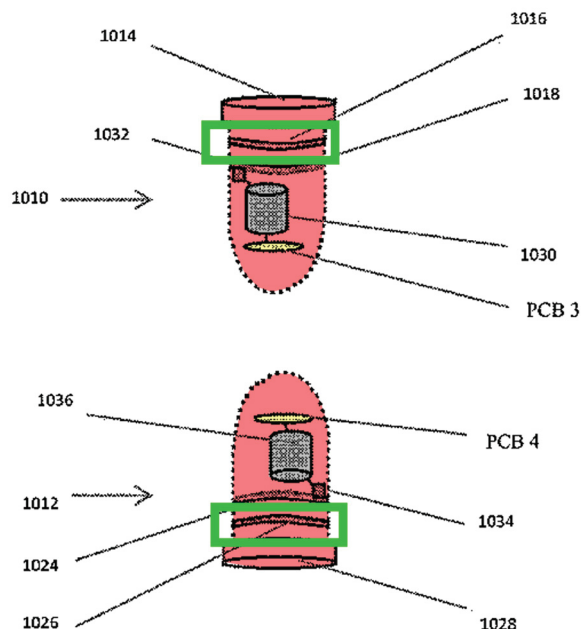
104. Moreover, as I explained above for Claim 4, Shaffer’s storage case is a smart case that applies a magnetic field to one or more of the wireless earpieces.

7. Claim 7: The method of claim 1, wherein the magnetic field is detected by a reed switch integrated in magnetic contacts that interface with a smart case for securing the wireless earpieces.

105. As I explained above for Elements [1A]-[1B] and Claim 5, Shaffer in view of Hain discloses that the magnetic field is detected by a reed switch (e.g., Shaffer’s earbuds 1010 and 1012 incorporating Hain’s reed contacts 6 and 16).

106. Moreover, Shaffer in view of Hain discloses that the reed switch is integrated in magnetic contacts that interface with a smart case (*see* Claims 4 and 6)

for securing the wireless earpieces. For example, Figure 10 of Shaffer (reproduced below) depicts details of the circuitry of the wireless earpieces.



Ex-1003-Shaffer, Figure 10. Figure 10 shows that earbuds 1010 and 1012 (red) include magnetic contacts (e.g., magnetic rings 1016 and 1026, green box) that interface with the storage case for securing the earbuds. *Id.* ¶¶ 62 (“The earbuds are outfitted with magnetic rings 1016 and 1026 that allow a connection [(i.e., interface)] with magnetized earbud aperture rings [of the storage case] to ensure the earbuds remain securely retained within earbud apertures (e.g., 834 and 830 of FIG. 8) which may also contain magnetic elements”), 63, 42. Consequently, when Shaffer’s earbuds are modified to use Hain’s reed contacts (*see* Section VIII.D.1(b)(i)), the modified teachings of Shaffer would have included a reed switch integrated in the

magnetic contacts. A POSITA would have been motivated to modify Shaffer in view of Hain's in this manner as described for Elements [1A]-[1B].

8. Claim 9: The method of claim 1, wherein the low power mode is a power saver mode.

107. Shaffer discloses that the low-power mode (e.g., “low-energy consumption idle mode”) is a power saver mode. *See* Section VIII.D.1(c). The ’853 patent describes the power saver mode as seeking to minimize power usage while supporting residual functions such as charging. Ex-1001-USP853, 10:10-24 (“During the power saver mode the wireless earpiece may utilize minimal power to maintain functionality and alert status of the wireless earpiece. For example, the wireless earpiece may be configured to communicate with one or more other external devices, such as the smart case, another pair of wireless earpieces, mobile devices, personal computers, routers, or so forth. Location data of the user may be shared with other external, devices and corresponding applications. In the power saver mode the wireless earpiece minimizes power utilization while still exerting full control over the power utilization, charging, and synchronization of the wireless earpieces.”).

108. As I explained above for Element [1B], Shaffer’s “low-energy consumption idle mode” minimizes power usage by limiting the functionality of the earpieces to residual functionality, such as the ability to recharge the battery and detect when the earpieces are been removed from the storage case. *See* Section

VIII.D.1(c). More generally, as I explained in Section VIII.D.1(c), even if the Patent Owner contends that there are any differences between Shaffer’s low-power mode and the claimed “power saver mode,” it would have been obvious to implement the low-power mode as a “power saver mode,” particularly because by the claimed priority date of the ’853 patent, many types of low power modes (including what the patent calls a power saver mode) were well-known, obvious to try, and routine to implement.

E. Ground 5

109. As I will explain in detail below, claims 4 and 6-8 would have been obvious over Shaffer in view of Hain and Sorensen.

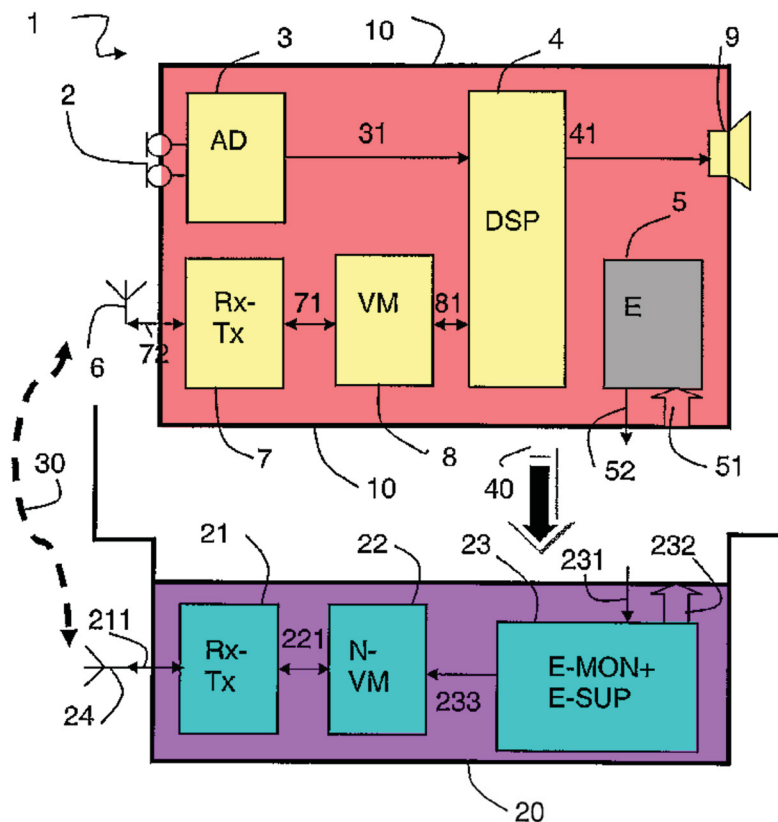
1. Claims 4, 6, and 7: “... a smart case ...”

110. Claims 4, 6, and 7 all recite a “smart case.” The ’853 patent’s specification discloses various exemplary capabilities of a smart case, such as facilitating battery charging and providing data connectivity. Ex-1001-USP853, 2:38-51 (“For example, the smart case may be utilized to preserve the battery life of the wireless earpieces by interacting with the wireless earpieces while in a low power mode or state. In addition, the smart cases may ensure that the wireless earpieces are charged to a desired level. Charging may be performed utilizing contact or wirelessly (e.g., inductive charging). The smart case may communicate with the wireless earpieces through physical interactions (e.g., magnetic contact points, physical

switches, etc.) or through wireless connections, standards, or protocols (e.g., near field communications, Bluetooth, Wi-Fi, etc.). The wireless earpieces may upload, synchronize, or store biometric and performance data associated with the wireless earpieces and/or associated user to the smart case.”).

111. As I explained above for claims 4, 6, and 7 in Ground 4, Shaffer’s storage case is such a “smart case” given that it includes PCB-mounted intelligent controls that carry out a variety of management functions for the case (e.g., authentication, battery charging, and data connectivity functions). *See* Section VIII.D.4.

112. Moreover, even if the Patent Owner contends that Shaffer’s storage case lacks any required capability of a “smart case,” Sorensen discloses yet further “smart” functionality of an earpiece storage case. Sorensen’s storage case (charging station 20, purple) is shown in Figure 1, reproduced below.



Ex-1005-Sorensen, Figure 1; *see also id.*, 6:26-47 (“FIG. 1 shows a first embodiment of a hearing aid system 1 comprising a hearing instrument 10 [(red)] and a charging station 20 [(purple)] for recharging a rechargeable battery [(gray)] of the hearing instrument”), 7:26-54. The storage case includes multiple intelligent controls (teal), such as a signal processor 21, a memory 22, and a monitoring and charging unit 23, which are used to establish data communications between charging station 20 and hearing instrument 10 and recharge the hearing instrument’s battery 5. For example, the intelligent controls carry out operations including:

- transferring configuration data from memory 22 to hearing instrument 10 (Ex-1005-Sorensen, 7:37-43);

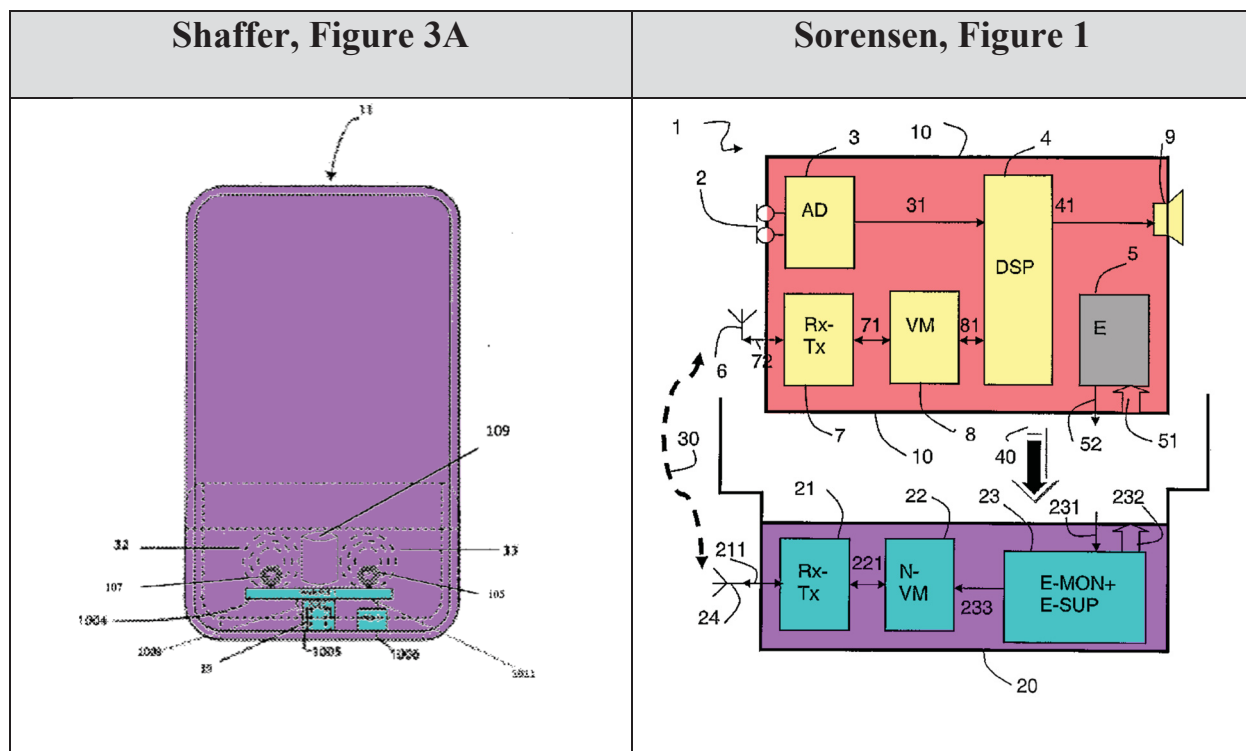
- transferring usage and operational data from hearing instrument 10 to charging station 20 (*id.*, 7:43-46);
- monitoring the status of hearing instrument battery 5 (*id.*, 7:54-60);
- executing data transfers intelligently based on the battery status (e.g., executing the transfers when hearing instrument battery 5 is charged above a threshold) (*id.*, 6:51-62, 8:10-15);
- connecting to a network (e.g., the Internet) to facilitate data transfer between hearing instrument 10 and remote servers (*id.*, 3:22-33); and
- updating software or firmware of hearing instrument 10 (*id.*, 3:36-42)

In view of these intelligent capabilities, a POSITA would have understood Sorensen's charging station 20 to be a "smart" case.

113. Moreover, to the extent any of these capabilities are not already provided by Shaffer's storage case, a POSITA would have been motivated to incorporate the above-described functionality of Sorensen's intelligent controls 21, 22, and 23 into Shaffer's storage case. This is particularly so because Sorensen discloses that including these capabilities in the case offers benefits including reducing the hardware requirements of the hearing instrument, which in turn "allow[s] a smaller and cheaper and more energy efficient hearing instrument to be made." Ex-1005-Sorensen, 2:33-35. Sorensen also explains that incorporating intelligent functionality into the case also advantageously "allow the user, dispenser,

or manufacturer to analyze the data from the hearing instrument and/or to upload basic data of the hearing instruments and/or software updates (e.g., firmware updates) to the hearing instrument.” *Id.*, 2:5-8.

114. A POSITA would have modified Shaffer’s storage case to incorporate one or more “smart” capabilities of Sorensen’s intelligent controls 21, 22, and 23 with a reasonable expectation of success. As I explained above for claims 4, 6, and 7, Shaffer’s storage case already includes intelligent controls (e.g., PCB circuitry 1004, 1005, and 1006) and uses them to perform management functions—Sorensen simply discloses further details and capabilities of the built-in control circuitry of the case. The modified system of Shaffer in view of Sorensen is shown below.

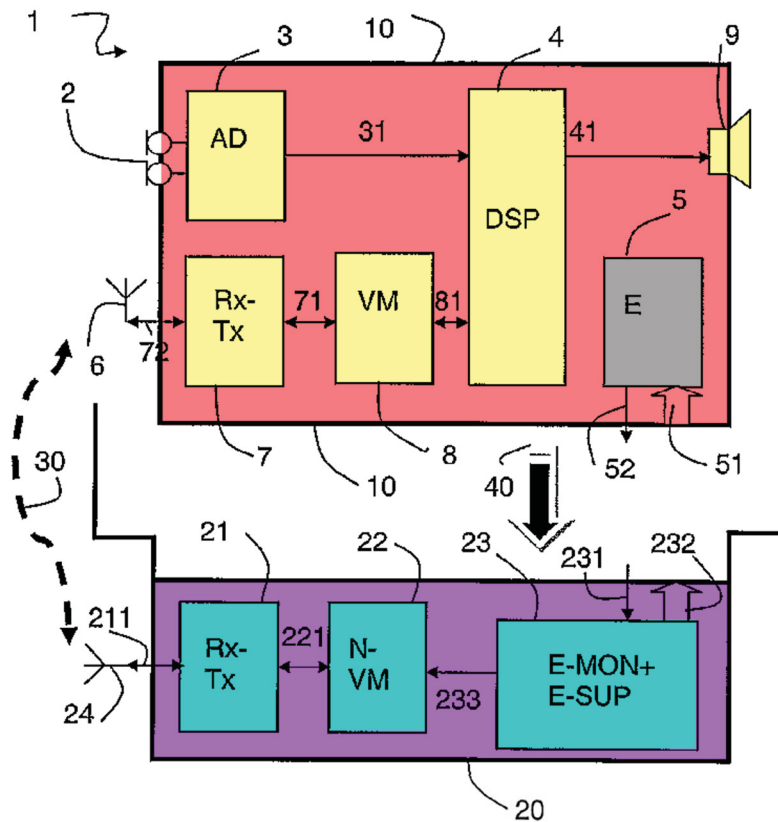


In the modified teachings of Shaffer, the functionality of Sorensen's intelligent controls 21, 22, and 23 would be used for its intended purpose of exchanging data with and recharging wireless earpieces when placed in a storage case. Thus, the modification does not introduce any complexity or technical challenges.

**2. Claim 8: A method of claim 1 further comprising:
synchronizing data between the wireless earpieces and a
smart case in response to detecting the magnetic field.**

115. Shaffer in view of Hain and Sorensen discloses synchronizing data between the wireless earpieces and a smart case in response to detecting the magnetic field. For example, data synchronization is enabled by the communication between the wireless earpieces and the smart case via the interfaces identified for Claims 4, 6, and 7, consistent with embodiments of the '853 patent's specification. *See* Ex-1001-USP853, 4:5-26 ("The smart case includes interfaces 108, 110 ... for electrically connecting the wireless earpieces 142, 144 to the smart case 102.... The interfaces 108, 110 may also be utilized to synchronize data between the wireless earpieces 142, 144.").

116. With respect to Sorensen, Figure 1 of Sorensen (reproduced below) depicts a wireless earpiece (hearing instrument 10, red) and a corresponding smart case (charging station 20, purple; *see* Section VIII.E.1).



Ex-1005-Sorensen, Figure 1; *see also id.*, 6:26-47 (“FIG. 1 shows a first embodiment of a hearing aid system 1 comprising a hearing instrument 10 and a charging station 20 for recharging a rechargeable battery of the hearing instrument”). In particular, Sorensen discloses synchronizing data between the hearing instrument 10 and charging station 20 by transferring configuration data from memory 22 (teal) to hearing instrument 10 (red) (*id.*, 7:37-43) and transferring usage and operational data from hearing instrument 10 (red) to charging station 20 (purple) (*id.*, 7:43-46).

117. Sorensen further discloses that the data is synchronized in response to determining that hearing instrument 10 is placed into charging station 20. For example, Sorensen discloses that its system initiates communication between the

devices when hearing instrument 10 is placed into charging station 20. Ex-1005-Sorensen, 4:43-62 (“The system is arranged to provide that communication between charging station and hearing instrument can be established via connection 30, when the hearing instrument is placed in the charging station”). A POSITA would have understood this communication to include the data synchronization described above (e.g., data transfers to and from hearing instrument 10) given that Sorensen discloses these data synchronization operations as examples of the types of communication that its system performs.

118. As I explained above for Claims 4, 6, and 7, a POSITA would have been motivated to modify Shaffer in view of Sorensen, e.g., by modifying Shaffer’s storage case to use the data synchronization functionality of Sorensen’s intelligent controls 21, 22, and 23. *See* Section VIII.E.1. Moreover, as I explained above, Shaffer in view of Hain discloses determining that the earpieces are in the storage case by detecting a magnetic field is applied to the earpieces. *See* Section VIII.D.1(b-c). Thus, modifying the system of Shaffer and Hain to use the data synchronization functionality of Sorensen results in a system in which data is synchronized between the earpieces and smart case in response to detecting the magnetic field.

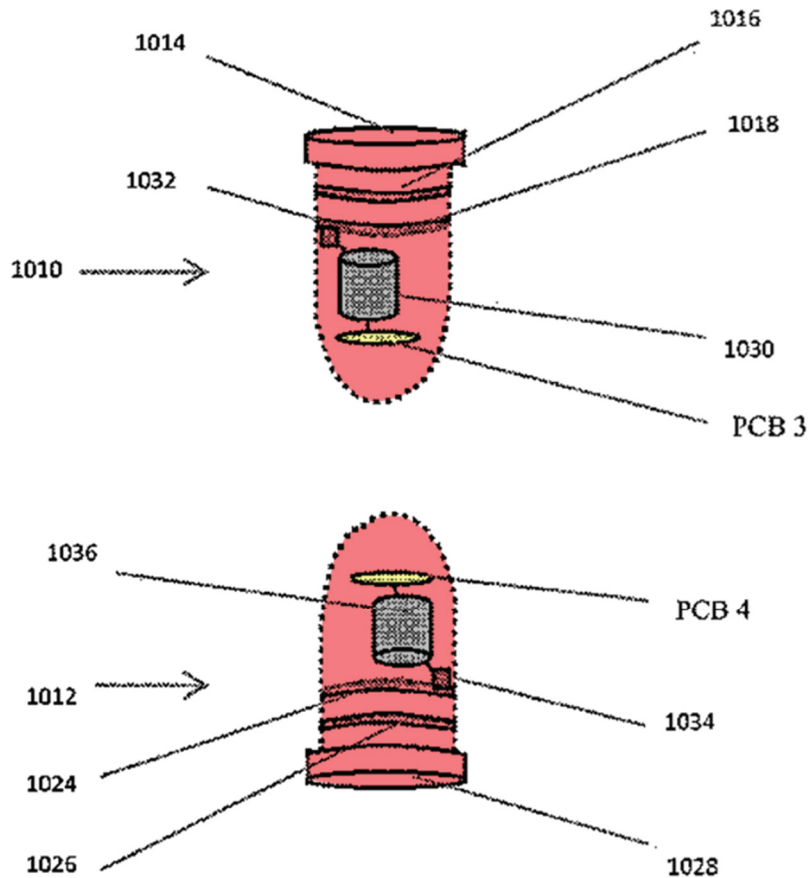
F. Ground 6

119. As I will explain in detail below, claims 10-12, 14, and 16-21 would have been obvious over the Shaffer in view of Steinbrecher.

1. Claim 10

(a) [10Preamble] A wireless earpiece comprising:

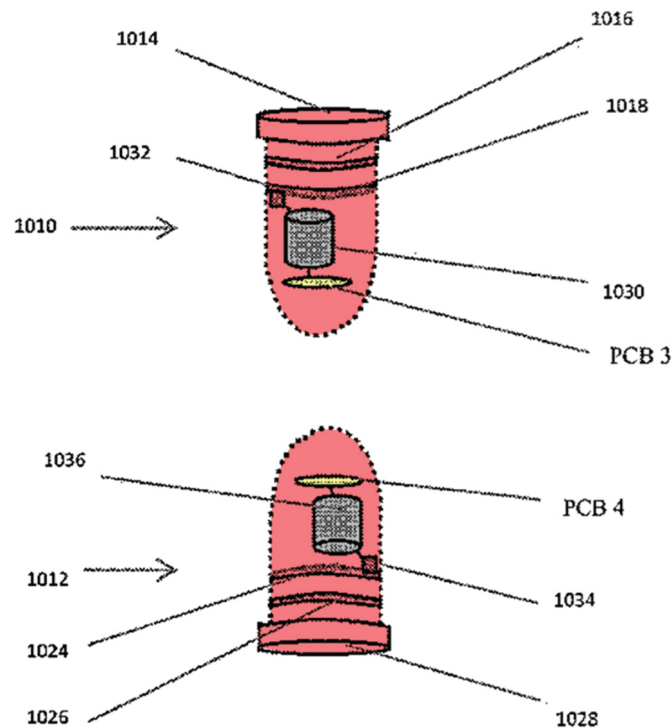
120. As I explained for Element [1Preamble], Shaffer discloses wireless earbuds 1010 and 1012 (red), which are wireless earpieces.



Ex-1003-Shaffer, Figure 10; *see also id.*, ¶¶ 62, 63.

(b) [10A] circuitry operating the wireless earpiece;

121. As I explained above for Elements [1A]-[1B], Shaffer discloses PCB circuitry 3 and 4 (yellow) that operates the wireless earpieces (e.g., earbuds 1010 and 1012, red).

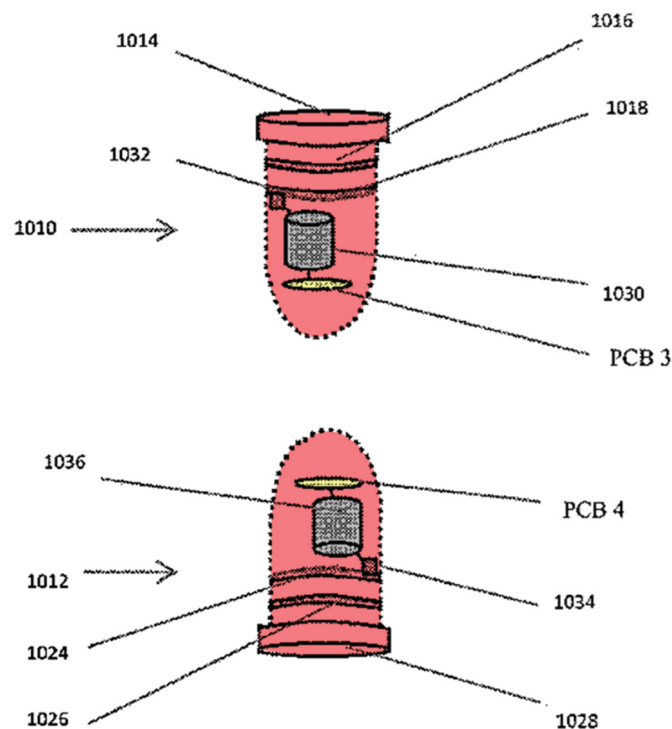


Ex-1003-Shaffer, Figure 10; *see also id.*, ¶¶ 62-63 (“[E]arbuds 1010 and 1012 include earbud rechargeable batteries 1030 and 1036.... These components may be connected to printed circuit boards PCB 3 and PCB 4.”). One exemplary function of the PCB circuitry is to automatically reduce the power consumption of the earbuds when the earbuds are placed into a storage case. *Id.*, ¶ 63 (“[PCB circuitry] may contain encoded firmware or other programming instructions to automatically trigger on when the earbuds are removed from the earbud apertures, and turn off

upon return to the apertures.... Each earbud may include one or more contact sensors, such as pressure sensors or magnetic sensors that detect when the earbud is in (or out of) the aperture and which send a corresponding signal to the earbud PCBs. Firmware embedded within the earbud PCBs could cause a circuit that includes the rechargeable earbud batteries 930 and 934 [sic] to switch on or off, or return them to a low-energy consumption idle mode.”).

(c) [10B] a battery powering the circuitry of the wireless earpiece; and:

122. As I explained above for Elements [1A]-[1B], Shaffer discloses rechargeable batteries 1030 and 1036 (gray) that power PCB circuitry 3 and 4 (yellow) of the wireless earpieces 1010 and 1012 (red), respectively.



Ex-1003-Shaffer, Figure 10; *see also id.*, ¶¶ 62-63 (“[E]arbuds 1010 and 1012 include earbud rechargeable batteries 1030 and 1036.... These components may be connected to printed circuit boards PCB 3 and PCB 4 within the earbuds.”).

(d) [10C] a reed switch connecting the battery to the circuitry wherein the reed switch connects the circuitry to the battery when a magnetic field is not detected, and wherein the reed switch disconnects the circuitry from the battery when a magnetic field is detected

123. Shaffer in view of Steinbrecher discloses a reed switch connecting the battery to the circuitry wherein the reed switch connects the circuitry to the battery when a magnetic field is not detected, and wherein the reed switch disconnects the circuitry from the battery when a magnetic field is detected.

124. As I explained above for Elements [1A]-[1B], Shaffer discloses connecting the connecting the battery (e.g., batteries 1030 and 1036) to the circuitry (e.g., PCB circuitry 3 and 4), wherein the circuitry is connected to the battery (e.g., powered) when a magnetic sensor detects that the earpieces are out of their storage case (*see* Section VIII.D.1(b)), and wherein the circuitry is disconnected from the battery (e.g., power is switched off) when the magnetic sensor detects that the earpieces are in their storage case (*see* Section VIII.D.1(c)).

125. Shaffer does not describe the implementation details of the magnetic sensor; however, Steinbrecher discloses an implementation of a magnetic sensor that uses a reed switch (e.g., microswitch M implemented as a reed contact) to connect

the battery to the circuitry, even calling this implementation of the magnetic sensor “particularly preferred.” Ex-1006-Steinbrecher, ¶¶ 20 (“In a particularly preferred embodiment, the microswitch is designed as a reed contact, which is actuated by a permanent magnet arranged in the storage case, which controls an input of the charging controller, whereupon the latter disconnects the electrical connection between the battery and the hearing aid’s electronics.”), 25 (“When placed in a storage case, the microswitch configured as a reed contact is actuated by means of a built-in permanent magnet.”).

126. In particular, as I explained above for Element [10C] in Ground 3, Steinbrecher discloses that the magnetic sensor (which includes a reed switch) connects or disconnects the circuitry from the battery by detecting whether a magnetic field is applied to the earpieces. *See* Section VIII.C.1(d); *see also* Ex-1006-Steinbrecher, ¶¶ 18, 19 (“A microswitch is preferably arranged in the hearing aid, which then controls an input of the charge controller when the hearing aid is placed in a storage case. In this case, the charge controller separates the hearing aid’s electronics from the battery, so that no current is consumed and no feedback whistling occurs.”), 20, 25 (“When placed in a storage case, the microswitch configured as a reed contact is actuated by means of a built-in permanent magnet, which controls an input of the charging controller, whereupon the latter disconnects the electrical connection between the battery and the hearing aid’s electronics.”).

(i) Motivation to combine

127. A POSITA would have been motivated to modify Shaffer in view of Steinbrecher and would have done so with a reasonable expectation of success. As I explained above, Shaffer discloses using a magnetic sensor to detect whether earbuds are in their storage case and should be powered down, and Steinbrecher provides implementation details of the magnetic sensor including the use of a reed switch (reed contacts 6 and 16) to detect the presence of a magnetic field. Accordingly, the modification would simply involve implementing Shaffer using Steinbrecher's magnetic sensor (which includes reed contacts) to detect whether a magnetic field is applied to the earbuds.

128. Steinbrecher discloses a well-known implementation of a magnetic sensor (e.g., using a reed switch actuated by a permanent magnet) that is suitable for Shaffer's purpose of detecting whether the earpieces are in their storage case—in fact, Steinbrecher uses the magnetic sensor for the same purpose as Shaffer. Ex-1003-Shaffer, ¶ 63 (“Each earbud may include one or more contact sensors, such as pressure sensors or magnetic sensors that detect when the earbud is in (or out of) the aperture [of the magnetic storage case] and which send a corresponding signal to the earbud PCBs”); Ex-1006-Steinbrecher, ¶¶ 20 (“In a particularly preferred embodiment, the microswitch is designed as a reed contact, which is actuated by a permanent magnet arranged in the storage case”), 25 (“When placed in a storage

case, the microswitch configured as a reed contact is actuated by means of a built-in permanent magnet.”).

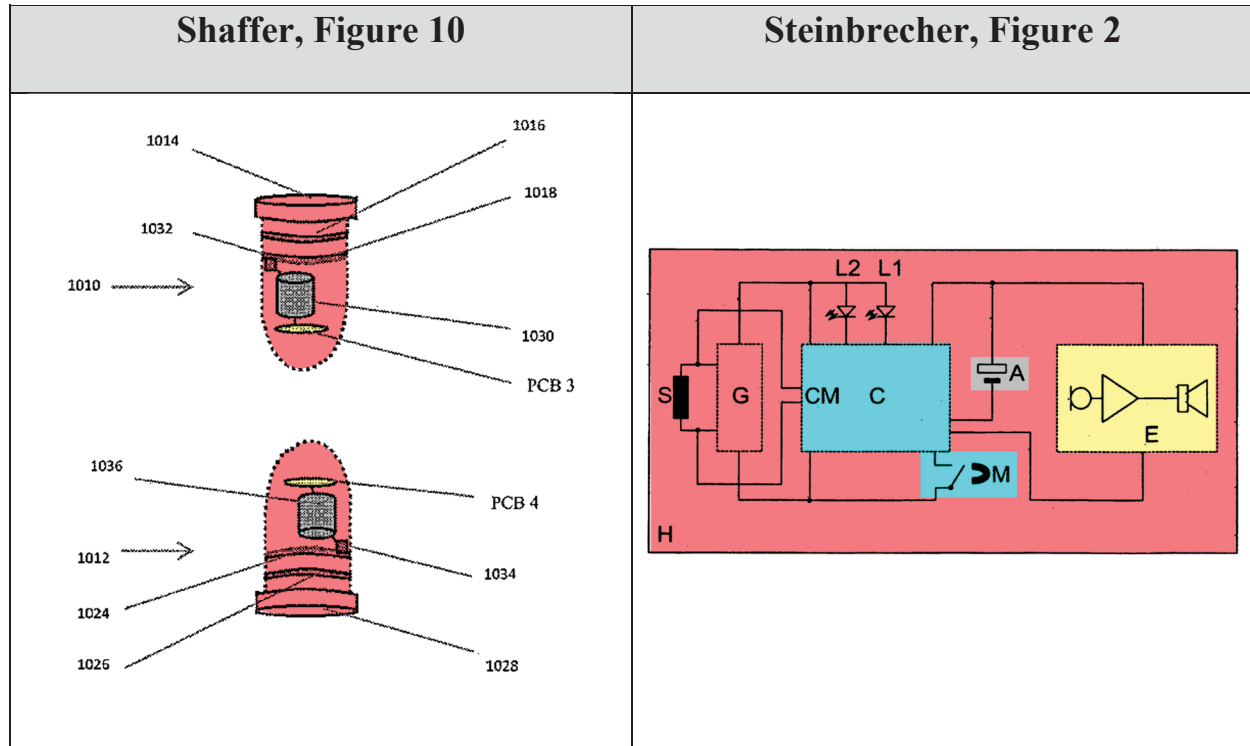
129. Moreover, the systems disclosed by Shaffer and Steinbrecher share the same goal of reducing the power consumption of wireless earpieces, such as hearing aids, when placed into a case for storage. *See, e.g.*, Ex-1003-Shaffer, ¶¶ 2 (“This patent document relates to a mobile device case that serves as an electrical charger and storage dock for rechargeable wireless audio earbuds”), 32 (“Examples of earbuds include in-ear headphones, hearing aids and the like”), 46, 62, 63 (“[The earbuds] may contain encoded firmware or other programming instructions to automatically trigger on when the earbuds are removed from the earbud apertures [of the magnetic storage case], and turn off upon return to the apertures”); Ex-1006-Steinbrecher, ¶¶ 1 (“The invention relates to a procedure and a device for the contactless loading of an accumulator battery in a hearing aid which, during the charge process, is located in a charging shell”), 18 (“In a preferred embodiment, the hearing aid's electronics are switched off using the charge controller, in particular during the charge process and as soon as the hearing aid is located in the charging shell. This ensures that energy is not consumed unnecessarily and feedback whistling does not occur.”). In fact, as I explained above (*see* Sections VIII.C.1(d) and VIII.D.1(b-c)), both Shaffer and Steinbrecher describe using the same approach to detect whether the earpieces are in their storage case, namely, by equipping the

earpieces with magnetic sensors to detect the presence or absence of a magnetic field applied by a magnetic storage case.

130. The benefits of reed switch-based magnetic sensors were well known (*see* Section VI.A), as further evidenced by Steinbrecher’s express disclosure that its reed switch-based approach is “particularly preferred” and ensures that “no current is consumed and no feedback whistling occurs.” Ex-1006-Steinbrecher, ¶ 19; *see also id.*, ¶¶ 18 (“In a preferred embodiment, the hearing aid’s electronics are switched off using the charge controller, in particular during the charge process and as soon as the hearing aid is located in the charging shell. This ensures that energy is not consumed unnecessarily and feedback whistling does not occur.”), 20 (using a reed contact is a “particularly preferred” implementation).

131. A POSITA would have had a reasonable expectation of success in applying Steinbrecher’s teachings to Shaffer’s system given that Steinbrecher’s teachings simply fill in routine implementation details of Shaffer’s magnetic sensors. Ex-1003-Shaffer, ¶ 63 (“Each earbud may include one or more contact sensors, such as pressure sensors or magnetic sensors that detect when the earbud is in (or out of) the aperture [of the magnetic storage case] and which send a corresponding signal to the earbud PCBs”); Ex-1006-Steinbrecher, ¶¶ 20, 25 (“When placed in a storage case, the microswitch configured as a reed contact is actuated by means of a built-in

permanent magnet.”). The modified system of Shaffer in view of Steinbrecher is shown below.



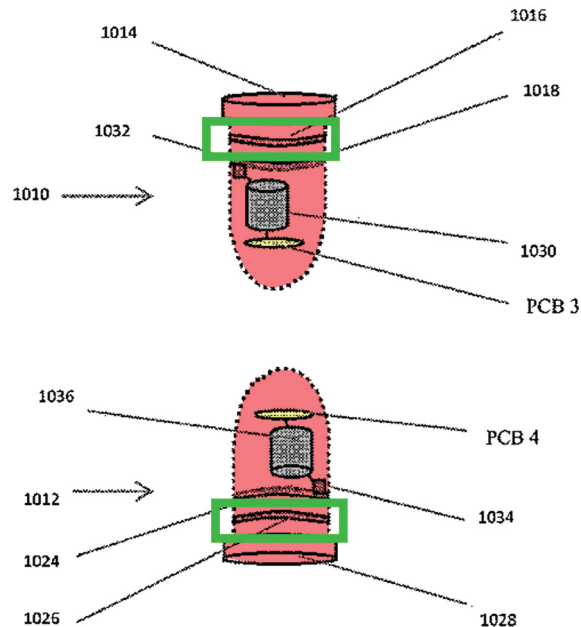
In the modified teachings, Steinbrecher's sensor (blue) comprising charge controller C and microswitch M would be used to detect the presence or absence of a magnetic field applied to Shaffer's earpieces 1010 and 1012, which is the same purpose for which the sensor is used in Steinbrecher's hearing aid H. Thus, the modification does not involve any additional complexity or technical challenges.

2. **Claim 11: The wireless earpiece of claim 10, wherein the magnetic field is applied by a smart case configured to receive the wireless earpiece, and wherein the smart case powers the wireless earpiece when received in the smart case.**

132. As I explained above for Claim 4, Shaffer discloses that the magnetic field is applied by a magnet of a smart case (e.g., storage case) configured to receive the wireless earpieces (e.g., earbuds 1010 and 1012). Shaffer further discloses that the smart case powers the wireless earpieces when received in the smart case. *See, e.g.,* Ex-1003-Shaffer, ¶¶ 6 (“Each earbud receiving aperture includes or is otherwise associated with one or more electrical components configured to transfer an electrical charge from a power source to an earbud when the earbud is positioned within the aperture [of the storage case]”), 53 (“earbuds 34 and 35 may receive power from earbud apertures 32 and 33 [of the storage case]”), Claim 1.

3. **Claim 12: The wireless earpiece of claim 10, further comprising: magnetic contacts in connection with the circuitry and the battery that interface with a smart case to charge the battery.**

133. As I explained above for Claim 7, Shaffer discloses magnetic contacts (e.g., magnetic rings 1016 and 1026) that interface with a smart case (e.g., storage case; *see* Claims 4 and 11). Moreover, referring to Figure 10, reproduced below, Shaffer discloses that the magnetic rings 1016 and 1026 are in connection with the circuitry and the battery.



Ex-1003-Shaffer, Figure 10. Figure 10 shows that magnetic ring 1016 (green box) is located on the same earbud 1010 (red) as the PCB circuitry 3 (yellow) and battery 1030 (gray), and is therefore in connection with these elements. Magnetic ring 1026, PCB circuitry 4, and battery 1036 are arranged in a similar manner within earbud 1012. *Id.* ¶¶ 62 (“The earbuds are outfitted with magnetic rings 1016 and 1026”), *id.* (“earbuds 1010 and 1012 include earbud rechargeable batteries 1030 and 1036”), 63 (“These components may be connected to printed circuit boards PCB 3 and PCB 4 within the earbuds”).

134. Shaffer further discloses that the magnetic rings 1016 and 1026 interface with the smart storage case to charge batteries 1030 and 1034. Ex-1003-Shaffer at ¶ 42 (“In certain embodiments, the aperture magnetic contact strips 41 and 42 [of the smart storage case] may also serve as electrical contacts, delivering charge

directly to [batteries 1030 and 1036 via] the earbud magnetic contact strips [(e.g., magnetic rings 1016 and 1026)] from the plug without the need for additional prongs or leaders.”).

4. Claim 14: The wireless earpiece of claim 10, wherein the wireless earpiece alters a power level of the wireless earpiece in response to the reed switch detecting the magnetic field.

135. As I explained above for Element [10C], Shaffer in view of Steinbrecher discloses that Shaffer’s earpieces 1010 and 1012 alter their power level in response to the reed switch (e.g., Steinbrecher’s reed switch used in Shaffer’s earpieces) detecting the magnetic field. *See* Section VIII.F.1(d); *see also* Section VIII.D.1(c). A POSITA would have been motivated to modify Shaffer in view of Steinbrecher as I explained for Element [10C] (*see* Section VIII.F.1(d)(i)).

5. Claim 16: The wireless earpiece of claim 10, wherein the circuitry includes logic that alters a power state of the wireless earpiece in response to detecting the magnetic field and a startup process in response to not detecting the magnetic field after having detected the magnetic field.

136. Shaffer in view of Steinbrecher discloses that the circuitry includes logic that alters a power state of the wireless earpiece in response to detecting the magnetic field. For example, as I explained above for Element [10C], Shaffer’s PCB circuitry 3 and 4 includes embedded firmware (which a POSITA would understand as logic) that disconnects at least a portion of the earpiece circuitry from the battery in response to detecting the magnetic field, thereby altering the power state of the

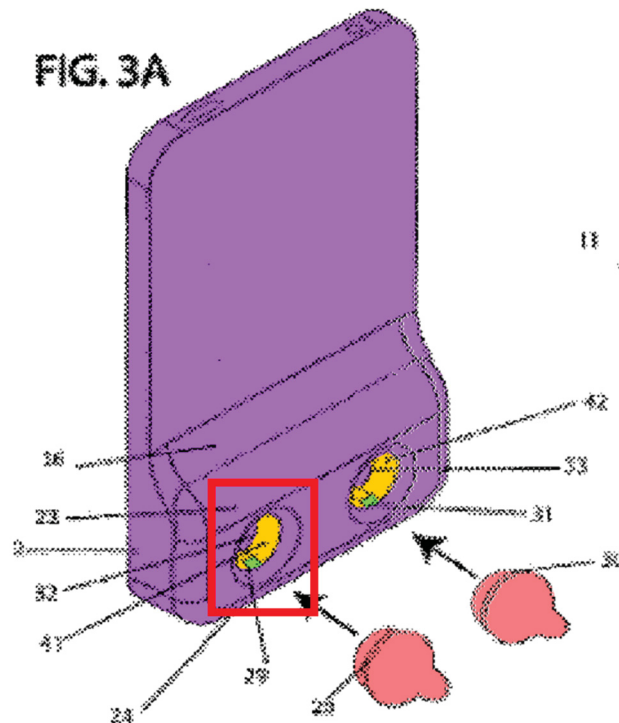
earpiece. *See* Section VIII.F.1(d); *see also* Ex-1003-Shaffer at ¶ 63 (“Firmware embedded within the earbud PCBs could cause a circuit that includes the rechargeable earbud batteries 930 and 934 to switch on or off, or return them to a low-energy consumption idle mode.”), Section VIII.D.1(b-c) (discussing the power states of the wireless earpieces)

137. Shaffer in view of Steinbrecher also discloses that the circuitry includes a startup process in response to not detecting the magnetic field after having detected the magnetic field. Namely when the earpieces are removed from the magnetic storage case, they will no longer detect a magnetic field after having detected the magnetic field applied by the storage case. In response, the earpiece circuitry automatically starts up to return the earpieces to their normal operation (after having been powered down while in the case). *See* Sections VIII.D.1(b-c), VIII.F.1(d); *see also* Ex-1003-Shaffer at ¶ 63 (“These components may be connected to printed circuit boards PCB 3 and PCB 4 within the earbuds and may contain encoded firmware or other programming instructions to automatically trigger on when the earbuds are removed from the earbud apertures [of the storage case].”).

6. Claim 17

- (a) [17Preamble] A system comprising the wireless earpiece of claim 10, wherein the wireless earpiece is a left earpiece and smart case for charging the left earpiece, the smart case comprising:

138. As I explained above for Elements [1Preamble] and [10Preamble], Shaffer's system includes a left earpiece (e.g., a pair of earbuds 1010 and 1012, one of which is a left earpiece) and a smart case (*see* Claims 4, 11) for charging the left earpiece. For example, Figure 3A of Shaffer is reproduced below.



Ex-1003-Shaffer, Figure 3A. Figure 3A shows that the storage case (purple) includes two apertures, such that a POSITA would have understood one of the apertures (e.g., the left aperture shown in the red box) to be used for charging the left earpiece. *See also id.*, Figure 10, ¶¶ 6 (“In an embodiment a case for a mobile electronic device

includes a housing and one or more earbud receiving apertures”), 34, 40 (“A user may insert a rechargeable earbud into each of the earbud apertures 32 and 33 [of the storage case] to provide electrical charge via the earbud electrical contacts 29 and 31”).

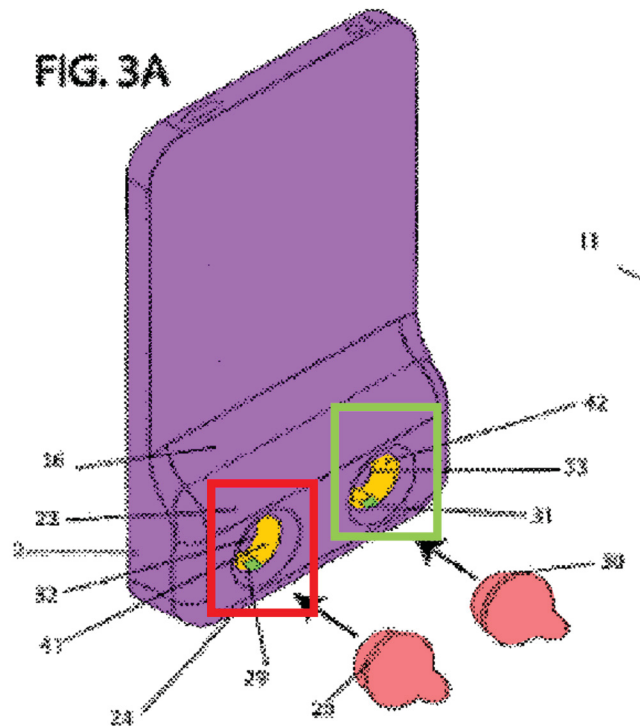
(b) [17A] a smart case housing;

139. Shaffer’s storage case 11 (i.e., a “smart case,” as I explained above for Element [17Preamble]) includes a smart case housing. *See, e.g.,* Ex-1003-Shaffer, ¶¶ 6 (“In an embodiment a case for a mobile electronic device includes a housing and one or more earbud receiving apertures”), 36, 41, 60, 61, Claims 1 and 12.

(c) [17B] a first receptacle for receiving the left earpiece disposed within the smart case housing;

(d) [17C] a second receptacle for receiving a right earpiece disposed within the smart case housing;

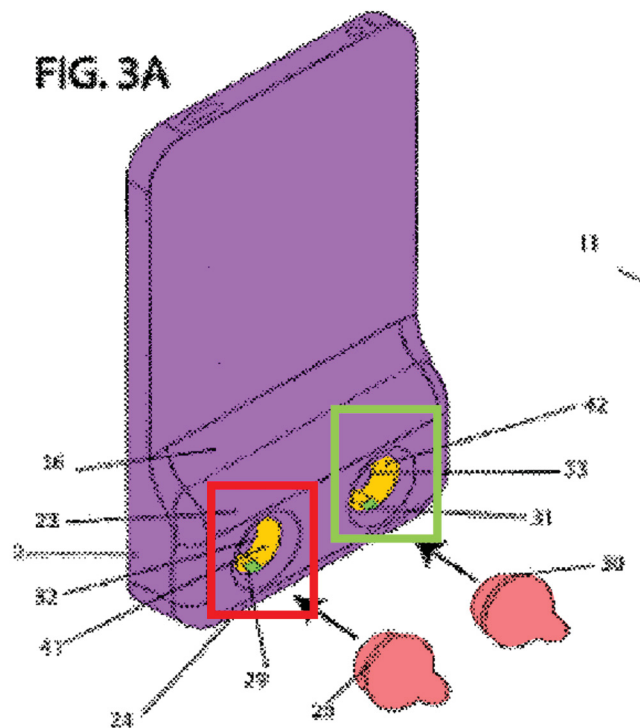
140. Referring to Figure 3A below, Shaffer discloses a first receptacle for receiving the left earpiece disposed within the smart case housing and a second receptacle for receiving the right earpiece disposed within the smart case housing.



Ex-1003-Shaffer, Figure 3A. Figure 3A shows that case 11 (purple) includes a first receptacle (aperture 32, red box) and a second receptacle (aperture 33, green box) which are for receiving the left and right earpieces, respectively, and which are each disposed within the housing of case 11. *See also id.*, Figure 10, ¶ 6 (“In an embodiment a case for a mobile electronic device includes a housing and one or more earbud receiving apertures [(i.e., receptacles)]”), 36, 40 (“The case also may include any number of earbud receiving apertures 32 and 33”), 41, 60, 61, Claims 1 and 12.

- (e) [17D] a first interface associated with the first receptacle for electrically connecting the smart case to the left earpiece;
- (f) [17E] a second interface associated with the second receptacle for electrically connecting the smart case to the right earpiece;

141. Referring to Figure 3A below, Shaffer discloses a first interface associated with the first receptacle for electrically connecting the smart case to the left earpiece and a second interface associated with the second receptacle for electrically connecting the smart case to the right earpiece.

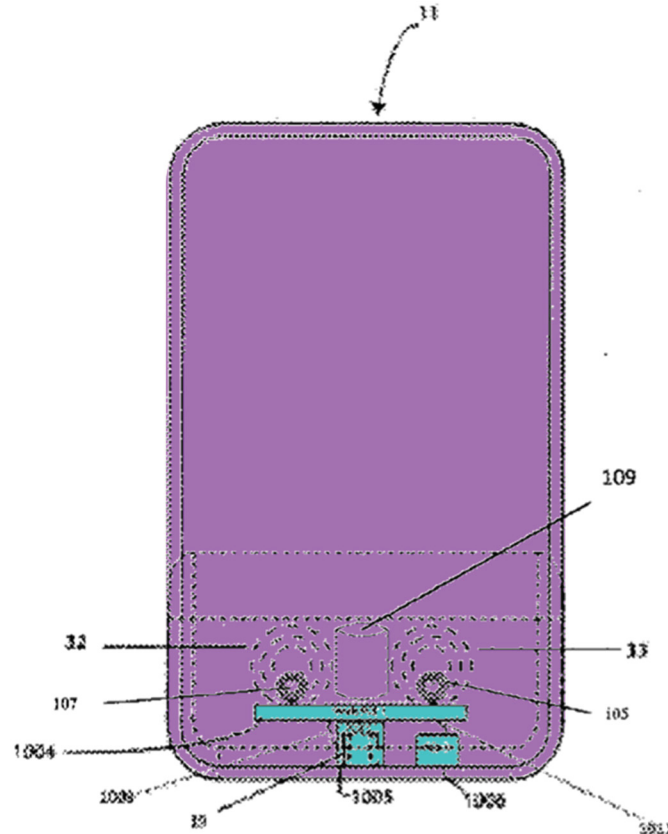


Ex-1003-Shaffer, Figure 3A. Figure 3A shows that storage case 11 (a smart case, purple) includes an electrical contact 29 (green), which is an interface that electrically connects case 11 to one of the pair of wireless earpieces (red). Case 11

further includes an electrical contact 31 (green), which is also an interface that electrically connects case 11 to the other one of the pair of wireless earpieces (red). *See id.*, Figure 10, ¶¶ 6, 36, 40 (“A user may insert a rechargeable earbud into each of the earbud apertures 32 and 33 [red and green boxes] to provide electrical charge via the earbud electrical contacts 29 and 31”), 41, 60, 61, Claims 1 and 12. Moreover, a POSITA would have understood the pair of wireless earpieces to correspond to left and right earpieces, such that electrical contacts 29 and 31 (green) correspond to the claimed first and second interfaces.

(g) [17F] an intelligent control disposed within the smart case housing and operatively connected to the first interface and the second interface.

142. Shaffer discloses an intelligent control disposed within the smart case housing and operatively connected to the first interface and the second interface. Figure 4 of Shaffer (reproduced below) depicts circuitry disposed within the housing of smart case 11 (purple; *see* Claims 4 and Element [17Preamble]).



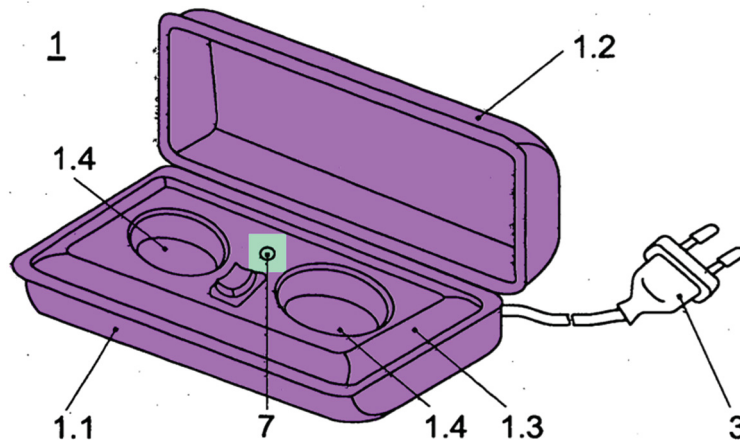
Ex-1003-Shaffer, Figure 4; *see also id.*, ¶ 48 (“FIG. 4 shows a view of the case 11 illustrating an example embodiment of its internal electrical components”). As shown in Figure 4, and as I previously explained for Claim 4 (Ground 4) and Element [17Preamble] (Ground 5), the internal circuitry of smart case 11 includes intelligent controls mounted on printed circuit boards 1004, 1005, and 1006 (teal). *Id.*, ¶ 48 (“As shown in [Figure 4], there may be three (or any number of) printed circuit boards (or ‘PCBs’), the main PCB1 1004, PCB2 1005, and PCB3 1006. PCB1 1004 is the main PCB in the example shown, and it may contain such items as a controller, firmware, an authentication chip, and a battery charging circuit. PCB2 1005 may

contain a case connector, such as a 30-pin connector, Lightning connector or other connector. PCB3 1006 may contain the USB connector.”).

143. Moreover, Shaffer discloses that the intelligent controls depicted in Figure 4 are operatively connected to the first and second interfaces (e.g., electrical contacts; see Elements [17D]-[17E]). *See, e.g.*, Ex-1004-Shaffer, ¶ 48 (“Main PCB1 is electrically connected to plug 1 and may transfer electrical charge to and from the rechargeable ear bud batteries 39 and 27 via earbud electrical contacts 48 and 49, as well as the mobile device 20.”).

7. 18. The system of claim 17 wherein the smart case further comprises a display.

144. Steinbrecher discloses that the smart case (e.g., charging shell 1; *see* Element [17Preamble]) comprises a display. Figure 1 of Steinbrecher is reproduced below.



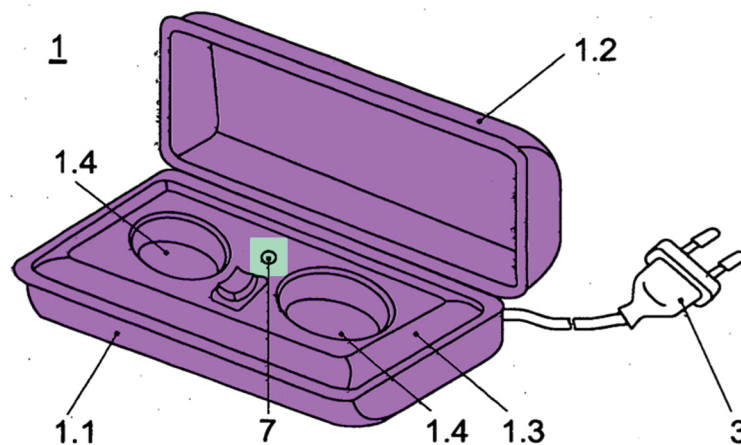
Ex-1006-Steinbrecher, Figure 1. Figure 1 shows that charging shell 1 (a smart case, purple; *see* Element [17Preamble]) has an output device 7 (light green) that uses a

light emitting diode (LED), an LED matrix, or other suitable optical display element as a display. *Id.* ¶¶ 24 (“An output device 7 is used in order to display the state of charge or information about the remaining life expectancy of a battery A in a hearing aid H that may have been inserted”), 8, 14 (“In particular, the output device can be an LED, an LED matrix, or another optical display, because this form of output is particularly eye-catching”), 15, 26, Figures 3 and 4.

145. As I explained above for Element [10C], a POSITA would have been motivated to modify Shaffer in view of Steinbrecher and would have done so with a reasonable expectation of success. With respect to Steinbrecher’s teachings regarding output device 7 (i.e., a display), a POSITA would have been motivated to modify Shaffer’s storage case to include a display, as taught by Steinbrecher, as this modification would have augmented Shaffer’s storage case with the ability to “display the state of charge or information about the remaining life expectancy of a battery” in a manner that is “particularly eye-catching.” Ex-1006-Steinbrecher, ¶¶ 14, 24. A POSITA would have modified Shaffer’s storage case to include a display with a reasonable expectation of success given that Shaffer’s storage case is already used to charge wireless earpieces, such that Steinbrecher’s display would be used for its intended purpose of displaying information related to charging wireless earpieces to a user. Therefore, the modification does not introduce any complexity or technical challenges.

8. 19. The system of claim 18 wherein the display is moveably connected to the smart case to transition from a first position to a second position.

146. As I explained above for claim 18, Steinbrecher discloses that a smart case (e.g., charging shell 1) that comprises a display (e.g., output device 7). Figure 1, reproduced below, depicts output device as being incorporated into the bottom part 1.1 of charging shell 1.



Ex-1006-Steinbrecher, Figure 1. Nevertheless, a POSITA would recognize many obvious alternative arrangements, including those in which output device 7 (or an additional display component) is located elsewhere on charging shell 1, such as on the lid 1.2. Modifying Steinbrecher to include a display located on lid 1.2 would result in the display being movably connected to charging shell 1 to transition from a first position (e.g., the open state of lid 1.2) to a second position (e.g., the closed state of lid 1.2). Depending on how one chooses to implement lid 1.2, the movable connection may be implemented as a hinge that connects lid 1.2 to bottom portion

1.1, a sliding element, or another movable connection that allows lid 1.2 to open and close relative to bottom portion 1.1.

147. A POSITA would have been motivated to modify Shaffer's storage case to incorporate a display on a movable lid, as disclosed by Steinbrecher. Putting a movable lid on a storage case, such as Steinbrecher's lid 1.2, has the obvious benefit of securing and protecting the contents of the storage case when storing wireless earpieces and protecting the receptacles (e.g., from debris) when the storage case is empty. The lid would then have been among a finite number of exterior surfaces of the storage case suitable for accommodating the display. Placing the display on the lid would have yielded the predictable benefit of allowing a user to view the display when the lid is shut. Moreover, a POSITA would have modified Shaffer's storage case to include a lid and a display with a reasonable expectation of success given that Steinbrecher already discloses a storage case that includes a lid and a display, and these accessory elements would be used in the same manner and for the same purpose in the modified teachings of Shaffer.

9. 20. The system of claim 19 wherein the smart case further comprises at least one manual input for receiving user input to provide additional functionality.

148. Steinbrecher discloses that the smart case (e.g., charging shell 1; *see* Element [17Preamble]) comprises a manual input (e.g., a button or switch) for

receiving user input to provide additional functionality. Figure 1 of Steinbrecher is reproduced below.

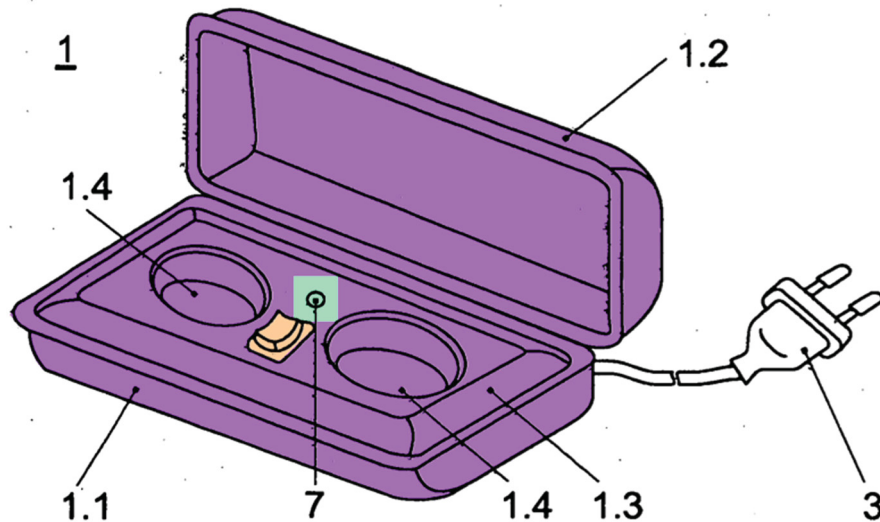


Figure 1 shows that charging shell 1 includes a button or switch (light orange) next to the display. A POSITA would have understood this button or switch to operate as a manual input to perform any number of well-known functions, such as turning the charging shell on or off, toggling the information displayed via output device 7, or the like. For example, Steinbrecher discloses that the output device 7 can display different types of information (e.g., charge state or remaining life expectancy), such that it would have been natural to include a manual input to toggle among these different types of information. *Id.*, ¶ 24 (“An output device 7 is used in order to display the state of charge or information about the remaining life expectancy of a battery A in a hearing aid H that may have been inserted”).

149. As I explained above for Element [10C] and Claim 18, a POSITA would have been motivated to modify Shaffer in view of Steinbrecher and would have done so with a reasonable expectation of success. With respect to Steinbrecher's teachings of a manual input, a POSITA would have been motivated to modify Shaffer's storage case to include Steinbrecher's manual input. For example, adding a button or switch would augment the functionality of Shaffer's storage case (e.g., by providing an enhanced level of control), and this functionality would be used for the same intended purpose for which it is used in Steinbrecher's charging shell 1.

10. **Claim 21.**

- (a) [21Preamble] A system comprising:
- (b) [21A] a first wireless earpiece, comprising:
- (c) [21B] circuitry operating the first wireless earpiece;
- (d) [21C] a battery powering the circuitry of the first wireless earpiece; and
- (e) [21D] a switch connecting the battery to the circuitry, wherein the switch connects the circuitry to the battery when a magnetic field is not detected, and wherein the switch disconnects the circuitry from the battery when a magnetic field is detected;
- (f) [21E] a smart case for charging the first wireless earpiece and a second wireless earpiece, the smart case comprising:
- (g) [21F] a smart case housing;
- (h) [21G] a first receptacle for receiving the first wireless earpiece disposed within the smart case housing;
- (i) [21H] a second receptacle for receiving the second wireless earpiece disposed within the smart case housing;
- (j) [21I] a first interface associated with the first receptacle for electrically connecting the smart case to the first earpiece;
- (k) [21J] a second interface associated with the second receptacle for electrically connecting the smart case to the second earpiece;
- (l) [21K] an intelligent control disposed within the smart case housing and operatively connected to the first interface and the second interface.

150. According to statements made by the applicant during examination of the '853 patent, Claim 21 has a scope that is substantially the same as, or potentially broader than, Claim 17. Ex-1008-FH [PDF215] (8/2/2017 RCE Amendment at 7) (identifying minor changes including replacing “reed switch” with “switch”; “left” with “first”; “right” with “second”; and “wireless earpiece” with “first wireless earpiece,” and relying on the original claims for written description support). Accordingly, Shaffer in view of Steinbrecher discloses the limitations of Claim 21 for at least the same reasons that it discloses the corresponding limitations of Claim 17 and Claim 10, from which Claim 17 depends. Elements [10Preamble]-[10C], [17Preamble]-[17F].

G. Ground 7

151. As I will explain in detail below, claims 11-13, 15, and 17-21 would have been obvious over Shaffer in view of Steinbrecher and Sorensen.

1. Claims 11, 12, and 17-21: “... a smart case ...”

152. Claims 11, 12, and 17-21 all recite a “smart case.” For the same reasons I provided for claims 4, 6, and 7 in Section VIII.E.1, Shaffer in view of Steinbrecher and Sorensen discloses these limitations.

2. Claim 13: The wireless earpiece of claim 12, wherein the wireless earpiece synchronizes data with the smart case.

153. For the same reasons I provided for claim 8 in Section VIII.E.2, Shaffer in view of Steinbrecher and Sorensen discloses these limitations.

3. Claim 15: The wireless earpiece of claim 10, wherein the wireless earpiece updates software of the wireless earpiece in response to detecting the magnetic field.

154. As I explained above for Element [10C] in Ground 6, Shaffer in view of Steinbrecher discloses detecting a magnetic field applied to a wireless earpiece. Shaffer in view of Steinbrecher and Sorensen further discloses updating software of the wireless earpiece in response to detecting the magnetic field. *See* Section VIII.F.1(d). Namely, Sorensen discloses that the software running on the wireless earpiece (hearing instrument 10) is updated in response to the earpiece being placed in its storage case (charging station). Ex-1005-Sorensen, 2:3-8, 3:22-42 (“the system is adapted to provide that a connection to a server is established ... to check for updates for the hearing instrument basic data and/or software, when the hearing instrument is mounted in the charging station”).

155. Moreover, as I explained above, Shaffer in view of Steinbrecher discloses that the mechanism for determining that the earpiece has been placed in its storage case is by detecting a magnetic field. *See* Section VIII.F.1(d). Accordingly, when a POSITA modifies the teachings of Shaffer and Steinbrecher to include the software update capabilities of Sorensen, the result is a modified system in which the earpiece software is updated in response to detecting the magnetic field. A POSITA would have been motivated to modify Shaffer in view of Steinbrecher and Sorensen as described in Sections VIII.F.1(d) and VIII.G.1.

IX. AVAILABILITY FOR CROSS EXAMINATION

156. In signing this declaration, I recognize that the declaration will be filed as evidence in a contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I also recognize that I may be subject to cross examination in the case and that cross examination will take place within the United States. If cross examination is required of me, I will appear for cross examination within the United States during the time allotted for cross examination.

X. RIGHT TO SUPPLEMENT

157. I reserve the right to supplement my opinions in the future to respond to any arguments that the Patent Owner raises and to take into account new information as it becomes available to me.

XI. JURAT

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

Dated: July 12, 2023

A handwritten signature in cursive script, reading "Sayfe Kiaei".

Dr. Sayfe Kiaei

Exhibit A

Dr. Sayfe Kiaei
School of Electrical, Computer and Energy Engineering
Arizona State University, Tempe, AZ 85287
Sayfe@asu.edu

Sayfe Kiaei

Professor, Motorola Endowed Chair Professor

School of Electrical, Computer and Energy Engineering, Arizona State University, Tempe, AZ

FIELDS OF SPECIALIZATION

- **Integrated Circuits (IC):** Analog & Digital IC, Mixed-Signal IC, VLSI, Processor, ASIC, RFIC
- **Radio Frequency:** RF, Receiver, Transmitter, Synthesizer, Antenna, MIMO, RF system
- **Power Management:** Power Management IC, Battery Management, Energy System, Energy Management
- **Sensors:** RFID, ZIGBEE, BT, Custom Sensors, MICS, IOT, Bio-Electronics, Bio-sensors, Hearing Aid sensors, Implanted devices electronics
- **Bio-Electronics:** Bio-Sensors, Hearing Aid, Implanted Bio-Electronics, Medical Implanted Communication System (MICS)
- **Signal Processing:** Digital Signal Processing, Adaptive Signal Processing, Video & Audio Signal Processing, Adaptive Audio Array processing, Audio and Acoustic & Speech processing
- **Wireless Communication Systems:** 1G-5G, 2-way radio, BT, WIFI, Sensors, ZIGBEE, wireless sensors
- **Wireline Communication System:** CABLE, DSL, Optical
- **Digital System:** VLSI, Processor, DSP processor

DEGREES

- **Ph.D.,** Electrical and Computer Engineering, Washington State University, 1987
- **M.S.,** Electrical and Computer Engineering, Washington State University, 1984
- **B.S.E.E.,** Electrical Engineering, Northeastern University, Washington State University, 1982

ACADEMIC POSITIONS

Fall 2001-Present: Professor, Motorola Endowed Chair Professor in Analog and RFIC School of Electrical, Computer and Energy Engineering, Arizona State University, Tempe, AZ

- **Professor:** Research and teaching in integrated circuits, RF circuits and systems, Communications, Wireless and Wireline transceiver, mixed-signal and Analog IC, Sensors, Power management IC, Signal processing, Bio-electronics, Signal Processing, Audio processing, GPS, wireless system
- **Research Projects:**
 - Analog and digital IC, Radio Frequency IC, RF transceiver
 - VLSI, Processor System Architecture, ASIC
 - Power Management IC, Battery Management & Sensing, Integrated Power Electronics

- Digital Signal Processing, Audio processing, adaptive signal processing, Array processing, AI
- Wireless communication system, wireless modems, 1G, 2G GSM, 3G CDMA, 4G LTE, 5G wireless mobile system, LTE, WiFi, Bluetooth, Wireless system standards
- Wireline Communication system and transceivers, MODEM standards, CABLE MODEM DOCIS, DSL
- Signal Processing, Digital Signal Processing, Adaptive Signal Processing
- Adaptive Audio Array processing, Audio and Acoustic & Speech processing,
- Sensors, Bio-electronics, Bio-sensors, Hearing Aid Electronics, Implanted devices electronics
- Research Funded by NSF, USAID, DARPA, JPL, NASA, Motorola Inc., Intel Inc., Broadcom, Qualcomm, Raytheon, General Dynamics, Texas Instruments, and over 10 other industries. List of Current significant research awards:
 - Center of Excellence for Energy (COE) in Egypt , Funding \$22.5M
 - Partnership Center for Energy systems, USAID, 2015-2020, \$18M. Principle Investigator
 - Solar Energy Development in ME, Private funds and World Bank, \$2M
 - Connection One NSF Center, Director, 2004-Present, Total funding \$5M, average annual funding over \$750K.

2021-Present, Director, USAID, Center of Excellence for Energy (COE) in Egypt , Funding \$22.5M

- Director and PI: COE - Energy Center funded by the USAID.
 - USIAD Centers of Excellence for Energy (COE) - established the Center of Excellence for Energy (COE/E) in Egypt with funding and support from the United States Agency for International Development (USAID/Egypt) in November 2021. COE/E is a partnership between ASU-US and three Egyptian partner universities (EPUs): Ain Shams University (ASU-EG), Aswan University (AU), and Mansoura University (MU).

2004-Present, Director and founder of NSF IUCRC Center Connection One, School of Electrical, Computer, and Energy Engineering, Arizona State University, Tempe, AZ; <https://connectionone.org>

- The NSF Connection One Industry/University Cooperative Research Center was established the center in 2002 with focus on communication system, integrated Circuits and Systems, wireless system, RF, sensors, and related areas. The center has five university member with over 30 industrial members. Total funding over \$10M.

2014-2020, Director, USAID, US-PCASE: Center for Advance Studies in Energy, Funding \$18M. <https://uspcase.asu.edu/>

- **Director and PI:** PCASE - Partnership Center for Energy systems, Energy Center funded by the USAID.
- USIAD Centers for Advanced Studies in Energy program (USPCAS-E) is a partnership between Arizona State University and two leading Pakistani universities: the National University of Science and Technology (NUST) Islamabad and the University of Engineering and Technology in

Peshawar (UET).

- PCASE has developed two new Graduate schools of Energy. Within 5 years, the center has over 1000 MS and PHD Students, with 14 new energy degrees in MS and PhD, two new building with 20+ energy labs in the power system, grid, power electronics, renewable energy, PV, Wind, Hydro, bio-fuel, fuel cell, batteries and storage, and thermal areas.

2008-2012: Associate Dean of Research, Ira A. Fulton Schools of Engineering, Arizona State University

Responsible for leading the research infrastructure, promoting and developing research programs with industry and federal agencies, leading large multi-university proposals, investing and providing seed funding to foster new research areas, and promoting graduate program in the college of engineering.

Research Enterprise support included:

- Increase College of Engineering research funding from \$50M to over \$80M.
- Working with Vice President for Research, Dean's, and directors on University-wide research initiatives.
- Established the first NSF Engineering Research Center (ERC) at the ASU on Solar Energy QESST. Managed, organized and planned the ERC proposal process. ASU is the lead school partnering with MIT, Georgia Tech, U of Delaware, Cal-Tech, U of New Mexico, and UA.
- Lead several trans-disciplinary 4M research projects (4M: multi-million, multi-investigator, multi-disciplinary, multi-university grants) in energy, security, and related initiatives.
- Oversight of over 20 existing research centers in the college of Engineering.
- Engage with industry and federal government to establish new research collaborations.
- Organized workshops and supported proposals for NSF, NIH, DOE, DOD, DARPA, etc.
- Organized workshops for new assistant professors to apply for NSF CAREER Awards. ASU CAREER awards grew from 3 annual awards in 2008 to over 15 CAREER awards by 2012.
- Research Administration and pre-award proposal administration for the schools. Developed a decentralized research administration and advancement team for the Schools supporting 5 schools, 12 departments, over 220 engineering faculty, with funding over \$70M.
- Annual budget over \$7M for supporting research centers, seed funding for new center, cost sharing, proposal support, equipment and infrastructure support, graduate scholarships, and research administration.
- ADR Staffs included, Director of industrial and government liaison, Director of research administration, and 14 research advancement staff.
- Graduate Programs: Recruiting, Fellowships, marketing, outreach, coordination with departments

1997-2001, Adjunct Professor, Electrical and Computer Engineering Dept., The University of Texas, Austin, Texas, Taught graduate courses at UT Austin on Introduction to Telecommunication System and Digital Communications. Co-advised two Ph.D. program committees in IC design and Telecomm (while at Motorola)

1987-1993, NSF Center For Digital / Analog IC (CDADIC) Co-Director, NSF IUCRC Center director at Oregon State University. The CDADIC was established the center in 1987 with focus on integrated circuits at WSU, UW, and OSU with over 20 industrial members - <https://cdadic.oregonstate.edu/>

1987-1993, Assistant / Associate Professor (Tenured) Electrical and Computer Engineering Department, Oregon State University, Corvallis, OR

- Research and classes in Electronics, DSP, Communication system and networks, Wireless systems, MODEMS. Graduated 30 MS and Ph.D. students.
- Faculty Chair, Computer Engineering Program, Developed a new Computer Engineering Program at OSU in 1987

INDUSTRIAL POSITIONS

1993-2001: Motorola Inc., Senior Member of Technical Staff, Personal Communication Sector, Austin, Texas - Worked projects related to wireless communications, two way radios, wireless networks, ADSL and MODEM RF, and related areas.

- **Motorola Cellular Division, Wireless Technology Center (WITC), 1997-2002.** Responsible for development of integrated circuits and systems for wireless handset. Lead number of projects including cellular (2G, 3G, 4G), wireless connectivity (Bluetooth and WIFI transceiver), GPS and location Receiver, wireless networks, 2-way radios and related areas. Worked on the development of various subcomponents including system design, link budget, RF front-end, RF receiver, RF transmitter, digital audio processing, audio processing, DSP, frequency synthesizer, ADC, DAC, filtering, analog front-end, power management, battery management, and baseband processor, baseband circuits and systems.
- **Motorola Semi-conductor products sector (SPS), Broadband Products Operations, 1995-1997,** Worked on the development of XDSL (ADSL, VDSL, G.lite) systems including OFDM, modulation, synchronization, equalization and the development of a single chip ADSL transceiver (*CopperGold™*). The transceiver contained Analog Front End (A/D, D/A, Hybrid), custom DSP, baseband processor, DMT, modulation/demodulation, FFT, IFFT, echo canceler, time domain equalizer, front-end constellation mapping, Trellis code modulation, Viterbi decoder), audio processing, DSP, signal processing, and an on-chip DSP core.
- **Land Mobile Products Sector LMPS 1993-1995,** Responsible for Wireless digital two-way radios, developed RFIC, RF receiver, RF transmitter, digital audio processing, audio custom IC, DSP, frequency synthesizer, ADC, DAC, hot spot wireless network, next generation of digital two-way radios, *"Talk about Radios"*, Japanese cellular systems (PHS).
- **Standards,** Represented Motorola in various standards including 2G-4G, GPS, Bluetooth working group, WiFi, 802.11, and DSL standards including T1E1, International Telecommunication Unit (ITU), T1E1, ETSI, 3GPPP, Universal ADSL Working Group (UAWG), Bluetooth working group, G.Lite working group, etc.
- **University relations,** Responsible for the development of collaborative research programs with several universities. Responsible for funding research in the areas of Wireless Transceiver IC Design, RF, and mixed-signal and baseband system architecture.

1985-87: Member of Research Staff, Boeing Co., Bellevue, Wa, Flight Systems Research and Technology Center, summer. Design Engineer, Hardware and CAD tool development for system control.

AWARDS

- IEEE Fellow 2004-Present
- IEEE Fellows CAS Committee Chair, 2009-2012
- Global Standards Award, For contributions in the International Telecommunication Unit (ITU) for Asymmetric Digital Subscriber Line (ADSL) G.Lite Standards. Motorola Inc., 1999.
- 10X Cycle Reduction Award, for development of new IC design process from DSP algorithm to IC layout, Motorola Inc., 1995.
- IEEE Darlington best paper Award, IEEE Circuits and Systems Society Best Paper Award, 1995. For “Characterization and Comparison of CMOS FSCL Circuits with Conventional CMOS for mixed-signal ICs,” Published at: *IEEE Trans. on Circuits and Systems II, Sept. 93*.
- Carter Best Teaching Award, College of Engineering Best Teacher Award, Oregon State University, 1992. For “*outstanding and inspirational teaching in the College of Engineering*”. Award is selected by the confidential vote of all of the undergraduate students in the College of Engineering among over 125 professors in the College.
- Industrial University Fellowship (IUF) Award, *National Science Foundation*, 1993.
- Research Initiation Award, *National Science Foundation*, 1990-93.
- Outstanding Graduate Student Scholarship, *Azur-Data Inc.* WSU, 1984

RESEARCH PROJECTS

Partial list of Research Awards (1987-Present):

- **2021-2026 – U.S. Agency for International Development (USAID)**
 - COE – Center of Excellence for Energy, PI and Director, \$22.5M.
- **2020-2022 - The National Science Foundation (NSF)**
 - SII Planning: Center for Next Generation Wireless Spectrum Sharing, PI, \$300K.
- **2002-2020 – The National Science Foundation (NSF) - Connection One**
 - Industry/University Cooperative Research Center (IUCRC), NSF contribution \$1.5M.
 - Annual Industry Contribution: Total over \$5M.
- **2015-2016 – The National Science Foundation (NSF)**
 - Integration of Smart Utility Grids with Dynamic Optical Communication Networks for Intelligent Distribution of Power Workload and Data in Disaster, \$200K
- **2015-2020 – U.S. Agency for International Development (USAID)**
 - PCASE – Center for Energy systems, PI and Director, \$18M.
- **2014-2015 NSF – Connection One**
 - Various projects funded by the Connection one center
- **2013-2014 NASA**
 - Arizona Space Grant Consortium, NASA: Goddard Space Flight Center, RADHARD electronics, \$200K

- **2012-2015 – Solar Energy, Private Donor**
 - Solar Energy Development on international projects, \$2M
- **2011-2014 – Semi-Conductor Research Corporation**
 - Self-Characterization for Calibration and Process Feedback of MEMS Devices, , \$300K
- **2011-2013 - The National Science Foundation (NSF)**
 - Microwave & RF Bio-Sensors for Vital Signs Monitoring Device Design, \$250K
- **2010-2011 – The National Science Foundation**
 - Adaptive Compensation of Analog circuits imperfections using DSP methods, \$150K,
- **2010-2011 – The National Science Foundation**
 - Autonomous Self-Healing Sensor Network Radio and Mixed-Signal Readout System Design National Science Foundation (NSF), \$300K
- **2010-2020 – The National Science Foundation (NSF)**
 - QESST NSF ERC Center on Solar Energy, Co-PI, Testbed Director
- **2010-2015 - The National Science Foundation (NSF)**
 - Research Experience for Undergraduate Students, total \$400K
- **2008-2013 - The Science Foundation of Arizona (SFAZ)**
 - PEPER- Photovoltaic Environmental Performance and Reliability for the Arizona-Wide Electric Grid, \$1.2M.
- **2008-2009 - The National Science Foundation (NSF)**
 - Micropower MICS Band RF Transceiver Design (C1/TI Enhancement Project), \$200K
- **2007-2011 – The National Science Foundation (NSF)**
 - Micro-Power Multi-Phase on-chip MEMS Hearing Aid, 2007-2011, \$500K.
- **2007-2009 - The National Science Foundation (NSF)**
 - High Efficiency Power Delivery and Front-End Module Design for Implantable Bio-Sensors \$480K
- **2005-2009 - The National Science Foundation (NSF)**
 - Cognitive MIMO Communications for Dynamic-Spectrum Wireless Networks \$150K
- **2005-2009 - The National Science Foundation (NSF)**
 - Autonomous Self-Healing Sensor Network Radio, , \$250K
- **2005-2008 BAE Systems**
 - Integrated on-chip Time Measurement Circuits LiDAR; \$650K
- **2005-2008 - Freescale Semiconductor**
 - PWM, Battery & Power management, \$150K
- **2005-2006 - DOD: Defense Advanced Research Projects Agency (DARPA)**
 - Radhard by Design - MRC/DARPA, Total funding \$1.5M
- **2005-2010 - State of Arizona**

- WINTECH- Wireless Integrated Nano Technology Center Support, 450K annually, total \$2.5M
- **2004-2005 – NASA**
 - Integration of Ultra-Low power RF CMOS, \$127K
- **2004-2008 – Deference Advance Research Project Agency (DARPA)**
 - Implanted Neural-Enabled Prostheses bio-sensor with Sensorimotor Integration, \$500K
- **2004-2008 – Deference Advance Research Project Agency (DARPA)**
 - Nano-Mechanical RF Band pass resonator for 2GHZ RF Applications, with JPL, \$2.2 M,
- **2003-2005 - DOD-ARMY-ARL: Army Research Office (ARO)**
 - Implanted Neuro-sensor, \$175K
- **2002-2005 - Intel Corporation**
 - Design of Multi-Standard RF Front-End Circuits for Cellular and WiFi, \$300K
- **2002 – SRC**
 - LOW POWER ULTRA - WIDE BAND GEOLACTION SYSTEMS, \$65K.
- **2001-2003 - SRC (Semi-conductors research Corp)**
 - Ultra-Wideband Transceivers for cellular and WiFi 802.11, \$225K
- **1987-1993 - The National Science Foundation**
 - Center for the Design of Analog/Digital IC's (CDADIC) 1987-1995, At Oregon State, \$1.5M
- **1992-1994 – Motorola LMPS**
 - Low Power IF processing for Direct Digital Transceivers, \$100K,
- **1993 - Hewlett-Packard**
 - Hewlett-Packard Faculty Chair position in Mixed-Signal IC, HP, \$500K
- **1992-1993 - The National Science Foundation**
 - National Science Foundation, Motorola Inc. Faculty Industry Fellowship, \$250K,
- **1992-1993 - The National Science Foundation**
 - National Science Foundation, Research Initiation Award (RIA) (same as current CAREER Award), Synthesis and Automatic Derivation of Multi-Rate VLSI Arrays for DSP Algorithms, \$320K.
- **1988-1992 – Center for the Design of Analog/Digital IC's (CDADIC)**
 - CDADIC, various projects on Low-Noise Source Coupled Logic (SCL), Mixed-Mode IC's, CDACIC \$350K.
- **1988- Tektronix Inc.**
 - Decimation Filters for A/D Noise Enhancements, Tektronix, Inc., \$100K,
- **1987-1993 – DARPA, MOSIS, Tektronix, IT, Motorola**
 - Various grants for IC Fabrication (DARPA/MOSIS, VLSI)

- Testing equipment (Tek, HP)
- DSP system development (TI, Motorola)

PROFESSIONAL RECOGNITION

- IEEE Fellow, 2004-Present
- IEEE Fellow Committee Chair, CAS, 2008-2010
- IEEE Fellow Committee member, 2007-2010.
- IEEE Senior Member, 1993-Present, IEEE Member 1987-1992.
- IEEE Faculty Advisor, Oregon State University, 1987-1990

IEEE Editorials

- IEEE Microwave Magazine, Editor,
- IEEE System Journal, Associate Editor, 2010-2011.
- IEEE Transactions on VLSI, Associate Editor, Jan 2001-2008.
- IEEE Communication Magazine, Editor, Feature Issues on “Circuits for Wireless and Wireline Communications,” April 1999.
- IEEE Transactions on Microwave Theory and Techniques , editor, Special Issue on: "Radio Frequency IC Design," Dec. 1998.
- IEEE Transactions on Circuits and Systems-II, editor, Special Issue on: “Low-Power Wireless Communication Systems,” June 1997.
- Associate Editor, IEEE Transactions on Circuits and Systems-II, 1993-1996.
- *Editor and Reviewer for many IEEE journals and conferences*
- *Founding member of IEEE RF Integrated Circuits Symposium*
- *Associate Editor, IEEE Communications, Tutorial & Surveys Magazine, 2006-2009.*

Conference Organizations

- RFIC Executive Committee members, 2000-2017
- RFIC Steering Committee Member, RFIC symposium, 1996-2017.
- RFIC Founding member, 1995-96.
- Technical Program Chair, IEEE International Sym. on Circuits and Systems, Phoenix, AZ, 2002.
- ISSCC Admin Council, Conferences Committee 2000-2005.
- General Chair, Radio Frequency IC (RFIC) Symposium, Seattle, WA, 2002.
- Technical Program Chair, RFIC Symposium, Phoenix, AZ, 2001.
- Finance Chair, RFIC symposium, Boston, MA, 2000.
- Publicity Chair, RFIC symposium, Los Angeles, CA, 1999.
- Transactions Chair, RFIC symposium, Baltimore, MD, 1998.
- General Chair, Int. Sym. on Low-Power Electronics and Design (ISLPED), Monterey, CA, 97.

- Executive Committee Member, Int. Symp. On Low-Power Electronics and Design, 96-2000.
- Technical Program Committee Member of the following conferences:
 - International Conference on Circuits and Systems: 1996, 2000, 2001, 2004-2008
 - RFIC Symposium, 1996-2018
 - Application Specific Array Processing (ASAP): 2000-2002
 - Technical Program Chair, Int. Sym. on Low-Power Electronics and Design, Monterey, CA, 96.
 - Arizona Telecom Comm (ATIC)
 - GLS VLSI 1998, Lafayette, Louisiana, 1998
 - VLSI Design 98, Chennai, India, Jan. 1998.
 - ICECS, Lisbon, Portugal, 98.
 - Application Specific Array Processing, 1995-97, 2000
 - Vehicular Technology Conference, 1995-97.
 - Inter. Conf. on Intelligent Information Systems, D.C., 1994-95.
 - IEEE Pacific Rim Conference on Communications & Computers, Victoria, BC, Canada, 1991.

Invited talks, Panelist, Session Chairs, Workshop Speaker

- Conference chair, Technical Program committee chair and TPC member, tutorials, workshops, session chair, etc. in RFIC, ISSCC, ISCAS, VLSI, ICASSP, Low-Power Symposium, ICC, Application Specific IC's, IMS, MTT, etc.

CONSULTANT

- Intel Inc. Chandler, AZ, 2002-2006: Development of 3G-4G Wireless transceiver.
- Sony Inc., San Diego, CA and Tokyo, Japan, 2002-2004: Review and development of various telecom cellular system architecture including 3G system architecture, and GPS system.
- Motorola Inc. 2002-2005: Supporting development of BT, WiFi, E911, GPS integrated circuits and systems for the cellular and mobile handsets.
- Hewlett Packard, Corvallis, OR – 1990-1993: Various project on development of custom analog and digital IC's for printer and inkjet system. Some of this work was under consultation, and some under various research grants with Oregon State University.
- Tektronix Inc, Beaverton, OR - 1988-1990: Design and Implementation of Data acquisition system for Spectrum analyzer, development of custom DSP algorithm for the Tektronix spectrum analyzer including system architecture, simulation, analysis, and design of oversampled data acquisition system.
- Boeing Commercial Aircraft, BCAC, Renton, WA - 1985-1987: Development of Airplane Controller Model, Simulation and Implementation of Flight control, Model reduction, and system control.

PUBLICATIONS

Standards Contributions

1. "Spectral Compatibility of ADSL: Frequency Overlap vs. FDM," T1E1, Dec. 97.
2. "Echo Cancellation for G.Lite Universal ADSL," OFDM, Universal ADSL Working Group, Atlanta, GA, Jan 98.
3. "8-bit QAM Constellation effects on reach for universal ADSL," OFDM, Universal ADAL Working Group, Atlanta, GA, Jan 98.
4. "Trellis Code Modulation coding gain for OFDM," Universal ADSL Working Group, Atlanta, GA, Jan 98.
5. "Monte Carlo Modeling and simulation of twisted pair wiring for OFDM," Universal ADAL Working Group, Atlanta, GA, Jan 98.
6. "Overlap Upstream/Downstream spectral allocation for OFDM ADSL," International Telecommunication Unit, Chicago, March 98.
7. "Echo Cancellation for ADSL OFDM," International Telecommunication Unit, Antwerp, Belgium, 98.
8. "Performance of Echo Cancellation ADSL in OFDM system in the presence of Near End Cross Talk (NEXT)," International Telecommunication Unit, Honolulu, Hawaii, June 98.
9. Presentations and editorials at various XDSL and OFDM standards: ITU, ETSI, UAWG, and T1E1, 97-99.
10. Presentations and editorials at various 3G and 4G and wireless standards including ITU, 3GPPP, 802.11, BT,

Books

"Design, Modeling and Testing of Data Converters, P Carbone, S Kiaei," F Xu - 2014 – Springer, © Springer-Verlag Berlin Heidelberg 2014

Refereed Journal Papers

1. CMOS Full-Duplex Mixer-First Receiver With Adaptive Self-Interference Cancellation S. -A. Ayati; A. Alizadeh; S. Kiaei, IEEE Transactions on Circuits and Systems I, Jan 2021.
2. A 10-W X-Band Class-F High-Power Amplifier in a 0.25 μ m GaAs pHEMT Technology, A. Alizadeh; M. Yaghoobi; M. Meghdadi; A. Medi; S. Kiaei, IEEE Transactions on Microwave Theory and Techniques, Jan 2021.
3. An X-Band Class-J Power Amplifier With Active Load Modulation to Boost Drain Efficiency A. Alizadeh; S. Hassanzadehyamchi; A. Medi; S. Kiaei, IEEE Transactions on Circuits and Systems I: Sep 2020
4. In-Field Recovery of RF Circuits from Wearout Based Performance Degradation D. Chang; J. N. Kitchen; S. Kiaei; S. Ozev, IEEE Transactions on Emerging Topics in Computing, Jun 2020
5. A 50-V Isolation, 100-MHz, 50-mW Single-Chip Junction Isolated DC-DC Converter With Self-Tuned Maximum Power Transfer Frequency, C. Liu; D. Mandal; Z. Yao; M. Sun; J. Todsén; B. Johnson; S. Kiaei; B. Bakkaloglu, IEEE Transactions on Circuits and Systems II: Express Briefs, May 2019
6. Wideband Hybrid Envelope Tracking Modulator With Hysteretic-Controlled Three-Level Switching Converter and Slew-Rate Enhanced Linear Amplifier, P. Mahmoudidaryan; D. Mandal; B. Bakkaloglu; S. Kiaei, IEEE Journal of Solid-State Circuits, 2019.
7. Low-Power/Low-Voltage Integrated CMOS Sense Resistor-Free Analog Power/Current Sensor Compatible With High-Voltage Switching DC-DC Converter, S. Singh; D. Mandal; B. Bakkaloglu; S. Kiaei IEEE Transactions on Circuits and Systems I, 2019
8. Adaptively Biased Output Cap-Less NMOS LDO With 19 ns Settling Time, D. Mandal; C. Desai; B. Bakkaloglu; S. Kiaei, IEEE Transactions on Circuits and Systems II: Express Briefs, 2019

9. Chirag Desai; Debashis Mandal; Bertan Bakkaloglu; Sayfe Kiaei, "A 1.66 mV FOM Output Cap-Less LDO With Current-Reused Dynamic Biasing and 20 ns Settling Time," *IEEE Solid-State Circuits Letters* Year: 2018, Volume: 1, Issue: 2, Pages: 50-53
10. Debashis Mandal ; Chirag Desai ; Bertan Bakkaloglu ; Sayfe Kiaei, Adaptively Biased Output Cap-Less NMOS LDO with 19 ns Settling-Time;; *IEEE Transactions on Circuits and Systems II*: Feb 2019
11. Ayati, Mandal, Bakkaloglu, Kiaei, "Integrated Quasi-Circulator With RF Leakage Cancellation for Full-Duplex Wireless Transceivers," *IEEE Trans of Microwave theory and techniques*, Dec 2017.
12. "A 50-mA 99.2% Peak Current Efficiency, 250-ns Settling Time Digital Low-Dropout Regulator With Transient Enhanced PI Controller", ChaiYong Lim ; Debashis Mandal ; Bertan Bakkaloglu ; Sayfe Kiaei; *IEEE Transactions on Very Large Scale Integration (VLSI) Systems*; Year: 2017, Volume: 25, Issue: 8; Pages: 2360 - 2370
13. Doohwang Chang; Jennifer N. Kitchen; Sayfe Kiaei; "Sule Ozev, In-field Recovery of RF Circuits from Wearout Based Performance Degradation", *IEEE Transactions on Emerging Topics in Computing*, 2017.
14. Edgar Martí-Arbona; Debashis Mandal; Bertan Bakkaloglu; Sayfe Kiaei, A High-Voltage-Compliant Current-to-Digital Sensor for DC–DC Converters in Standard CMOS Technology, *IEEE Transactions on Power Electronics*, 2017, Volume: 32, Issue: 3. Pp. 2180 - 2188
15. Michael Cheah ; Debashis Mandal ; Bertan Bakkaloglu ; Sayfe Kiaei, "A 100-mA, 99.11% Current Efficiency, 2-mVpp Ripple Digitally Controlled LDO With Active Ripple Suppression", Aug 2016.
16. Marti-Arbona, E.; Mandal, D.; Bakkaloglu, B.; Kiaei, S., "A High-Voltage Compliant Current-to-Digital Sensor for DC-DC Converters in Standard CMOS Technology," *IEEE Transactions on Power Electronics*, no. 99, 2016.
17. Chang, D.; Kitchen, J.N.; Bakkaloglu, B.; Kiaei, S.; Ozev, S., "Monitor-Based In-Field Wearout Mitigation for CMOS LC Oscillators," in *IEEE Transactions on Device and Materials Reliability*, vol. 16, no. 2, pp. 183-193, 2016.
18. Chang, D.; Kitchen, J.N.; Bakkaloglu, B.; Kiaei, S.; Ozev, S., "Design-Time Reliability Enhancement Using Hotspot Identification for RF Circuits," in *IEEE transactions on Very Large Scale Integration (VLSI) Systems*, -vol. 24, no. 3, pp. 1179-1183, 2016
19. Seungkee Min; Copani, T.; Kiaei, S.; Bakkaloglu, B., "A 90-nm CMOS 5-GHz Ring-Oscillator PLL With Delay-Discriminator-Based Active Phase-Noise Cancellation," *Solid-State Circuits, IEEE Journal of* , vol.48, no.5, pp.1151,1160, May 2013
20. Junghan Lee; Tino Copani; Terry Mayhugh Jr.; Bhaskar Aravind; Sayfe Kiaei; Bertan Bakkaloglu.;, "A 280 mW, 0.07% THD+N class-D audio amplifier using a frequency-domain quantizer," *Analog Integrated Circuits and Signal Processing*, 173-186, 2012.
21. Seungkee Min; Copali, T.; Kiaei, S.; Bakkaloglu, B.; , "A 90nm CMOS 5GHz ring oscillator PLL with delay-discriminator based active phase noise cancellation," *Radio Frequency Integrated Circuits Symposium (RFIC), 2012 IEEE*, pp. 173-176, 2012
22. Deligoz, I.; Naqvi, S.R.; Copani, T.; Kiaei, S.; Bakkaloglu, B.; Sang-Soo Je; Junseok Chae; , "A MEMS-Based Power-Scalable Hearing Aid Analog Front End," *Biomedical Circuits and Systems, IEEE Transactions on* , vol.5, no.3, pp.201-213, June 2011
23. Copani, T.; Seungkee Min; Shashidharan, S.; Chakraborty, S.; Stevens, M.; Kiaei, S.; Bakkaloglu, B.; , "A CMOS Low-Power Transceiver With Reconfigurable Antenna Interface for Medical Implant Applications," *Microwave Theory and Techniques, IEEE Transactions on* , vol.59, no.5, pp.1369-1378, May 2011
24. Khalil, W.; Shashidharan, S.; Copani, T.; Chakraborty, S.; Kiaei, S.; Bakkaloglu, B.; , "A $700\text{-}\mu\text{A}$ 405-MHz All-Digital Fractional- N Frequency-Locked Loop for ISM Band Applications," *Microwave Theory and Techniques, IEEE Transactions on* , vol.59, no.5, pp.1319-1326, May 2011

25. Lashkarian, N.; Nassiri-Toussi, K.; Jula, P.; Kiaei, S.; , "Performance Bound on Ergodic Capacity of MIMO Beam-Forming in Indoor Multi-Path Channels," *Communications, IEEE Transactions on* , vol.58, no.11, pp.3254-3264, November 2010
26. Hyungseok Kim; Junghan Lee; Copani, T.; Bazarjani, S.; Kiaei, S.; Bakkaloglu, B.; , "Adaptive Blocker Rejection Continuous-Time $\Sigma\Delta$ ADC for Mobile WiMAX Applications," *Solid-State Circuits, IEEE Journal of* , vol.44, no.10, pp.2766-2779, Oct. 2009
27. Kitchen, J.N.; Chu, C.; Kiaei, S.; Bakkaloglu, B.; , "Combined Linear and Δ -Modulated Switch-Mode PA Supply Modulator for Polar Transmitters," *Solid-State Circuits, IEEE Journal of* , vol.44, no.2, pp.404-413, Feb. 2009
28. Sang-Soo Je; Rivas, F.; Diaz, R.E.; Jiuk Kwon; Jeonghwan Kim; Bakkaloglu, B.; Kiaei, S.; Junseok Chae; , "A Compact and Low-Cost MEMS Loudspeaker for Digital Hearing Aids," *Biomedical Circuits and Systems, IEEE Transactions on* , vol.3, no.5, pp.348-358, Oct. 2009
29. Taleie, S.M.; Copani, T.; Bakkaloglu, B.; Kiaei, S.; , "A Linear Digital IF to RF SD DAC Transmitter With Embedded Mixer," *Microwave Theory and Techniques, IEEE Transactions on* , vol.56, no.5, pp.1059-1068, May 2008
30. Wing-Yee Chu; Bakkaloglu, B.; Kiaei, S.; , "A 10 MHz Bandwidth, 2 mV Ripple PA Regulator for CDMA Transmitters," *Solid-State Circuits, IEEE Journal of* , vol.43, no.12, pp.2809-2819, Dec. 2008.
31. Lyles, U. J.; Copani, T.; Bakkaloglu, B.; Kiaei, S.; , "An Injection-Locked Frequency-Tracking $\Sigma\Delta$ Direct Digital Frequency Synthesizer," *Circuits and Systems II: Express Briefs, IEEE Transactions on* , vol.54, no.5, pp.402-406, May 2007
32. Khalil, W.; Bakkaloglu, B.; Kiaei, S.; , "A Self-Calibrated On-Chip Phase-Noise Measurement Circuit With -75 dBc Single-Tone Sensitivity at 100 kHz Offset," *Solid-State Circuits, IEEE Journal of* , vol.42, no.12, pp.2758-2765, Dec. 2007
33. Chen, X.; Kiaei, S.; , "Pulse generation scheme for low-power low-complexity impulse ultra-wideband," *Electronics Letters* , vol.43, no.1, pp.44-45, Jan. 4 2007
34. Carlosena, A.; Wing-Yee Chu; Bakkaloglu, B.; Kiaei, S.; , "Randomized Carrier PWM With Exponential Frequency Mapping," *Power Electronics, IEEE Transactions on* , vol.22, no.3, pp.960-966, May 2007
35. Abedinpour, S.; Bakkaloglu, B.; Kiaei, S.; , "A Multistage Interleaved Synchronous Buck Converter With Integrated Output Filter in $0.18 \mu\text{m}$ SiGe Process," *Power Electronics, IEEE Transactions on* , vol.22, no.6, pp.2164-2175, Nov. 2007
36. Kitchen, J. N.; Deligoz, I.; Kiaei, S.; Bakkaloglu, B.; , "Polar SiGe Class E and F Amplifiers Using Switch-Mode Supply Modulation," *Microwave Theory and Techniques, IEEE Transactions on* , vol.55, no.5, pp.845-856, May 2007
37. A Multistage Interleaved Synchronous Buck Converter With Integrated Output Filter in $0.18 \mu\text{m}$ SiGe Process, S Abedinpour, B Bakkaloglu, S Kiaei - Power Electronics, IEEE Transactions on, Nov. 2007, Volume: 22, pp - 2164-2175
38. [Delta-sigma \(\$\Delta\Sigma\$ \) frequency synthesizers for wireless applications](#) - B Bakkaloglu, S Kiaei, B Chaudhuri - Computer Standards & Interfaces, 2007 – Elsevier, Analog Computer Standards & Interfaces Volume 29, Issue 1 , January 2007, Pages 19-30
39. Pulse generation scheme for low-power low-complexity impulse ultra-wideband, Chen, X.; Kiaei, S.; Electronics Letters; Volume: 43 Issue: 1 Jan. 2007 ; Page(s): 44-45
40. Bandwidth extension technique for polar modulated RF transmitters ; Bakkaloglu, B.; Kiaei, S.; Dwyer, R.; Electronics Letters; Volume: 42 Issue: 8 13 April 2006 ; Page(s): 476- 478 ;
41. Frequency modulated bandpass SD chirp synthesizer for sensor applications; Chung, H.H.; Lyles, U.; Copani, T.; Bakkaloglu, B.; Kiaei, S.; Electronics Letters; Volume: 42 Issue: 16 August 3, 2006 ; Page(s): 917- 918
42. Radiation Hardened by Design RF Circuits Implemented in $0.13 \mu\text{m}$ CMOS Technology; Chen, W.; Pouget, V.; Gentry, G. K.; Barnaby, H. J.; Vermeire, B.; Bakkaloglu, B.; Kiaei, K.; Holbert,

- K. E.; Fouillat, P. ; Nuclear Science, IEEE Transactions on ; Volume: 53 Issue: 6 Part=1, Dec. 2006 ; Page(s): 3449-3454 ;
43. Analysis of Single Events Effects on Monolithic PLL Frequency Synthesizers ; Chung, H. H.; Chen, W.; Bakaloglu, B.; Barnaby, H. J.; Vermeire, B.; Kiaei, S. ; Nuclear Science, IEEE Transactions on ; Volume: 53 Issue: 6 Part=1, Dec. 2006 ; Page(s): 3539-3543
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 48. Radiation Hardened by Design RF Circuits Implemented in 0.13 mm CMOS Technology; Chen, W.; Pouget, V.; Gentry, G. K.; Barnaby, H. J.; Vermeire, B.; Bakaloglu, B.; Kiaei, K.; Holbert, K. E.; Fouillat, P. ; Nuclear Science, IEEE Transactions on ; Volume: 53 Issue: 6 Part=1, Dec. 2006 ; Page(s): 3449-3454 ;
 49. Analysis of Single Events Effects on Monolithic PLL Frequency Synthesizers ; Chung, H. H.; Chen, W.; Bakaloglu, B.; Barnaby, H. J.; Vermeire, B.; Kiaei, S. ; Nuclear Science, IEEE Transactions on ; Volume: 53 Issue: 6 Part=1, Dec. 2006 ; Page(s): 3539-3543
 50. "Channel Shortening For Discrete Multi-tone Transceivers To Maximize Channel Capacity" OFDM and DSL, G. Arslan, B. Evans, S. Kiaei; ; IEEE Transactions for Signal Processing, Vol 49; No. 12; Pp: 3123-3135. Dec 2001.
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 52. Class of cyclic-based estimators for frequency-offset estimation of OFDM systems; Lashkarian, N.; Kiaei, S. , IEEE Transactions on Communications , Volume: 48 Issue: 12 , Jan 2001; Page(s): 2139 –2149
 53. Systems and circuits for broadband communications; Kiaei, S. IEEE Communications Magazine , Volume: 37 Issue: 4 , April 1999 Page(s): 70 –70
 54. Westgate, C.R.; Gupta, R.K.; Kiaei, S. ; Microwave Theory and Techniques, IEEE Transactions on , Volume: 46 Issue: 12 Part: 2 , Dec. 1998 ; Page(s): 2180 –2181
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 56. Adaptive multiuser detector for asynchronous DS-CDMA in Rayleigh fading; Dutta, A.K.; Kiaei, S. , IEEE Transactions on Circuits and Systems II: Analog and Digital Signal Processing, Volume: 44 Issue: 6 , June 1997; Page(s): 468 -472
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 59. "Adaptive Multi-user Detector For Asynchronous DS- CDMA In Raleigh Fading," IEEE Transactions on CAS-II, pp. 468-473, June 97. [A.K. Dutta, S. Kiaei]
 60. "Multi-Rate Transformation of Recurrence Equations for Regular VLSI Arrays, " Application Specific Array Processors, IEEE Press, 1994. [L. Aihua, S. Kiaei]

61. "Analog Logic Techniques," IEEE Circuits and Devices Magazine, pp. 12-21, May 1993. [S. Kiaei, D. Allstot, R. Zele]
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63. "Characterization and Comparison of CMOS FSCL Circuits with Conventional CMOS Logic for Hybrid ICs," IEEE Trans. on Circuits and Systems, Sept. 93. [S.H. Chee, S. Kiaei, D. Allstot]
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67. "Adaptive self-correcting D-S Modulators," IEE Electronics Letters, Vol. 28, No. 14, pp. 1288-1290, July 92. [S. Abdenadher, S. Kiaei, G. Temes, R. Schreier]
68. "On-line Adaptive Digital Correction of Dual-Quantization Delta-Sigma Modulators," IEE Electronics Letters, Vol. 28, No. 16, pp. 1511-1513, July 92.[Y. Yang, R. Schreier, G. Temes, S. Kiaei]
69. "Piecewise Linear Schedules for Recurrence Equations," VLSI Sig. Proc. VI, IEEE Press, 1992. [S. Rajopadhye, L. Mui, S. Kiaei]
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71. "VLSI Design of Wavefront Array Processors for Recursive Filters," VLSI Signal Processing II, IEEE Press, pp. 152-164, 1988. [S. Kiaei, U.B. Desai]
72. "RFIC Design," IEEE Transactions on Microwave Theory and Techniques, v. 46, pp. 2180-2183, Dec. 98. [S. Kiaei, R. Gupta]
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Conference Publications

1. " Switching Battery Charger with Cascaded Two Loop Control Using Time-Based Techniques,". ChaiYong Lim; Debashis Mandal; Bertan Bakkaloglu; Sayfe Kiaei, Published in: 2021 IEEE Applied Power Electronics Conference and Exposition (APEC), June 2021
2. 27.5 A 91%-Efficiency Envelope-Tracking Modulator Using Hysteresis-Controlled Three-Level Switching Regulator and Slew-Rate-Enhanced Linear Amplifier for LTE-80MHz Applications P. Mahmoudidaryan; D. Mandal; B. Bakkaloglu; S. Kiaei, 2019 IEEE International Solid- State Circuits Conference - (ISSCC), 2019
3. Integrated High-Efficiency Single-Inductor CCM Boost Converter for Multi-Junction PV Energy Harvesting, Q. Peng; D. Mandal; P. Mahmoudidaryan; B. Bakkaloglu; S. Kiaei, 2019 IEEE Applied Power Electronics Conference and Exposition (APEC), 2019
4. Sense resistor-free analog power sensor for boost converter with 14.1% gain error and 9.4% offset error, Shrikant Singh ; Debashis Mandal ; Bertan Bakkaloglu ; Sayfe Kiaei; 2018 IEEE 9th Latin

American Symposium on Circuits & Systems (LASCAS), 2018

5. Ayati, S. A.; Mandal, D.; Bakkaloglu, B.; Kiaei, S., "Adaptive Integrated CMOS Circulator," in *IEEE Symposium on Radio Frequency Integrated Circuits (RFIC)*, May 2016
6. Khunti, H.; Krehbiel, J.; Cheah, M.; Bakkaloglu, B.; Kiaei, S., "SSB transceiver for vital sign detection," in *IEEE Biomedical Circuits and Systems Conference (BioCAS)*, Oct. 2015.
7. Marti-Arbona, E.; Mandal, D.; Bakkaloglu, B.; Kiaei, S., "Low power integrated on-chip current to digital converter," in *Applied Power Electronics Conference and Exposition (APEC)*, March 2015
8. Marti-Arbona, E.; Mandal, D.; Bakkaloglu, B.; Kiaei, S., "PV panel power optimization using MPPT," in *Applied Power Electronics Conference and Exposition (APEC)*, March 2015
9. Chang, D.; Ozev, S.; Bakkaloglu, B.; Kiaei, S.; Afacan, E.; Dundar, G., "Reliability enhancement using in-field monitoring and recovery for RF circuits," in *VLSI Test Symposium (VTS)*, 2014
10. Deng, Lingfei; Kundur, Vinay; Naga, Naveen Sai Jangala; Ozel, Muhlis Kenan; Yilmaz, Ender; Ozev, Sule; Bakkaloglu, Bertan; Kiaei, Sayfe; Pratab, Divya; Dar, Tehmoor, "Electrical calibration of spring-mass MEMS capacitive accelerometers," *Design, Automation & Test in Europe Conference & Exhibition (DATE)*, 2013, vol., no., pp.571,574, 18-22 March 2013
11. Kiaei, M.S.; Fouli, K.; Scheutzow, M.; Maier, M.; Reisslein, M.; Assi, C., "Delay analysis for ethernet long-reach passive optical networks," *Communications (ICC)*, 2012 *IEEE International Conference on*, vol., no., pp.3099,3104, 10-15 June 2012
12. Marti-Arbona, Edgar; Bakkaloglu, Bertan; Kiaei, Sayfe, "Ultra-Low Power Current-to-Digital Sensor for Switching DC-DC Converters," *Ph.D. Research in Microelectronics and Electronics (PRIME)*, 2012 *8th Conference on*, vol., no., pp.1,4, 12-15 June 2012
13. Seungkee Min; Copani, T.; Kiaei, S.; Bakkaloglu, B., "A 90nm CMOS 5GHz ring oscillator PLL with delay-discriminator based active phase noise cancellation," *Radio Frequency Integrated Circuits Symposium (RFIC)*, 2012 *IEEE*, vol., no., pp.173,176, 17-19 June 2012
14. A fully integrated pulsed-LASER time-of-flight measurement system with 12ps single-shot precision; Copani, T.; Vermeire, B.; Jain, A.; Karaki, H.; Chandrashekar, K.; Goswami, S.; Kitchen, J.; Chung, H.H.; Deligoz, I.; Bakkaloglu, B.; Barnaby, H.; Kiaei, S.; Custom Integrated Circuits Conference, 2008. CICC 2008. IEEE; 21-24 Sept. 2008. 359-362.
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16. Supply modulators for RF polar transmitters. Kitchen, J.; Chu, C.; Kiaei, S.; Bakkaloglu, B. Radio Frequency Integrated Circuits Symposium, 2008. RFIC 2008. IEEE. June 17 2008-April 17 2008. 417-420.
17. A 700uA, 405MHz fractional-N All digital frequency-locked loop for MICS band applications. Shashidharan, S.; Khalil, W.; Chakraborty, S.; Kiaei, S.; Copani, T.; Bakkaloglu, B. Radio Frequency Integrated Circuits Symposium (RFIC), 2010 IEEE. 23-25 May 2010. 409-412.
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GRADUATE STUDENT ADVISEES & RESEARCH PROJECT

(Partial list of Students graduated, current employment to the best of my knowledge)

1. J. Durgam, VLSI Design of Dynamically Reconfigurable Array Processors, MSEE, 1988. Intel.
2. J. Gilbert, Minimization Techniques for PLAs, MSEE, 1988, Tektronix Inc.
3. L. Luo, CCA Methods for ARMA Spectral Estimation, MSEE, 1989. Berkeley Research Center
4. E. Zahl, Enhancement Methods for A/D Noise Reduction, MSEE, 1989. AT&T
5. L. Aihua, Synthesis of MRAs, MSEE, 1990. Intel.
6. F. Aslam, Image Restoration Methods, MSEE, 1990.
7. S.H. Chee, FSCL Circuits for Mixed-Mode IC's, MSEE, 1990. Linear Tech.
8. C. Dawson, MSEE, 1990. Boeing
9. A. Chow, Source-Coupled Logic ALU, MSEE, 1990. Intel
10. S. Maskai, Decimation Filters Using FSCL Circuits, MSEE, 1991. Intel
11. L. Louis, VLSI Implementation of Toeplitz Matrices, MSEE, 1991.
12. R. Badyal, Bit/Serial VLSI Design of IIR Filters, MSEE, 1992, HP
13. Lap Mui, Piece-Wise Linear Schedule for VLSI Arrays, MSEE, 1992. HP
14. S. Abdennadher, Adaptive Sigma-Delta Modulators, MSEE, 1992. Level One / Intel.
15. H. Bribech, Second Order Adaptive A/D Schemes, MSEE, 1992.
16. B. Hickman, MSEE, 92. Tektronix
17. M. Maleki, Current-Mode Flash A/D, MSEE, 1992. University of Oregon
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40. *Chaudhuri, Bikram, Synthesizer, MS/PhD, MS 2004.*
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46. *Umar Lyles, Power Amplifier, MS, 2006. Texas Instruments*
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48. Waleed Khali, (Co-Advisor), Professor at Ohio State
49. Jennifer Kitchen, PhD, 2009, Professor at ASU
50. Shahin Mehdizad Taleie, RFDAC, PhD, 2009, Qualcomm
51. Ilker Deligoz, PHD, 2009, Qualcomm
52. Hyung Kim, PhD, Jan 2010, Intel
53. Jung Le, PhD 2010, Intel, TI
54. Syed Naqvi, PhD, 2012, Intel.
55. Todd Martin, MS, 2011, TI
56. Seungkee Min, PhD, 2011, Intel
57. Ali Meamar, Post Doc, RFIC 2013
58. Hitesh Khunti, MS 2013, Qualcom
59. Debashis Mandal, Post Doc, Research faculty 2015-2018
60. Edgar Martinez, PhD, 2015, Qualcomm
61. Chirag Desai, MS, 2016, Qualcom
62. Sanjay Avasarala, MS, 2016
63. Li Ming, MS, 2017

64. Qirong Peng, MS, 2017,
65. Yu Geng, PhD, 2018
66. Amir Ayati, PhD Aug 2018; Qualcomm
67. Pasisa Mahmoudi, PhD, May 2019, Qualcomm
68. Chai Yong, MS: 2015, PHD: 2019, Qualcomm
69. Shrikant Singh, MS: 2016, PhD, 2019, Movandi
70. Amir Alizadeh, Research Faculty 2019-Present
71. Ata S. PhD, 2021, Ata Sarrafinejad, PhD, 2021

UNIVERSITY COMMITTEES

Various Committees at ASU, Oregon State University, etc.

INDUSTRY COMMITTEES

- Arizona Telecommunications and Information Council (ATIC), Board Member
- CAS Fellows Committee (ends December 31, 2006)
- *IEEE CAS Phoenix Chapter Organizers (the committee is in the process of determining new chair – current chair not active)*
- *Executive Committee, RFIC 2006.*
- *Technical Program Comm, IEEE RFIC 2006.*
- *Executive Committee, Conferences, International Solid State System's Conference.*
- *IEEE CAS Society, VLSI Technical Comm. Member*
- *Editorial Board, IEEE Communications Surveys & Tutorials*
- *Radio Frequency Integrated Circuits- RFIC 2006*
- *IEEE RF Integrated Circuits Conference, Committee Chair for two workshops*
- *International Microwave Symposium, IMS-MTT 2006*
- *Int. Symposium on Circuits and Systems - ISCAS 2006*
- *Wireless Networks & Emerging Technologies, WNET06*
- *Midwest Symposium on Circuits and System*
- *Arizona Governor IT Advisory Committee – GITA*
- *Arizona Telecom – ATIC*

INSTRUCTIONAL SUMMARY

- Digital IC Design, Analog IC Design, Advance CMOS Analog IC, VLSI, RFIC Design
- Wireless Transceiver Design, Wireless Communications, GPS, Telecomm Systems, Digital Communication
- Signal Processing, Advance digital signal processing, Communication, Digital Communication, Digital Audio Processing, Adaptive array processing
- Computer Architecture, Microprocessor System Architecture, Pipeline Array Processing