

**UNITED STATES DISTRICT COURT
WESTERN DISTRICT OF TEXAS
WACO DIVISION**

KOSS CORPORATION,

Plaintiff,

v.

BOSE CORPORATION,

Defendant.

Case No. 6:20-cv-00661

**COMPLAINT FOR PATENT
INFRINGEMENT**

DEMAND FOR JURY TRIAL

ORIGINAL COMPLAINT FOR PATENT INFRINGEMENT

Plaintiff, Koss Corporation (“Koss”), files this complaint for patent infringement against Bose Corporation (“Bose”) and in support thereof alleges and avers as follows:

NATURE OF THE ACTION

1. This is a civil action arising under the patent laws of the United States, 35 U.S.C. § 1 et seq., including specifically 35 U.S.C. § 271, based on Bose’s willful infringement of U.S. Patent Nos. 10,206,025 (“the ’025 Patent”), 10,368,155 (“the ’155 Patent”), and 10,469,934 (“the ’934 Patent”) (collectively “the Patents-in-Suit”).

THE PARTIES

2. Plaintiff Koss Corporation is a corporation existing under the laws of the State of Delaware having its principal place of business located at 4129 North Port Washington Avenue, Milwaukee, Wisconsin 53212.

3. Koss markets a complete line of high-fidelity headphones and audio accessories. Koss’s products, branded under the Koss brand name or private label brands, are sold at various retail chains throughout the United States and the world, including Walmart stores and other large brick-and-mortar establishments, as well as direct to customers in at least the following cities in this District: Alpine, Austin, Del Rio, El Paso, Midland, Odessa, San Antonio, and Waco.

4. Koss also serves as an Original Equipment Manufacturer (“OEM”) for a customer in this Judicial District. In this role, Koss manufactures OEM headphones sold under its customer’s brand.

5. On information and belief, Bose Corporation (“Bose”), is a Delaware corporation with its principal place of business at The Mountain, Framingham, Massachusetts 01701. Bose may be served through its registered agent CT Corporation System, 1999 Bryan Street, Suite 900, Dallas, Texas 75201. On information and belief, Bose is registered to do business in the State of Texas and has been since at least December 12, 1988.

6. Bose has a regular and established place of business at 3939 IH-35 South, Suite 725, San Marcos, Texas 78666. Bose has facilities in the Western District of Texas where it sells, and/or markets its products, including its Bose Factory Store located in San Marcos, Texas.

7. Bose is registered in the state of Texas and lists C T Corp. System, located at 1999 Bryan St., Suite 900, Dallas, TX 75201 as its registered agent in the state.

JURISDICTION AND VENUE

8. This Court has subject matter jurisdiction pursuant to 28 U.S.C. §§ 1331 and 1338(a) because the claims herein arise under the patent laws of the United States, 35 U.S.C. § 1 et seq., including 35 U.S.C. § 271.

9. This Court has personal jurisdiction over Bose in this action because Bose has committed acts of infringement within the State of Texas and within this District through, for example, the sale of Accused Headphones both online and from the Bose Factory Store in this District. Bose regularly transacts business in the State of Texas and within this District. Bose engages in other persistent courses of conduct and derives substantial revenue from products and/or services provided in this District and in Texas, and has purposefully established substantial, systematic, and continuous contacts within this District and should reasonably expect to be sued in a court in this District. For example, Bose has a store in this District and has a Texas registered

agent for service. Bose operates a website and various advertising campaigns that solicit sales of the infringing products by consumers in this District and in Texas. Bose has entered into partnerships with numerous resellers and distributors to sell and offer for sale the Accused Products to consumers in this District, both online and in stores, and offers support service to customers in this District. Given these contacts, the Court's exercise of jurisdiction over Bose will not offend traditional notions of fair play and substantial justice

10. Venue in the Western District of Texas is proper pursuant to 28 U.S.C. §§ 1391(b), (c) and 1400(b). Bose has a regular and established place of business at 3939 IH-35 South, Suite 725, San Marcos, Texas 78666. Bose has facilities in the Western District of Texas where it sells, and/or markets its products, including its Bose Factory Store located in San Marcos, Texas. Bose has committed acts within this judicial district giving rise to this action. Bose continues to conduct business in this judicial district, including one or more acts of making, selling, using, importing and/or offering for sale infringing products or providing support service to Bose's customers in this District.

KOSS'S LEGACY OF AUDIO INNOVATION

11. Koss was founded in 1953 as a television rental company in Milwaukee, Wisconsin.

12. In 1958, John C. Koss invented the world's first SP/3 Stereophone as part of a "private listening system" that would enable the wearer to listen to a phonograph without disturbing others in the vicinity:



13. The SP/3 Stereophone provided, for the first time, a high-quality stereophonic headphone that approximated the sounds of a concert hall.

14. John C. Koss demonstrated the SP/3 Stereophone at a Wisconsin audio show in 1958. Initially designed to demonstrate the high-fidelity stereo sound that a portable phonograph player delivered, these revolutionary SP/3 Stereophones became the hit of the show.

15. The SP/3 Stereophone has since been enshrined in the Smithsonian Museum's collection in Washington, DC, with John C. Koss delivering the SP/3 for enshrinement along with an explanation of the story of the SP/3 in 1972:



16. Koss's commitment to headphone development continued into the 1960s and beyond. In 1962, Koss developed and brought to market the PRO/4 Stereophone, which was bestowed with Consumer Union Magazine's #1 choice award in 1963:



17. Due to the success and quality of the Pro/4, the United States government awarded Koss with a contract to install fifty (50) Pro/4 units in the staff, press, and presidential quarters of Air Force One. Passengers accessing the aircraft's state-of-the-art entertainment system listened to the system using the Pro/4:



18. In 1970, Koss moved its World Headquarters to the current location at 4129 North Port Washington Ave., Milwaukee, Wisconsin:



19. Also in 1970, Koss set the standard for full-size professional headphones with its Pro/4AA:



20. At the time of introduction, the Pro/4AA were regarded as the first dynamic headphones to deliver true full frequency and high-fidelity performance with noise-isolating capabilities.

21. Koss continued improving its Stereophone product line throughout the 1970s and into the 1980s. In 1984, Koss introduced the Porta Pro, an acclaimed product that set performance and comfort standards for on-the-go listening:



22. The Porta Pro continues to be one of the most popular headphone products around the world, particularly because of its exceptional audio fidelity and performance capabilities. In fact, as recently as 2008, CNET awarded the Porta Pros a four-star rating of 8.3 (out of 10), with a performance score of 9 (out of 10), stating that “there’s no denying the sound quality here: they’re the ideal companion for mobile audiophiles and home theater enthusiasts.” (<https://www.cnet.com/reviews/koss-portapro-with-case-review/>).

23. In 1965, Koss introduced the award-winning speaker, the Acoustech X, which was heralded as a breakthrough product by Billboard Magazine, touting its concert hall quality and ability to accurately amplify an acoustic guitar to large concert halls. *Acoustic System Succeeds In Classical Guitar Concert*, BILLBOARD, May 27, 1967, at 71.

24. Following on Acoustech X, Koss went on to develop a number of additional products: the world’s first computer maximized loudspeaker in 1976; the Kossfire speaker line in the 1980s; the dynamic audio/video Dynamite bookshelf series speaker line; a line of portable/desktop computer speakers that employed a unique magnetic shield to protect nearby computer video and data equipment; and an amplified portable loudspeaker, the M/100, in early 1987.

25. In 1987, Koss pioneered one of the earliest completely wireless infrared speaker systems: the JCK 5000. In 1986, Koss also unveiled a portable speaker, the KSC/50, which was utilized by thousands of members of the United States military during the Gulf War in 1990. Related to the KSC/50, Koss’s KSC/5000 included a built-in amplifier. Those products were profiled in a Newsweek feature on October 12, 1987:



26. Over the following years, Koss continued to expand its portable speaker offerings, including by expanding into speakerphones for teleconferencing systems with the Speakeasy line, followed by various additional wireless models for portable use.

27. Elite musicians including Tony Bennett, Les Brown, and Frank Sinatra Jr., have used Koss headphones, including the Pro/4, while recording and/or performing. Koss's official spokespeople have included music legends Mel "the Velvet Fog" Tormé and Doc Severinsen, the trumpet-playing bandleader for Johnny Carson's Tonight Show band.

28. In 1979, John C. Koss was inducted into the Audio Hall of Fame.

29. In 2000, John C. Koss was inducted into the inaugural class of the Consumer Electronics Hall of Fame.

30. In 2004, John C. Koss was inducted into the Wisconsin Business Hall of Fame.

KOSS DEVELOPS THE FIRST EVER TRUE WIRELESS HEADPHONES

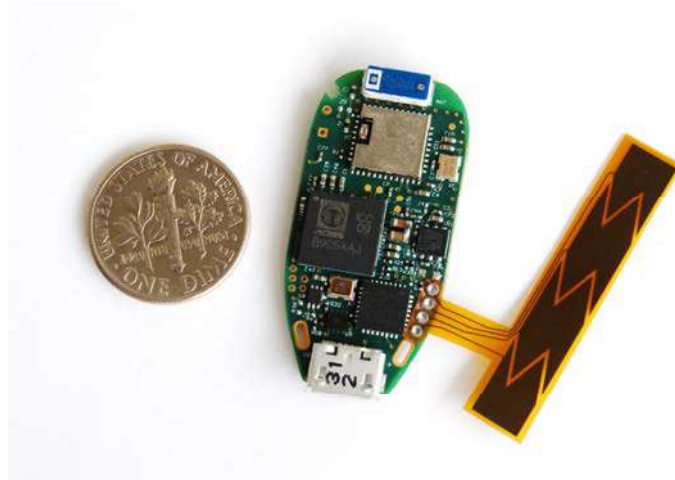
31. Continuing its culture of innovation in high-fidelity audio equipment, in the early 2000s, Koss began developing what became known as the “Striva” project. The vision for the Striva project was borne out of Koss’s recognition that wireless headphones were going to be an integral part of peoples’ audio consumption. In particular, Koss recognized that as radios were needing less power and as batteries and other power sources became smaller and more efficient, people would eventually consume audio content through headphones wirelessly connected to some kind of a source, be it a handheld computing device or in the cloud.

32. In the early 2000s, Koss began making substantial monetary investments in the Striva project, with the goal of bringing “True Wireless” listening to its loyal customers as the next in a long series of headphone innovations.

33. Koss recognized that the future was a wireless world, complete with mobile internet connectivity that went beyond traditional hardwired, or computer-based, network topologies. It recognized that wireless ubiquity was coming, and would extend to wearable devices, including Koss’s area of expertise: the headphone.

34. With these recognitions in mind, Koss made a substantial commitment to investing in what it saw as the future of headphone technology. This work eventually became the Striva project, and over the course of its work, Koss invested tens of millions of dollars developing chips, fabrication techniques, prototype headphones, and other related technology to bring the Striva vision to life.

35. In particular, Koss’s work on Striva resulted in the development of a system-on-chip smaller than a human fingertip that could provide audio and wireless communications processing on a low power budget for incorporation into headphones of various form factors:



36. Koss’s work to develop Striva also predicted some of the interactions that modern headphone users take for granted today. In particular, Koss recognized early on that the inclusion of a microphone (with appropriate voice recognition software and circuitry) could provide a convenient, hands-free way to interact with wireless headphones. Koss developed technology that could react to such voice prompts, and in fact implemented prototypes that reacted to users saying “Striva” into a headphone-mounted microphone to begin a voice-based interaction to, for example, switch tracks or adjust headphone volume.

37. Koss also recognized a headphone concept that users today take for granted: different headphones for different applications. In particular, as part of the Striva project, Koss developed different form factors with different performance capabilities depending on anticipated use. Over-ear headphones provided users with higher-quality sound, ambient noise dampening capabilities, and better battery life (due to additional battery real estate), while in-ear headphones provided portability and capability in a smaller, less-intrusive package.

38. Koss developed prototype in-ear headphones that relied on its chip development efforts, with working prototypes from the mid-2000s looking very much like commonly-known consumer products that flood the market a decade-and-a-half later:



39. In 2012, Koss introduced Wi-Fi enabled headphones, the result of its Striva project, which BizTimes hailed as the first wireless headphones to use Wi-Fi transmission and credited Koss with “introducing personal listening to the Internet.” (<https://biztimes.com/koss-creates-wireless-headphones-for-wi-fi-music-access/>).

40. In April 2012, Koss brought to market both an in-ear and over-ear embodiment of the Striva vision, with the Striva Pro model being the first true Wi-Fi over the ear headphones (and mirroring many features and aesthetics modern-day users expect in wireless, over-ear headphones):



41. The Striva Tap, a smaller, in-ear version of the Striva Pro Wi-Fi headphone, provided users with some of the features that modern-day consumers take for granted in in-ear

headphones, like independent wireless earphones with touch gestures to control listening preferences by manipulating the surface of the headphones:



42. Koss also developed (though ultimately did not market) a smart speaker that incorporated many of the Striva features, albeit in a non-wearable form factor. The Striva-based speaker product had a capacitive touch interface to mimic the features of the Striva headphones, and also included a microphone for voice control. In addition, the Striva-based speaker had the capability to be included in a distributed network as part of a precursor to the presently understood Internet of Things, such that the input devices (e.g., the microphone) could be used to control other items in the distributed network (e.g., light switches). The speaker therefore allowed, for example, a user to say “Striva, turn on the lights,” and the lights would turn on.

43. The Striva-based speaker product, referred to as the LS2, exists as a working prototype:



44. Unfortunately, the economic reality of Koss's market position did not permit it to bring its Striva-based product vision to the masses. In particular, due to events abroad (and Koss's reliance on sales into those foreign countries), Koss's supply chain and customer base were thrown into upheaval in the late-2000's and early-2010's.

45. Moreover, Koss conducted market research during the mid-2000's, and concluded that given the market that was likely to develop for wireless headphones, larger companies with more manufacturing capability would become a substantial threat to bringing Striva fully to market. As a result, Koss invested substantially on part-purchasing, machinery, fabrication, and the like.

46. The circumstances above, and other circumstances outside of Koss's control, meant that the advanced features first developed for Striva were not able to be fully experienced by the majority of the purchasing public.

47. Koss brings the instant lawsuit because the industry has caught up to Koss's early-2000s vision: the technology Koss developed as part of its substantial Striva investment has become standardized, with whole listening ecosystems having been built around the techniques Koss conceived of over a decade ago.

48. More fundamentally, Koss is responsible for creating an entire headphone industry beginning from its release of the pioneering Stereophone as a ubiquitous way to consume information in 1958. Bose and others are reaping enormous benefits due to John C. Koss's vision, and Koss Corporation's commitment to that vision, for more than six decades.

THE PATENTS-IN-SUIT

49. On February 12, 2019, U.S. Patent No. 10,206,025, entitled "System with Wireless Earphones," was duly and legally issued by the United States Patent and Trademark Office. A true and accurate copy of the '025 Patent is attached hereto as Exhibit A.

50. On July 30, 2019, U.S. Patent No. 10,368,155, entitled "System with Wireless Earphones," was duly and legally issued by the United States Patent and Trademark Office. A true and accurate copy of the '155 Patent is attached hereto as Exhibit B.

51. On November 5, 2019, U.S. Patent No. 10,469,934, entitled "System with Wireless Earphones," was duly and legally issued by the United States Patent and Trademark Office. A true and accurate copy of the '934 Patent is attached hereto as Exhibit C.

52. The Patents-in-Suit represent Koss's significant investment into the wireless headphone and wearable technology space, including its commitment in the form of decades of research and millions of dollars.

DEFENDANT'S KNOWLEDGE OF THE PATENTS-IN-SUIT

53. On July 09, 2020, Defendant was notified of its infringement by way of the letter attached hereto as Exhibit G.

FIRST CAUSE OF ACTION

(Infringement of the '025 Patent)

54. Koss incorporates by reference and realleges each and every allegation of Paragraphs 1 through 53 as if set forth herein.

55. Koss owns all substantial rights, interest, and title in and to the '025 Patent, including the sole and exclusive right to prosecute this action and enforce the '025 Patent against infringers, and to collect damages for all relevant times.

56. The '025 Patent generally describes wireless earphones that comprise a transceiver circuit for receiving streaming audio from a data source, such as a digital audio player or a computer, over a wireless network.

57. The written description of the '025 Patent describes in technical detail each of the limitations of the claims, allowing a skilled artisan to understand the scope of the claims and how the non-conventional and non-generic combination of claim limitations is patentably distinct from and improved upon what may have been considered conventional or generic in the art at the time of the invention.

58. Bose has made, had made, used, imported, supplied, distributed, sold, or offered for sale products and/or systems, including systems in which its SoundSport, 700, and/or QC 35 branded products and/or systems are incorporated (“Accused Headphones”).

59. As set forth in the attached non-limiting Claim chart (Exhibit D), Bose has infringed and is infringing at least Claim 1 of the '025 Patent by making, having made, using, importing, supplying, distributing, selling, and/or offering for sale the Accused Headphones. In particular, the use of the Accused Headphones by Bose to, for example, demonstrate those products in brick-and-mortar stores in Austin, Texas or to, for example, test those products, constitute acts of direct infringement of Claim 1 of the '025 Patent.

60. Bose actively induces infringement of at least Claim 1 of the '025 Patent by selling the Accused Headphones with instructions as to how to use the Accused Headphones in a system such as that recited in the '025 Patent. Bose aids, instructs, or otherwise acts with the intent to cause an end user to use the Accused Headphones. Bose knew of the '025 Patent and knew that its use and sale of the Accused Headphones infringe at least Claim 1 of the '025 Patent.

61. Bose is liable for contributory infringement of at least Claim 1 of the '025 Patent by providing, and by having knowingly provided, a material part of the instrumentalities, namely the Accused Headphones, used to infringe Claim 1 of the '025 Patent. The Accused Headphones have no substantial non-infringing uses. When an end user uses the Accused Headphones in combination with, for example, a smart phone such as, for example, an Apple iPhone and/or a periphery device, such as, for example, an Apple Watch, the end user directly infringes Claim 1 of the '025 Patent. Bose knew that the Accused Headphones were especially made for use in an infringing manner prior to the filing of this lawsuit. For at least the reasons set forth above, Bose contributes to the infringement of the '025 Patent by others.

62. Koss has been damaged as a result of the infringing conduct by Bose alleged above. Thus, Bose is liable to Koss in an amount that compensates it for such infringement, which by law cannot be less than a reasonable royalty, together with interest and costs as fixed by this Court under 35 U.S.C. § 284.

63. Bose's infringement of the '025 Patent has caused, and will continue to cause, Koss to suffer substantial and irreparable harm.

64. Bose has been aware that it infringes the '025 Patent since at least July 9, 2020, upon the receipt of the letter attached as Exhibit G. Since obtaining knowledge of its infringing activities, Bose has failed to cease its infringing activities.

65. Bose's infringement of the '025 Patent is, has been, and continues to be, willful, intentional, deliberate, and/or in conscious disregard of Koss's rights under the patent.

66. Koss has complied with 35 U.S.C. § 287 with respect to the '025 Patent.

SECOND CAUSE OF ACTION

(Infringement of the '155 Patent)

67. Koss incorporates by reference and realleges each and every allegation of Paragraphs 1 through 66 as if set forth herein.

68. Koss owns all substantial rights, interest, and title in and to the '155 Patent, including the sole and exclusive right to prosecute this action and enforce the '155 Patent against infringers, and to collect damages for all relevant times.

69. The '155 Patent generally describes wireless earphones that comprise a transceiver circuit for receiving streaming audio from a data source, such as a digital audio player or a computer, over a wireless network.

70. The written description of the '155 Patent describes in technical detail each of the limitations of the claims, allowing a skilled artisan to understand the scope of the claims and how the non-conventional and non-generic combination of claim limitations is patentably distinct from and improved upon what may have been considered conventional or generic in the art at the time of the invention.

71. Bose has made, had made, used, imported, supplied, distributed, sold, or offered for sale products and/or systems, including systems in which its Bose branded products and/or systems, such as SoundSport, 700, and/or QC 35 branded product, are incorporated (“Accused Headphones”).

72. As set forth in the attached non-limiting Claim chart (Exhibit E), Bose has infringed and is infringing at least Claim 1 of the '155 Patent by making, having made, using, importing, supplying, distributing, selling, and/or offering for sale the Accused Headphones. In particular, the use of the Accused Headphones by Bose to, for example, demonstrate those products in brick-and-mortar stores in Austin, Texas or to, for example, test those products, constitute acts of direct infringement of Claim 1 of the '155 Patent.

73. Bose actively induces infringement of at least Claim 1 of the '155 Patent by selling the Accused Headphones with instructions as to how to use the Accused Headphones in a system such as that recited in the '155 Patent. Bose aids, instructs, or otherwise acts with the intent to

cause an end user to use the Accused Headphones. Bose knew of the '155 Patent and knew that its use and sale of the Accused Headphones infringe at least Claim 1 of the '155 Patent.

74. Bose is also liable for contributory infringement of at least Claim 1 of the '155 Patent by providing, and by having knowingly provided, a material part of the instrumentalities, namely the Accused Headphones, used to infringe Claim 1 of the '155 Patent. The Accused Headphones have no substantial non-infringing uses. When an end user uses the Accused Headphones in combination with, for example, a smart phone such as, for example, an Apple iPhone and/or a peripheral device such as, for example, an Apple Watch, the end user directly infringes Claim 1 of the '155 Patent. Bose knew that the Accused Headphones were especially made for use in an infringing manner prior to the filing of this lawsuit. For at least the reasons set forth above, Bose contributes to the infringement of the '155 Patent by others.

75. Koss has been damaged as a result of the infringing conduct by Bose alleged above. Thus, Bose is liable to Koss in an amount that compensates it for such infringement, which by law cannot be less than a reasonable royalty, together with interest and costs as fixed by this Court under 35 U.S.C. § 284.

76. Bose's infringement of the '155 Patent has caused, and will continue to cause, Koss to suffer substantial and irreparable harm.

77. Bose has been aware that it infringes the '155 Patent since at least July 9, 2020, upon the receipt of the letter attached as Exhibit G. Since obtaining knowledge of its infringing activities, Bose has failed to cease its infringing activities.

78. Bose's infringement of the '155 Patent is, has been, and continues to be, willful, intentional, deliberate, and/or in conscious disregard of Koss's rights under the patent.

79. Koss has complied with 35 U.S.C. § 287 with respect to the '155 Patent.

THIRD CAUSE OF ACTION

(Infringement of the '934 Patent)

80. Koss incorporates by reference and realleges each and every allegation of Paragraphs 1 through 79 as if set forth herein.

81. Koss owns all substantial rights, interest, and title in and to the '934 Patent, including the sole and exclusive right to prosecute this action and enforce the '934 Patent against infringers, and to collect damages for all relevant times.

82. The '934 Patent generally describes wireless earphones that comprise a transceiver circuit for receiving streaming audio from a data source, such as a digital audio player or a computer, over a wireless network.

83. The written description of the '934 Patent describes in technical detail each of the limitations of the claims, allowing a skilled artisan to understand the scope of the claims and how the non-conventional and non-generic combination of claim limitations is patentably distinct from and improved upon what may have been considered conventional or generic in the art at the time of the invention.

84. Bose has made, had made, used, imported, supplied, distributed, sold, or offered for sale products and/or systems, including systems in which its SoundSport, 700, and/or QC 35 products and/or systems are incorporated (“Accused Headphones”).

85. As set forth in the attached non-limiting Claim chart (Exhibit F), Bose has infringed and is infringing at least Claim 1 of the '934 Patent by making, having made, using, importing, supplying, distributing, selling, and/or offering for sale the Accused Headphones. In particular, the use of the Accused Headphones by Bose to, for example, demonstrate those products in brick-and-mortar stores in Austin, Texas or to, for example, test those products, constitute acts of direct infringement of Claim 1 of the '934 Patent.

86. Bose actively induces infringement of at least Claim 1 of the '934 Patent by selling the Accused Headphones with instructions as to how to use the Accused Headphones in a system such as that recited in the '934 Patent. Bose aids, instructs, or otherwise acts with the intent to

cause an end user to use the Accused Headphones. Bose knew of the '934 Patent and knew that its use and sale of the Accused Headphones infringe at least Claim 1 of the '934 Patent.

87. Bose is also liable for contributory infringement of at least Claim 1 of the '934 Patent by providing, and by having knowingly provided, a material part of the instrumentalities, namely the Accused Headphones, used to infringe Claim 1 of the '934 Patent. The Accused Headphones have no substantial non-infringing uses. When an end user uses the Accused Headphones in combination with, for example, a smart phone such as, for example, Apple iPhone and/or a peripheral device such as, for example, an Apple Watch, the end user directly infringes Claim 1 of the '934 Patent. Bose knew that the Accused Headphones were especially made for use in an infringing manner prior to the filing of this lawsuit. For at least the reasons set forth above, Bose contributes to the infringement of the '934 Patent by others.

88. Koss has been damaged as a result of the infringing conduct by Bose alleged above. Thus, Bose is liable to Koss in an amount that compensates it for such infringement, which by law cannot be less than a reasonable royalty, together with interest and costs as fixed by this Court under 35 U.S.C. § 284.

89. Bose's infringement of the '934 Patent has caused, and will continue to cause, Koss to suffer substantial and irreparable harm.

90. Bose has been aware that it infringes the '934 Patent since at least July 9, 2020, upon the receipt of the letter attached as Exhibit G. Since obtaining knowledge of its infringing activities, Bose has failed to cease its infringing activities.

91. Bose's infringement of the '934 Patent is, has been, and continues to be, willful, intentional, deliberate, and/or in conscious disregard of Koss's rights under the patent.

92. Koss has complied with 35 U.S.C. § 287 with respect to the '934 Patent.

JURY DEMAND

Koss hereby requests a trial by jury on all issues so triable by right.

PRAYER FOR RELIEF

WHEREFORE, Koss requests that:

A. The Court find that Bose has directly infringed the Patents-in-Suit and hold Bose liable for such infringement;

B. The Court find that Bose has indirectly infringed the Patents-in-Suit by inducing its customers to directly infringe the Patents-in-Suit and hold Bose liable for such infringement;

C. The Court find that Bose has indirectly infringed the Patents-in-Suit by contributing to Bose's customers' direct infringement of the Patents-in-Suit and hold Bose liable for such infringement;

D. The Court award damages pursuant to 35 U.S.C. § 284 adequate to compensate Koss for Bose's past infringement of the Patents-in-Suit, including both pre- and post-judgment interest and costs as fixed by the Court;

E. The Court increase the damages to be awarded to Koss by three times the amount found by the jury or assessed by the Court;

F. The Court declare that this is an exceptional case entitling Koss to its reasonable attorneys' fees under 35 U.S.C. § 285; and

G. The Court award such other relief as the Court may deem just and proper.

Dated: July 22, 2020

Respectfully submitted,

/s/ Darlene F. Ghavimi
Darlene F. Ghavimi (TX Bar No. 24072114)
K&L GATES LLP
2801 Via Fortuna, Suite #350
Austin, TX 78746
Tel.: (512) 482-6919
Fax: (512) 482-6859
darlene.ghavimi@klgates.com

Benjamin E. Weed (*pro hac vice* to be filed)

Philip A. Kunz (*pro hac vice* to be filed)

Erik J. Halverson (*pro hac vice* to be filed)

Gina E. Johnson (*pro hac vice* to be filed)

K&L GATES LLP

Suite 3300

70 W. Madison Street

Chicago, IL 60602

Tel.: (312) 372-1121

Fax: (312) 827-8000

benjamin.weed@klgates.com

philip.kunz@klgates.com

erik.halverson@klgates.com

gina.johnson@klgates.com

Peter E. Soskin (*pro hac vice* to be filed)

K&L GATES LLP

Suite 1200

4 Embarcadero Center

San Francisco, CA 94111

Tel.: (415) 882-8046

Fax: (415) 882-8220

peter.soskin@klgates.com

ATTORNEYS FOR PLAINTIFF

KOSS CORPORATION

CIVIL COVER SHEET

The JS 44 civil cover sheet and the information contained herein neither replace nor supplement the filing and service of pleadings or other papers as required by law, except as provided by local rules of court. This form, approved by the Judicial Conference of the United States in September 1974, is required for the use of the Clerk of Court for the purpose of initiating the civil docket sheet. (SEE INSTRUCTIONS ON NEXT PAGE OF THIS FORM.)

I. (a) PLAINTIFFS

KOSS CORPORATION

(b) County of Residence of First Listed Plaintiff Milwaukee (EXCEPT IN U.S. PLAINTIFF CASES)

(c) Attorneys (Firm Name, Address, and Telephone Number) Darlene F. Ghavimi K&L Gates, LLP 2801 Via Fortuna, Suite 350, Austin, Texas 78746 512-482-6919 darlene.ghavimi@klgates.com

DEFENDANTS

BOSE CORPORATION

County of Residence of First Listed Defendant Middlesex (IN U.S. PLAINTIFF CASES ONLY)

NOTE: IN LAND CONDEMNATION CASES, USE THE LOCATION OF THE TRACT OF LAND INVOLVED.

Attorneys (If Known)

II. BASIS OF JURISDICTION (Place an "X" in One Box Only)

- 1 U.S. Government Plaintiff, 2 U.S. Government Defendant, 3 Federal Question (U.S. Government Not a Party), 4 Diversity (Indicate Citizenship of Parties in Item III)

III. CITIZENSHIP OF PRINCIPAL PARTIES (Place an "X" in One Box for Plaintiff and One Box for Defendant)

Table with columns for Plaintiff (PTF) and Defendant (DEF) citizenship and business location (Citizen of This State, Citizen of Another State, Citizen or Subject of a Foreign Country, Incorporated or Principal Place of Business In This State, Incorporated and Principal Place of Business In Another State, Foreign Nation).

IV. NATURE OF SUIT (Place an "X" in One Box Only)

Large table with categories: CONTRACT, REAL PROPERTY, CIVIL RIGHTS, PRISONER PETITIONS, TORTS, PERSONAL INJURY, FORFEITURE/PENALTY, LABOR, IMMIGRATION, BANKRUPTCY, SOCIAL SECURITY, FEDERAL TAX SUITS, OTHER STATUTES.

V. ORIGIN (Place an "X" in One Box Only)

- 1 Original Proceeding, 2 Removed from State Court, 3 Remanded from Appellate Court, 4 Reinstated or Reopened, 5 Transferred from Another District (specify), 6 Multidistrict Litigation - Transfer, 8 Multidistrict Litigation - Direct File

VI. CAUSE OF ACTION

Cite the U.S. Civil Statute under which you are filing (Do not cite jurisdictional statutes unless diversity): 35 USC 271. Brief description of cause: Patent Infringement

VII. REQUESTED IN COMPLAINT:

CHECK IF THIS IS A CLASS ACTION UNDER RULE 23, F.R.Cv.P. DEMAND \$ CHECK YES only if demanded in complaint: JURY DEMAND: X Yes No

VIII. RELATED CASE(S) IF ANY

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EXHIBIT A



US010206025B2

(12) **United States Patent**
Koss et al.

(10) **Patent No.:** **US 10,206,025 B2**
 (45) **Date of Patent:** ***Feb. 12, 2019**

(54) **SYSTEM WITH WIRELESS EARPHONES**

(71) Applicant: **Koss Corporation**, Milwaukee, WI (US)

(72) Inventors: **Michael J. Koss**, Milwaukee, WI (US); **Michael J. Pelland**, Princeton, WI (US); **Michael Sagan**, Fairfield, CA (US); **Steven R. Reckamp**, Crystal Lake, IL (US); **Gregory J. Hallingstad**, Deforest, WI (US); **Jeffery K. Bovee**, Sterling, IL (US); **Morgan J. Lowery**, Deforest, WI (US)

(73) Assignee: **KOSS CORPORATION**, Milwaukee, WI (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.
 This patent is subject to a terminal disclaimer.

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(22) Filed: **Apr. 25, 2018**

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 (63) Continuation of application No. 15/650,362, filed on Jul. 14, 2017, now Pat. No. 9,986,325, which is a (Continued)

(51) **Int. Cl.**
H04R 1/10 (2006.01)
H04M 1/02 (2006.01)
 (Continued)

(52) **U.S. Cl.**
 CPC **H04R 1/1041** (2013.01); **H03G 3/02** (2013.01); **H03K 17/9622** (2013.01);
 (Continued)

(58) **Field of Classification Search**
 CPC H04R 5/033; H04W 92/18
 (Continued)

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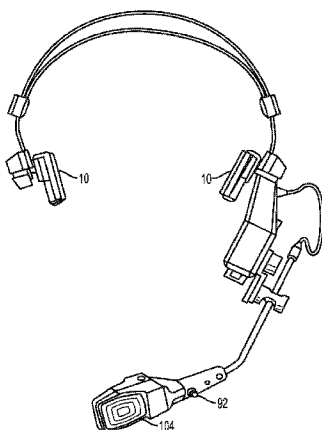
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Primary Examiner — Kiet M Doan
 (74) *Attorney, Agent, or Firm* — K&L Gates LLP

(57) **ABSTRACT**
 Apparatus comprises adapter and speaker system. Adapter is configured to plug into port of personal digital audio player. Speaker system is in communication with adapter, and comprises multiple acoustic transducers, programmable processor circuit, and wireless communication circuit. In first operational mode, processor circuit receives, via adapter, and processes digital audio content from personal digital audio player into which adapter is plugged, and the multiple acoustic transducers output the received audio content from the personal digital audio player. In second operational mode, wireless communication circuit receives digital audio content from a remote digital audio source over a wireless network, processor circuit processes the digital audio content received from remote digital audio source, and the multiple acoustic transducers output the audio content received from the remote digital audio source.

56 Claims, 16 Drawing Sheets



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Related U.S. Application Data

continuation of application No. 15/293,785, filed on Oct. 14, 2016, now Pat. No. 9,729,959, which is a continuation of application No. 15/082,040, filed on Mar. 28, 2016, now Pat. No. 9,497,535, which is a continuation of application No. 14/695,696, filed on Apr. 24, 2015, now Pat. No. 9,438,987, which is a continuation of application No. 13/609,409, filed on Sep. 11, 2012, now Pat. No. 9,049,502, which is a continuation of application No. 13/459,291, filed on Apr. 30, 2012, now Pat. No. 8,571,544, which is a continuation of application No. 12/936,488, filed as application No. PCT/US2009/039754 on Apr. 7, 2009, now Pat. No. 8,190,203.

(60) Provisional application No. 61/123,265, filed on Apr. 7, 2008.

(51) Int. Cl.

H04R 3/00 (2006.01)
H04R 5/033 (2006.01)
H04R 5/04 (2006.01)
H04W 48/20 (2009.01)
H03G 3/02 (2006.01)
H03K 17/96 (2006.01)
H04R 1/02 (2006.01)
H04H 20/95 (2008.01)
H04L 29/12 (2006.01)
H04W 4/80 (2018.01)
H04R 25/00 (2006.01)
H04W 84/18 (2009.01)
H04W 84/12 (2009.01)

(52) U.S. Cl.

CPC **H04H 20/95** (2013.01); **H04L 61/6068** (2013.01); **H04M 1/0254** (2013.01); **H04R 1/02** (2013.01); **H04R 1/1091** (2013.01); **H04R 3/00** (2013.01); **H04R 5/033** (2013.01); **H04R 5/04** (2013.01); **H04W 4/80** (2018.02); **H04W 48/20** (2013.01); **H03K 2217/960785** (2013.01); **H04R 25/554** (2013.01); **H04R 2201/103** (2013.01); **H04R 2201/107** (2013.01); **H04R 2225/55** (2013.01); **H04R 2420/07** (2013.01); **H04W 84/12** (2013.01); **H04W 84/18** (2013.01)

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USPC 455/456.1, 41.2, 3.05, 573; 381/301, 381/380, 74, 151
 See application file for complete search history.

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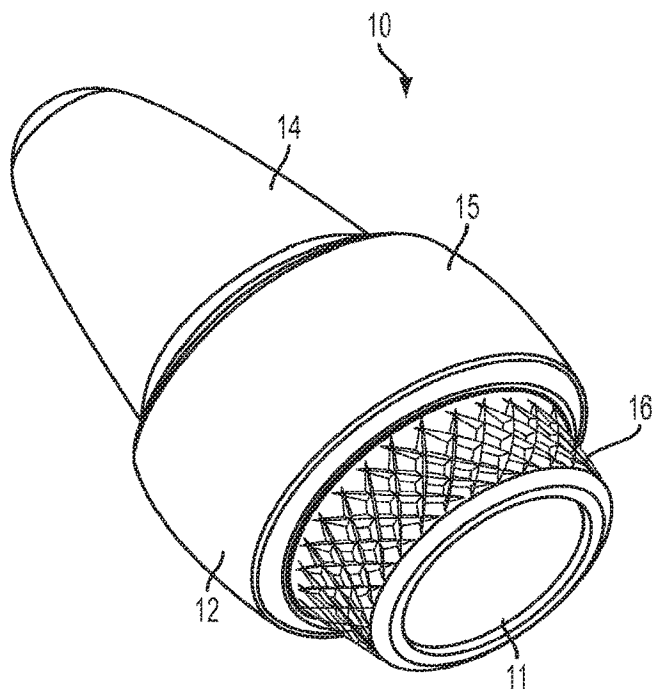


FIG. 1A

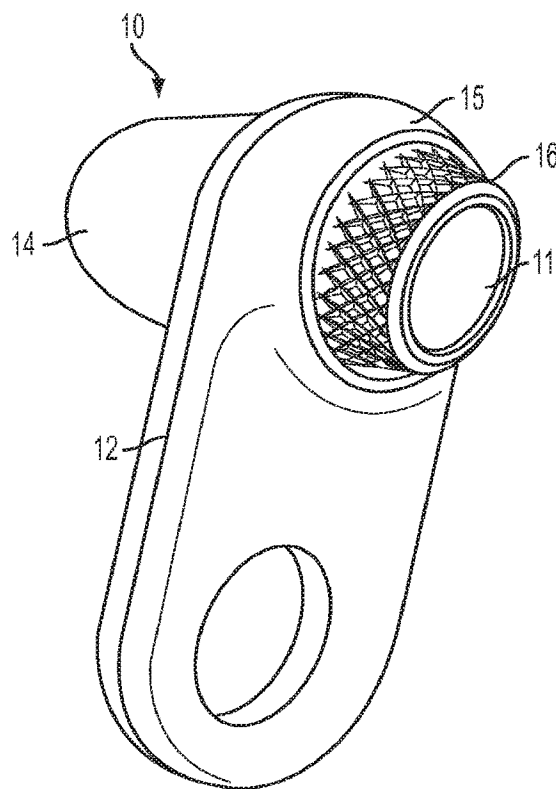


FIG. 1B

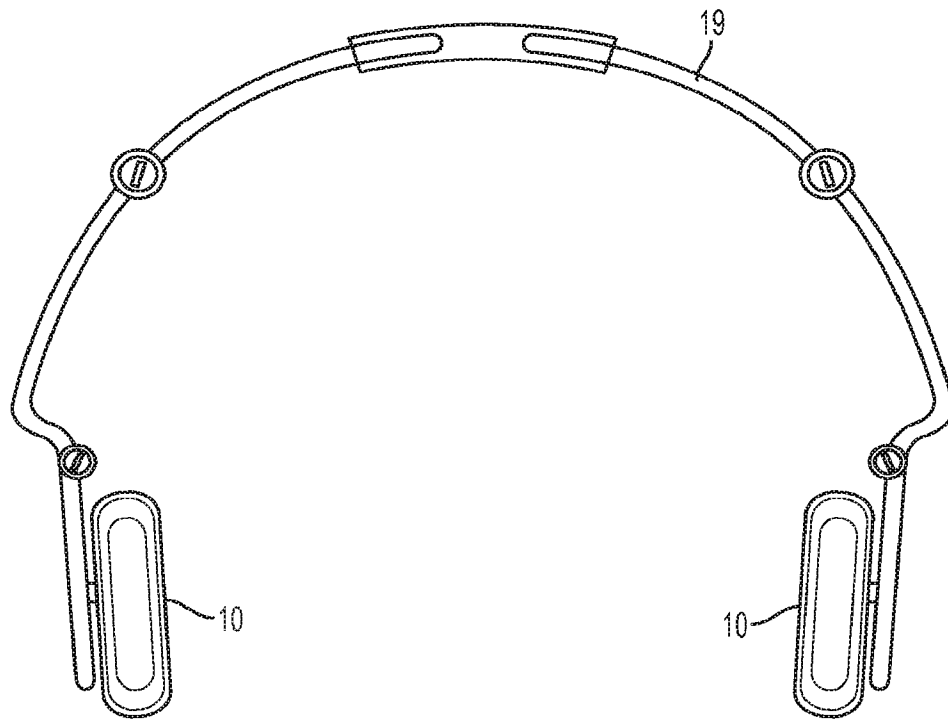


FIG. 1C

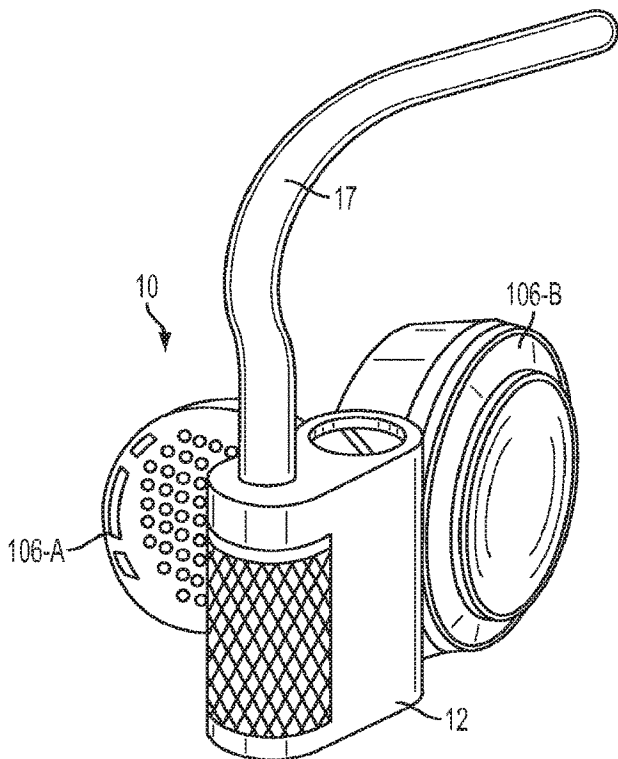


FIG. 1D

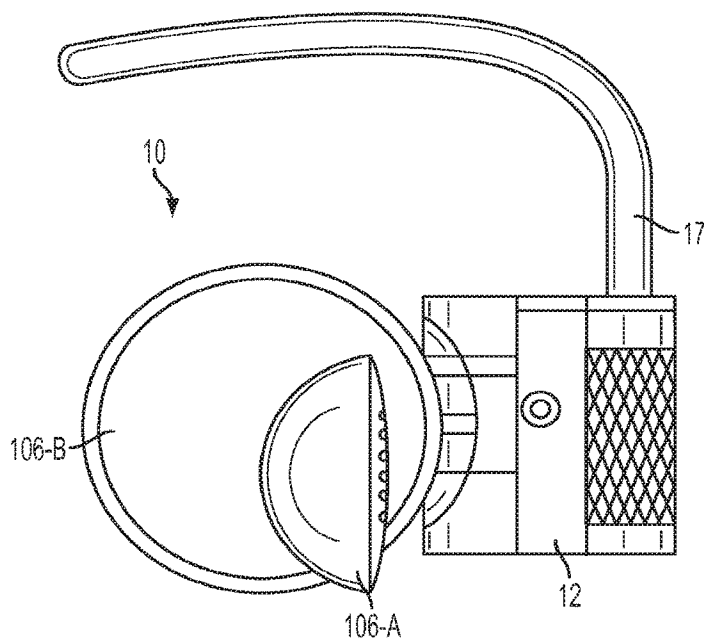


FIG. 1E

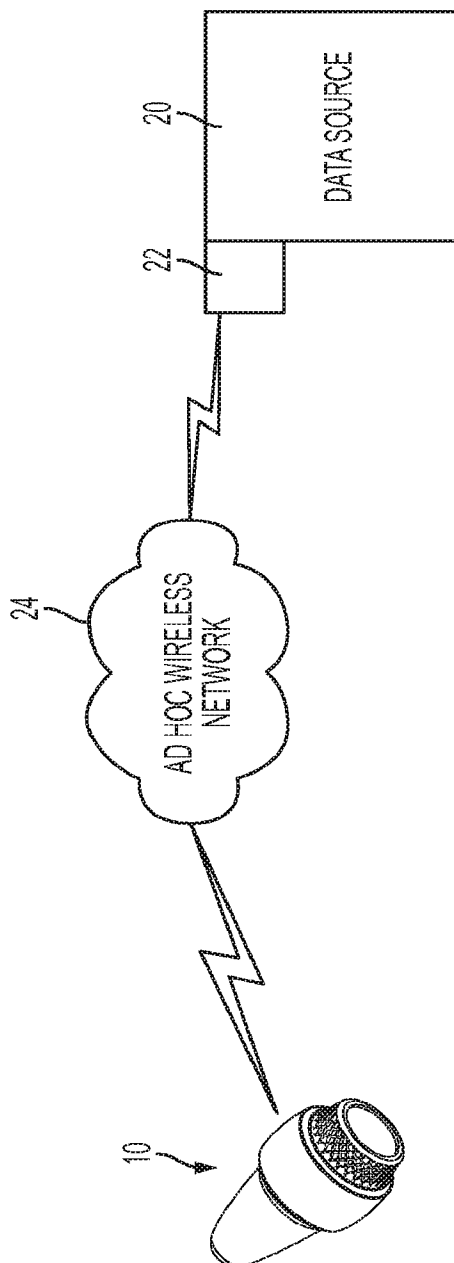


FIG. 2A

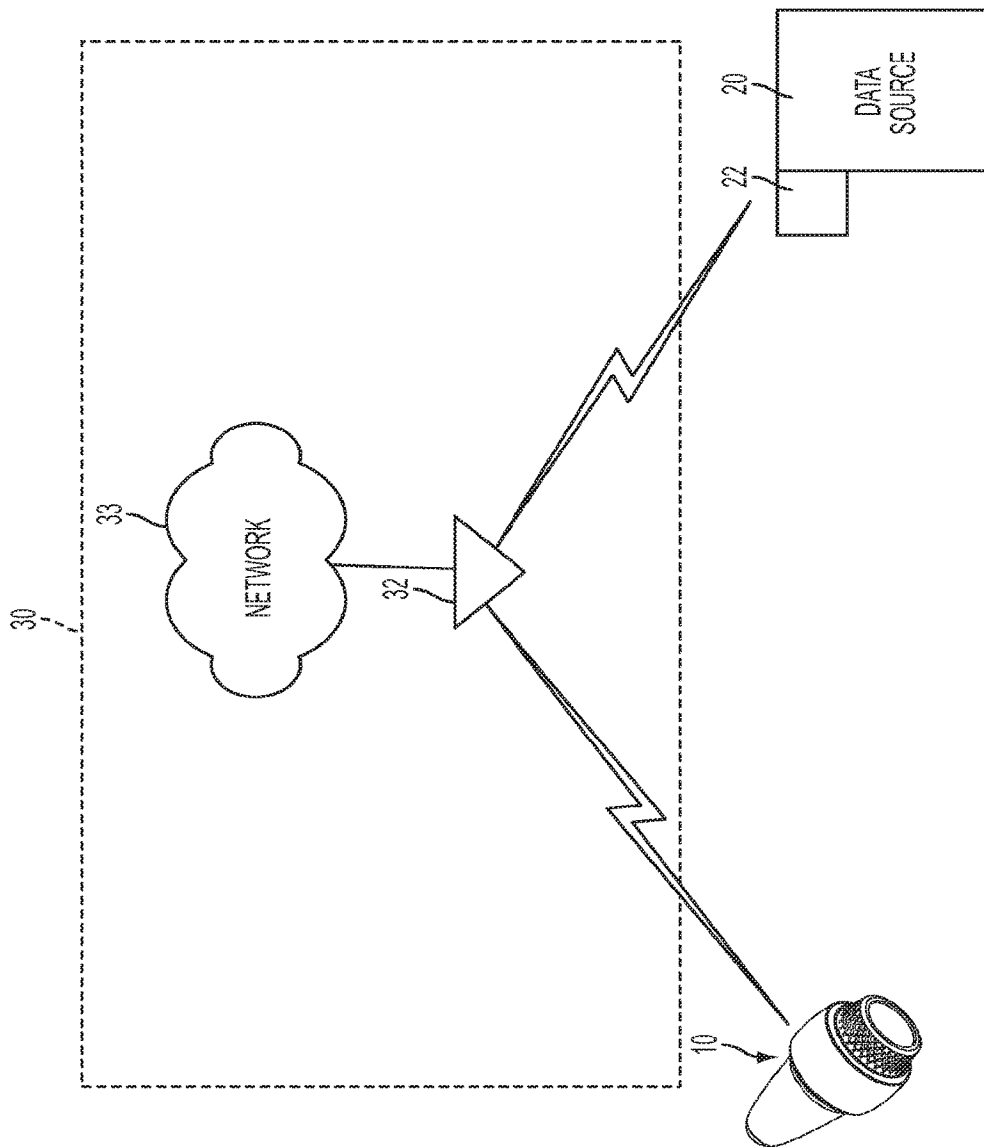


FIG. 2B

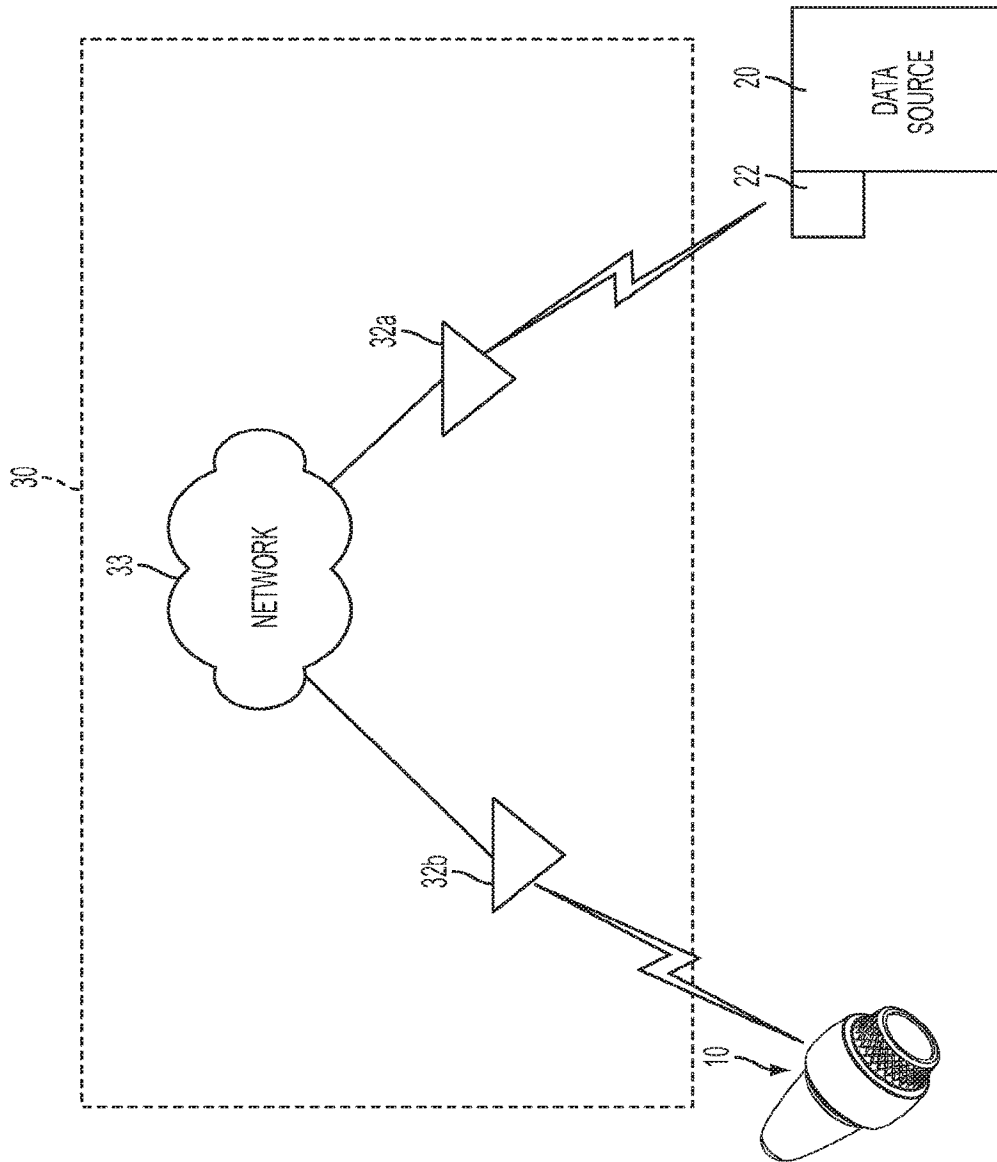


FIG. 2C

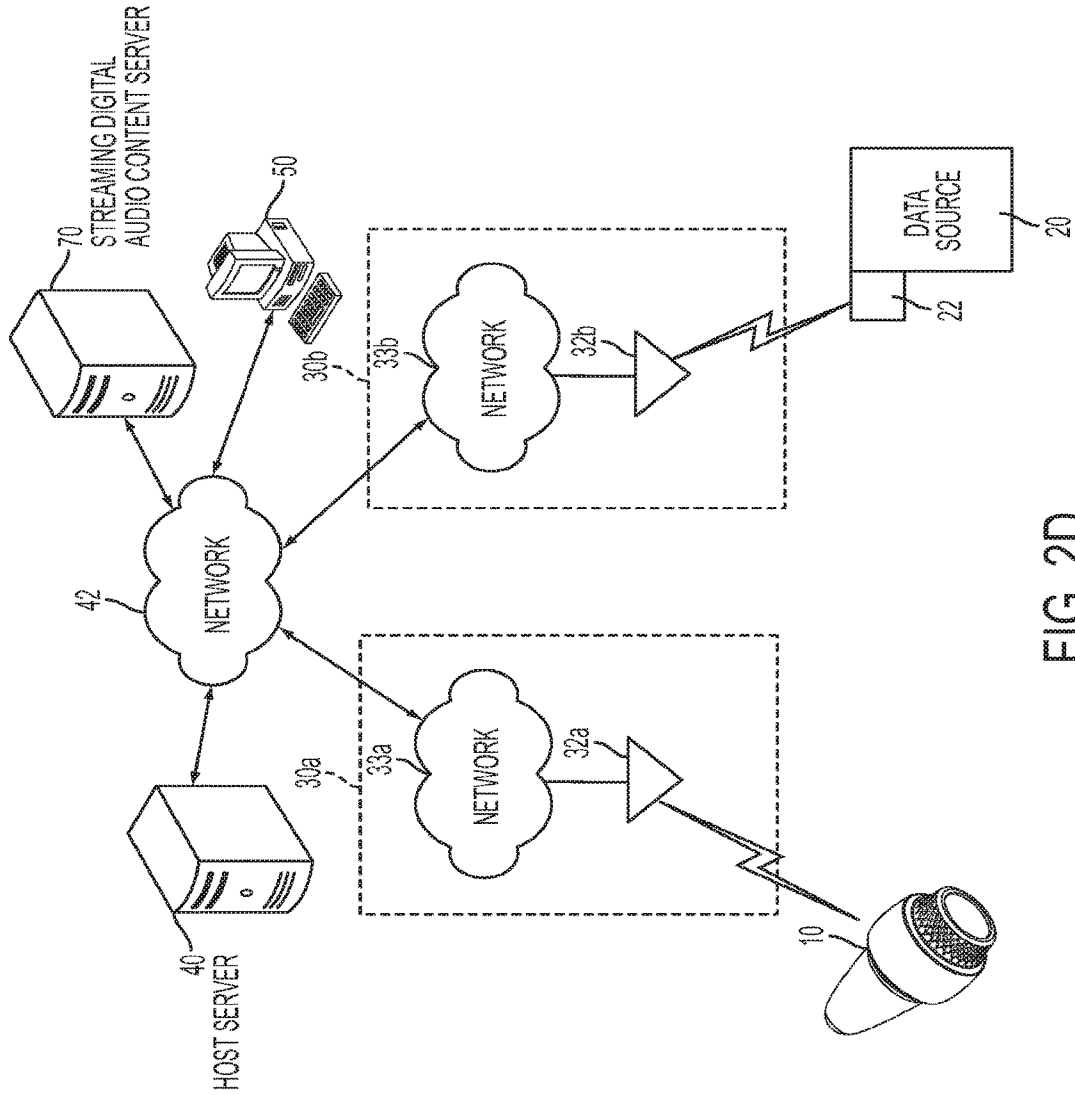


FIG. 2D

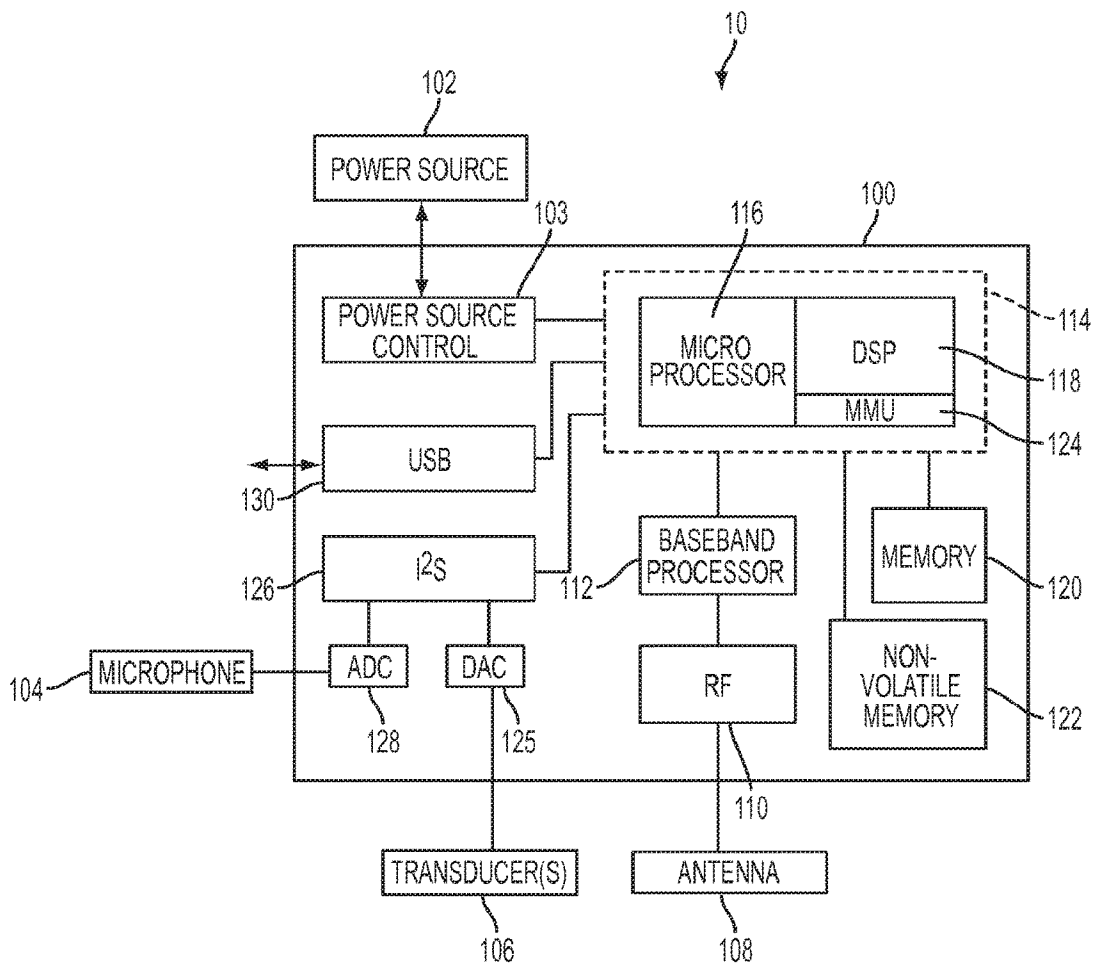


FIG. 3

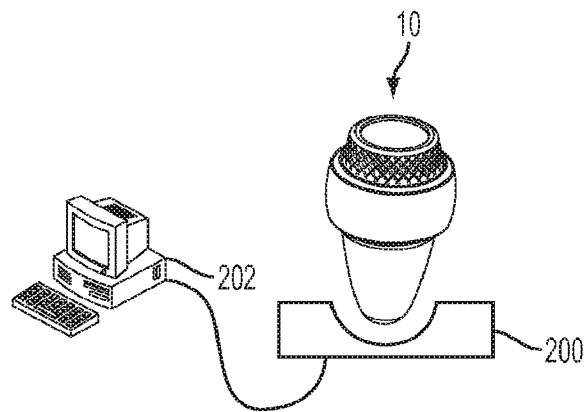


FIG. 4A

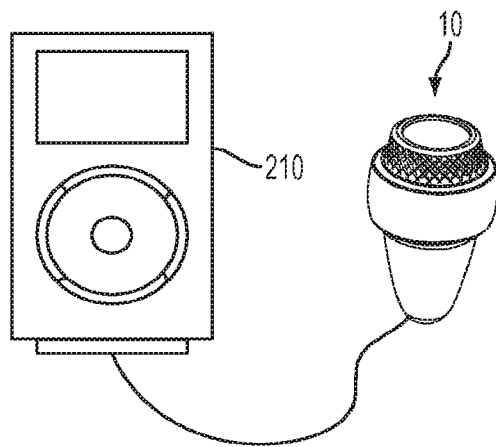


FIG. 4B

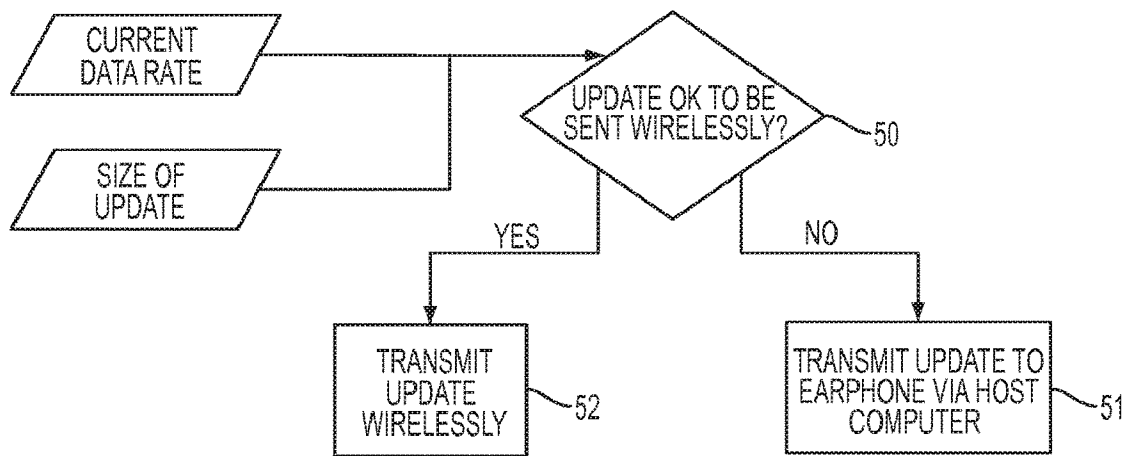


FIG. 5

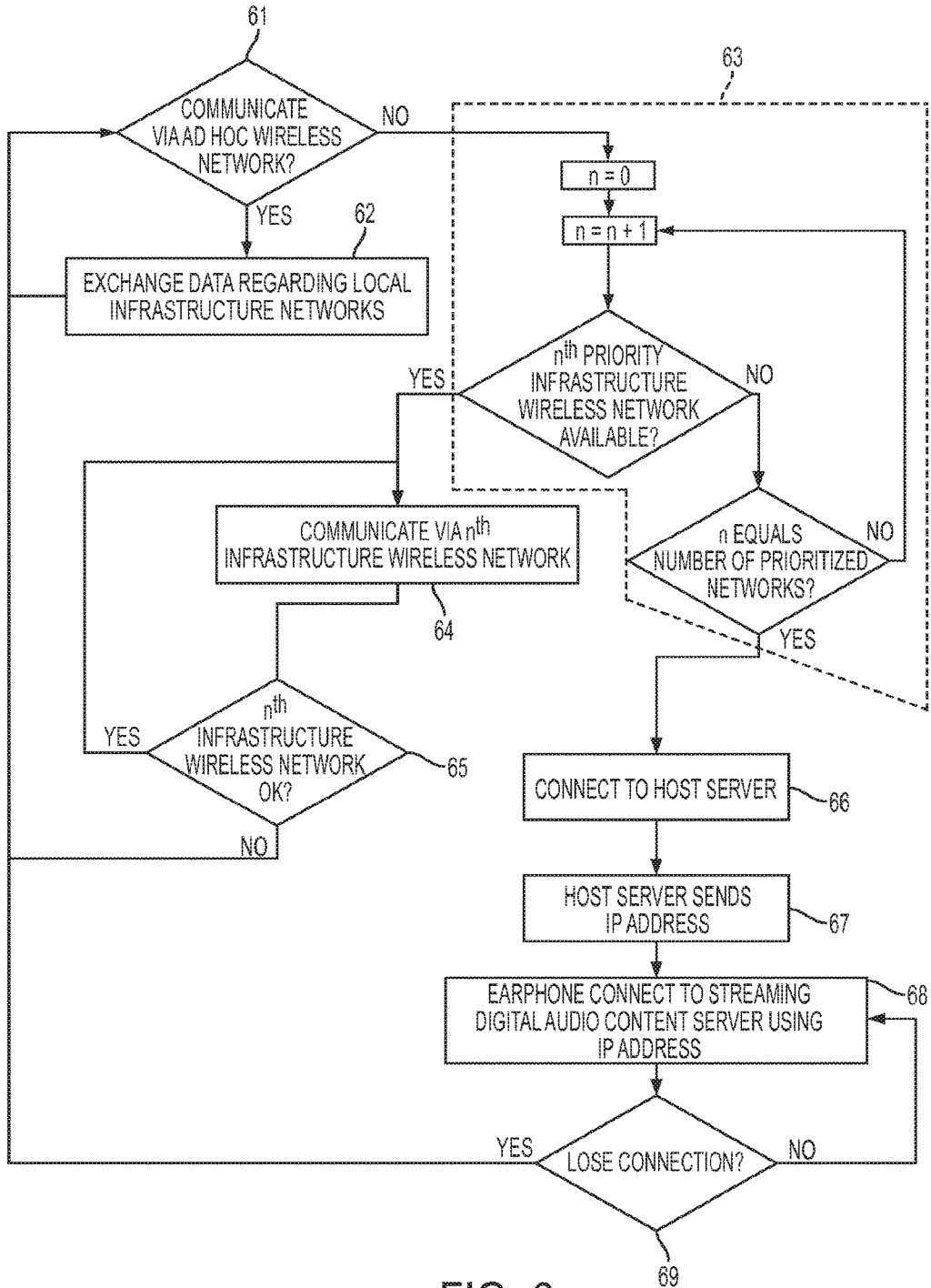


FIG. 6

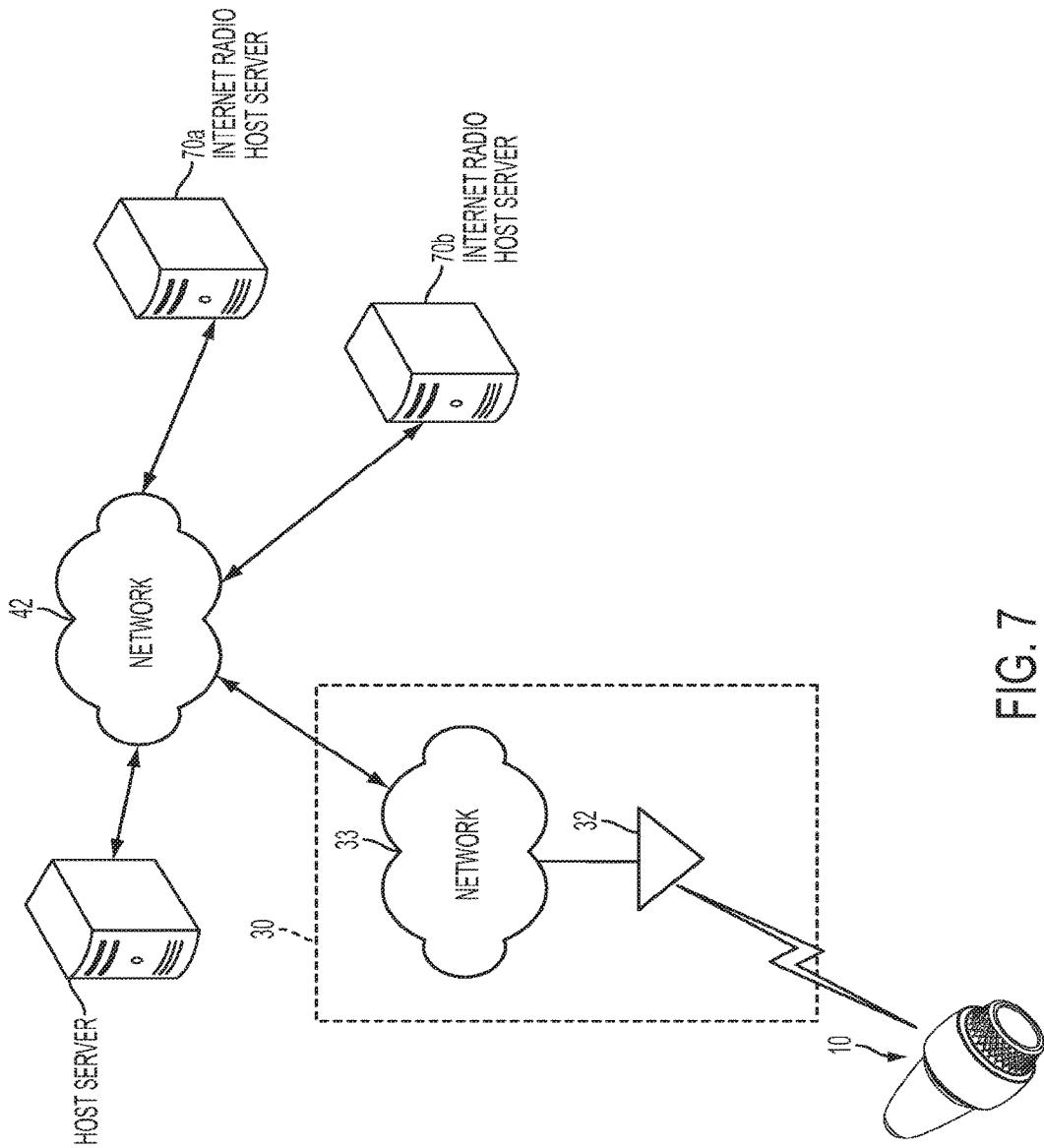


FIG. 7

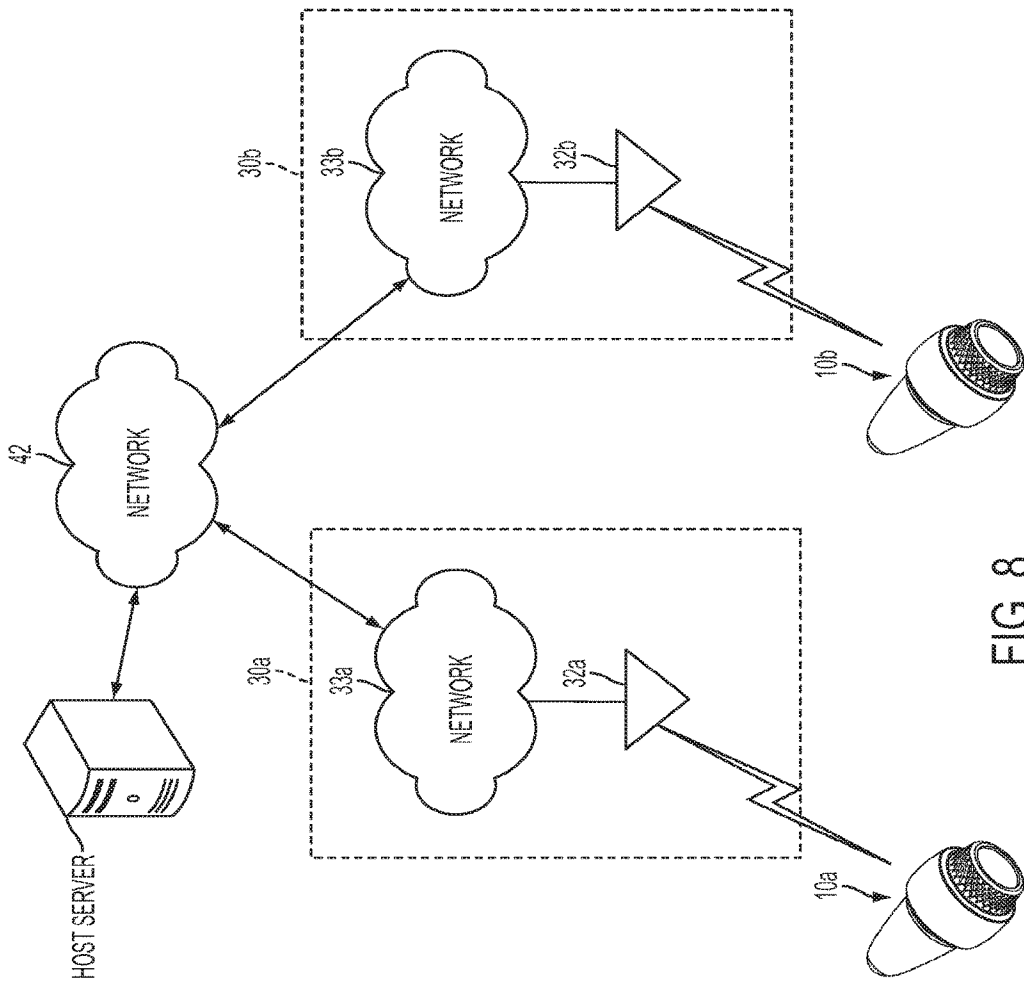


FIG. 8

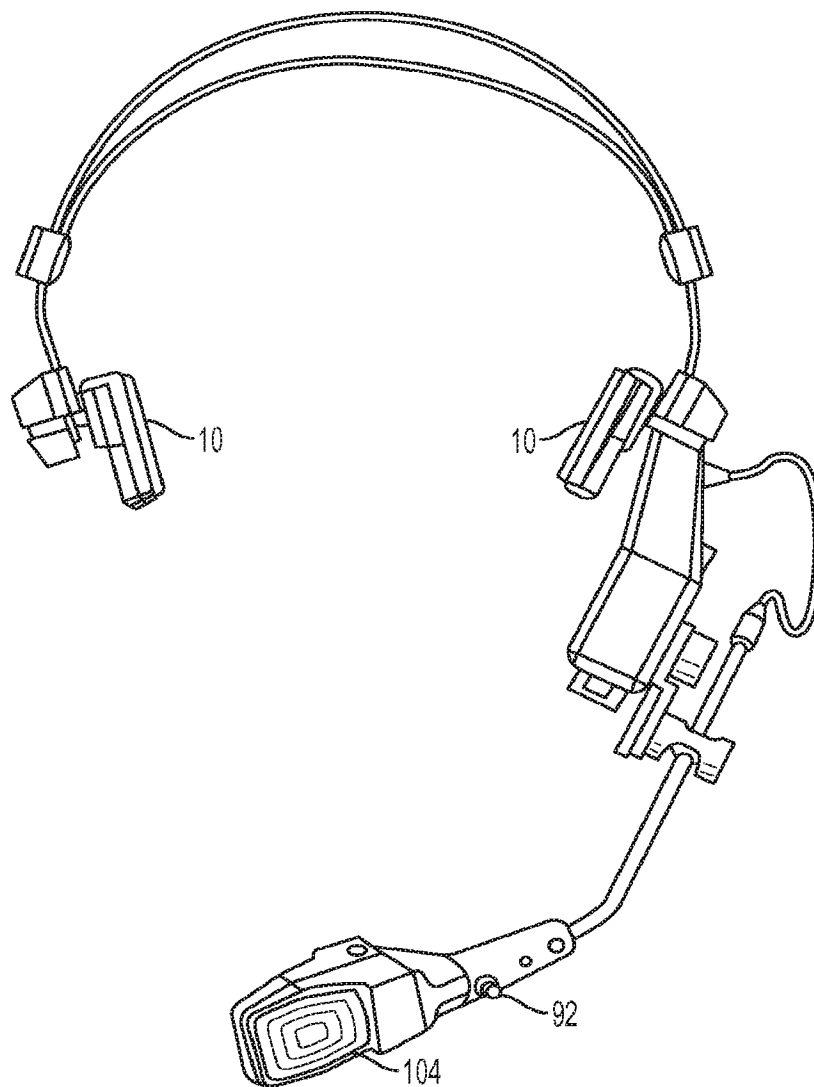


FIG. 9

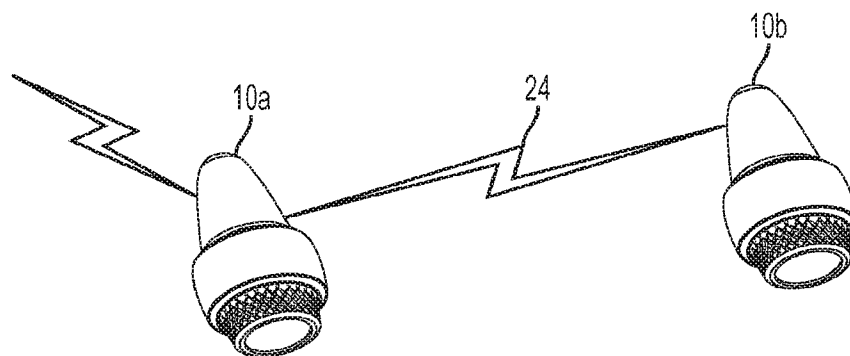


FIG. 10

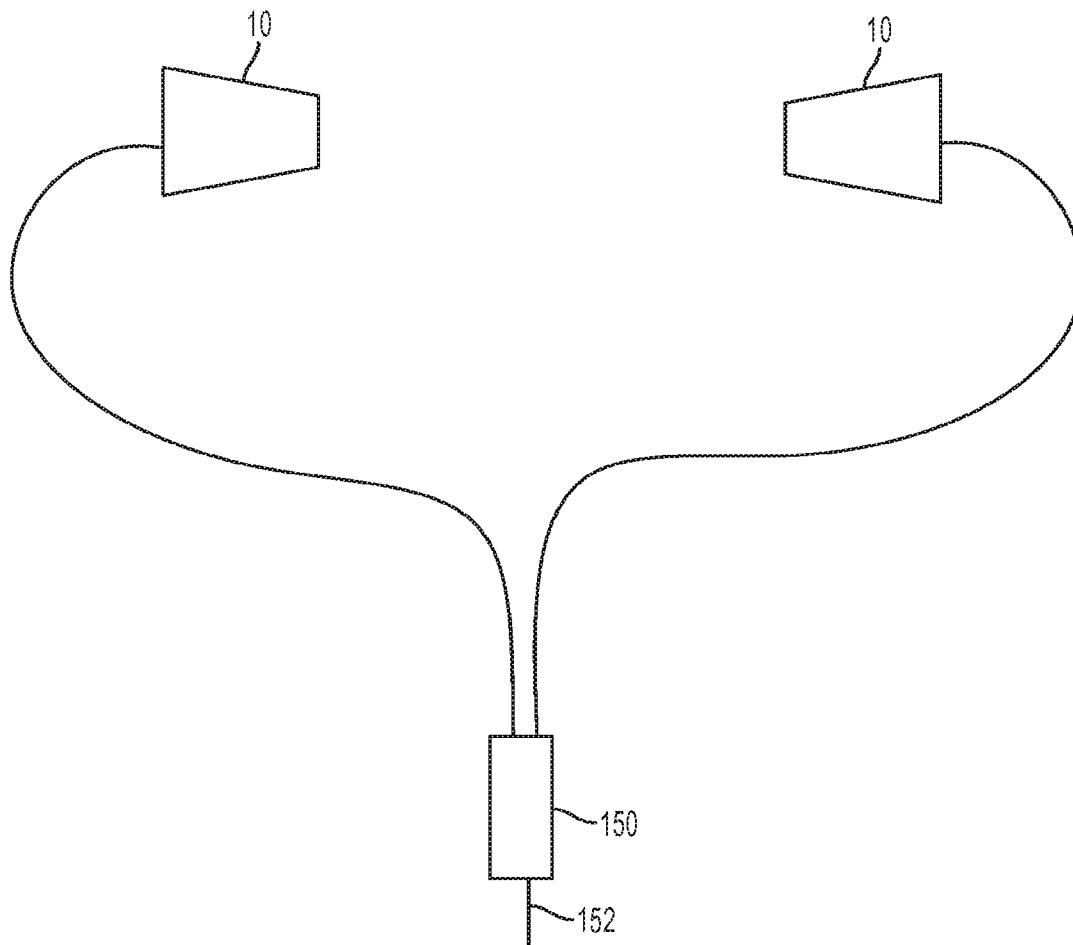


FIG. 11

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SYSTEM WITH WIRELESS EARPHONES

PRIORITY CLAIM

The present application claims priority as a continuation to U.S. nonprovisional patent application Ser. No. 15/650,362, filed Jul. 14, 2017, now U.S. Pat. No. 9,986,325, issued May 29, 2018, which is a continuation of U.S. nonprovisional patent application Ser. No. 15/293,785, filed Oct. 14, 2016, now U.S. Pat. No. 9,729,959, issued Aug. 8, 2017, which is a continuation of U.S. nonprovisional patent application Ser. No. 15/082,040, filed Mar. 28, 2016, now U.S. Pat. No. 9,497,535, issued Nov. 15, 2016, which is a continuation of U.S. nonprovisional patent application Ser. No. 14/695,696, filed Apr. 24, 2015, now U.S. Pat. No. 9,438,987, issued on Sep. 6, 2016, which is a continuation of U.S. nonprovisional patent application Ser. No. 13/609,409, filed Sep. 11, 2012, now U.S. Pat. No. 9,049,502, issued Jun. 2, 2015, which is a continuation of U.S. nonprovisional patent application Ser. No. 13/459,291, filed Apr. 30, 2012, now U.S. Pat. No. 8,571,544, issued Oct. 29, 2013, which is a continuation of U.S. patent application Ser. No. 12/936,488, filed Dec. 20, 2010, now U.S. Pat. No. 8,190,203, issued May 29, 2012, which is a national stage entry of PCT/US2009/039754, filed Apr. 7, 2009, which claims priority to U.S. provisional patent application Ser. No. 61/123,265, filed Apr. 7, 2008, all of which are incorporated herein by reference in their entireties.

CROSS-REFERENCE TO RELATED APPLICATIONS

U.S. nonprovisional patent application Ser. No. 14/031,938, filed Sep. 13, 2013, now U.S. Pat. No. 8,655,420, issued Feb. 18, 2014, is also a continuation of U.S. nonprovisional patent application Ser. No. 13/609,409, filed Sep. 11, 2012, now U.S. Pat. No. 9,049,502, mentioned above.

BACKGROUND

Digital audio players, such as MP3 players and iPods, that store and play digital audio files, are very popular. Such devices typically comprise a data storage unit for storing and playing the digital audio, and a headphone set that connects to the data storage unit, usually with a ¼" or a 3.5 mm jack and associated cord. Often the headphones are in-ear type headphones. The cord, however, between the headphones and the data storage unit can be cumbersome and annoying to users, and the length of the cord limits the physical distance between the data storage unit and the headphones. Accordingly, some cordless headphones have been proposed, such as the Monster iFreePlay cordless headphones from Apple Inc., which include a docking port on one of the earphones that can connect directly to an iPod Shuffle. Because they have the docking port, however, the Monster iFreePlay cordless headphones from Apple are quite large and are not in-ear type phones. Recently, cordless headphones that connect wirelessly via IEEE 802.11 to a WLAN-ready laptop or personal computer (PC) have been proposed, but such headphones are also quite large and not in-ear type phones.

SUMMARY

In one general aspect, the present invention is directed to a wireless earphone that comprises a transceiver circuit for receiving streaming audio from a data source, such as a

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digital audio player or a computer, over an ad hoc wireless network. When the data source and the earphone are out of range via the ad hoc wireless network, they may transition automatically to a common infrastructure wireless network (e.g., a wireless LAN). If there is no common infrastructure wireless network for both the data source and the earphone, the earphone may connect via an available infrastructure wireless network to a host server. The host server may, for example, broadcast streaming audio to the earphone and/or transmit to the earphone a network address (e.g., an Internet Protocol (IP) address) for a network-connected content server that streams digital audio. The earphone may then connect to the content server using the IP address. The content server may be an Internet radio server, including, for example, an Internet radio server that broadcasts streaming audio from the data source or some other content.

These and other advantageous, unique aspects of the wireless earphone are described below.

FIGURES

Various embodiments of the present invention are described herein by way of example in conjunction with the following figures, wherein:

FIGS. 1A-1E are views of a wireless earphone according to various embodiments of the present invention;

FIGS. 2A-2D illustrate various communication modes for a wireless earphone according to various embodiments of the present invention;

FIG. 3 is a block diagram of a wireless earphone according to various embodiments of the present invention;

FIGS. 4A-4B show the wireless earphone connected to another device according to various embodiments of the present invention;

FIG. 5 is a diagram of a process implemented by a host server according to various embodiments of the present invention;

FIG. 6 is a diagram of a process implemented by the wireless earphone to transition automatically between wireless networks according to various embodiments of the present invention;

FIGS. 7, 8 and 10 illustrate communication systems involving the wireless earphone according to various embodiments of the present invention;

FIG. 9 is a diagram of a headset including a wireless earphone and a microphone according to various embodiments of the present invention; and

FIG. 11 is a diagram of a pair of wireless earphones with a dongle according to various embodiments of the present invention.

DESCRIPTION

In one general aspect, the present invention is directed to a wireless earphone that receives streaming audio data via ad hoc wireless networks and infrastructure wireless networks, and that transitions seamlessly between wireless networks. The earphone may comprise one or more in-ear, on-ear, or over-ear speaker elements. Two exemplary in-ear earphone shapes for the wireless earphone 10 are shown in FIGS. 1A and 1B, respectively, although in other embodiments the earphone may take different shapes and the exemplary shapes shown in FIGS. 1A and 1B are not intended to be limiting. In one embodiment, the earphone transitions automatically and seamlessly, without user intervention, between communication modes. That is, the earphone may transition automatically from an ad hoc wireless network to

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an infrastructure wireless network, without user intervention. As used herein, an “ad hoc wireless network” is a network where two (or more) wireless-capable devices, such as the earphone and a data source, communicate directly and wirelessly, without using an access point. An “infrastructure wireless network,” on the other hand, is a wireless network that uses one or more access points to allow a wireless-capable device, such as the wireless earphone, to connect to a computer network, such as a LAN or WAN (including the Internet).

FIGS. 1A and 1B show example configurations for a wireless earphone 10 according to various embodiments of the present invention. The examples shown in FIGS. 1A and 1B are not limiting and other configurations are within the scope of the present invention. As shown in FIGS. 1A and 1B, the earphone 10 may comprise a body 12. The body 12 may comprise an ear canal portion 14 that is inserted in the ear canal of the user of the earphone 10. In various embodiments, the body 12 also may comprise an exterior portion 15 that is not inserted into user’s ear canal. The exterior portion 15 may comprise a knob 16 or some other user control (such as a dial, a pressure-activated switch, lever, etc.) for adjusting the shape of the ear canal portion 14. That is, in various embodiments, activation (e.g. rotation) of the knob 16 may cause the ear canal portion 14 to change shape so as to, for example, radially expand to fit snugly against all sides of the user’s ear canal. Further details regarding such a shape-changing earbud earphone are described in application PCT/US08/88656, filed 31 Dec. 2008, entitled “Adjustable Shape Earphone,” which is incorporated herein by reference in its entirety. The earphone 10 also may comprise a transceiver circuit housed within the body 12. The transceiver circuit, described further below, may transmit and receive the wireless signals, including receive streaming audio for playing by the earphone 10. The transceiver circuit may be housed in the exterior portion 15 of the earphone 10 and/or in the ear canal portion 14.

Although the example earphones 10 shown in FIGS. 1A and 1B include a knob 16 for adjusting the shape of the ear canal portion 14, the present invention is not so limited, and in other embodiments, different means besides a knob 16 may be used to adjust the ear canal portion 14. In addition, in other embodiments, the earphone 10 may not comprise a shape-changing ear canal portion 14.

In various embodiments, the user may wear two discrete wireless earphones 10: one in each ear. In such embodiments, each earphone 10 may comprise a transceiver circuit. In such embodiments, the earphones 10 may be connected by a string or some other cord-type connector to keep the earphones 10 from being separated.

In other embodiments, as shown in FIG. 1C, a headband 19 may connect the two (left and right) earphones 10. The headband 19 may be an over-the-head band, as shown in the example of FIG. 1C, or the headband may be a behind-the-head band. In embodiments comprising a headband 19, each earphone 10 may comprise a transceiver circuit; hence, each earphone 10 may receive and transmit separately the wireless communication signals. In other embodiments comprising a headband 19, only one earphone 10 may comprise the transceiver circuit, and a wire may run along the headband 19 to the other earphone 10 to connect thereby the transceiver circuit to the acoustic transducer in the earphone that does not comprise the transceiver circuit. The embodiment shown in FIG. 1C comprises on-ear earphones 10; in other embodiments, in-ear or over-ear earphones may be used.

In other embodiments, the earphone 10 may comprise a hanger bar 17 that allows the earphone 10 to clip to, or hang

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on, the user’s ear, as shown in the illustrated embodiment of FIGS. 1D-1E. FIG. 1D is a perspective view of the earphone and FIG. 1E is a side view according to one embodiment. As shown in the illustrated embodiment, the earphone 10 may comprise dual speaker elements 106-A, 106-B. One of the speaker elements (the smaller one) 106-A is sized to fit into the cavum concha of the listener’s ear and the other element (the larger one) 106-B is not. The listener may use the hanger bar to position the earphone on the listener’s ear. In that connection, the hanger bar may comprise a horizontal section that rests upon the upper external curvature of the listener’s ear behind the upper portion of the auricula (or pinna). The earphone may comprise a knurled knob that allows the user to adjust finely the distance between the horizontal section of the hanger bar and the speaker elements, thereby providing, in such embodiments, another measure of adjustability for the user. More details regarding such a dual element, adjustable earphone may be found in U.S. provisional patent application Ser. No. 61/054,238, which is incorporated herein by reference in its entirety.

FIGS. 2A-2D illustrate various communication modes for a wireless data communication system involving the earphone 10 according to embodiments of the present invention. As shown in FIG. 2A, the system comprises a data source 20 in communication with the earphone 10 via an ad hoc wireless network 24. The earphone 10, via its transceiver circuit (described in more detail below), may communicate wirelessly with a data source 20, which may comprise a wireless network adapter 22 for transmitting the digital audio wirelessly. For example, the data source 20 may be a digital audio player (DAP), such as an mp3 player or an iPod, or any other suitable digital audio playing device, such as a laptop or personal computer, that stores and/or plays digital audio files. In other embodiments, the data source 20 may generate analog audio, and the wireless network adapter 22 may encode the analog audio into digital format for transmission to the earphone 10.

The wireless network adapter 22 may be an integral part of the data source 20, or it may be a separate device that is connected to the data source 20 to provide wireless connectivity for the data source 20. For example, the wireless network adapter 22 may comprise a wireless network interface card (WNIC) or other suitable transceiver that plugs into a USB port or other port or jack of the data source 20 (such as a TRS connector) to stream data, e.g., digital audio files, via a wireless network (e.g., the ad hoc wireless network 24 or an infrastructure wireless network). The digital audio transmitted from the data source 20 to the earphone 10 via the wireless networks may comprise compressed or uncompressed audio. Any suitable file format may be used for the audio, including mp3, lossy or lossless WMA, Vorbis, Musepack, FLAC, WAV, AIFF, AU, or any other suitable file format.

When in range, the data source 20 may communicate with the earphone 10 via the ad hoc wireless network 24 using any suitable wireless communication protocol, including Wi-Fi (e.g., IEEE 802.11a/b/g/n), WiMAX (IEEE 802.16), Bluetooth, Zigbee, UWB, or any other suitable wireless communication protocol. For purposes of the description to follow, it is assumed that the data source 20 and the earphone 10 communicate using a Wi-Fi protocol, although the invention is not so limited and other wireless communication protocols may be used in other embodiments of the invention. The data source 20 and the earphone 10 are considered in range for the ad hoc wireless network 24 when the signal strengths (e.g., the RSSI) of the signals received by the two devices are above a threshold minimum signal strength

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level. For example, the data source **20** and the earphone **10** are likely to be in range for an ad hoc wireless network when then are in close proximity, such as when the wearer of the earphone **10** has the data source **20** on his/her person, such as in a pocket, strapped to their waist or arm, or holding the data source in their hand.

When the earphone **10** and the data source **20** are out of range for the ad hoc wireless network **24**, that is, when the received signals degrade below the threshold minimum signal strength level, both the earphone **10** and the data source **20** may transition automatically to communicate over an infrastructure wireless network (such as a wireless LAN (WLAN)) **30** that is in the range of both the earphone **10** and the data source **20**, as shown in FIG. 2B. The earphone **10** and the data source **20** (e.g., the wireless network adapter **22**) may include firmware, as described further below, that cause the components to make the transition to a common infrastructure wireless network **30** automatically and seamlessly, e.g., without user intervention. The earphone **10** may cache the received audio in a buffer or memory for a time period before playing the audio. The cached audio may be played after the connection over the ad hoc wireless network is lost to give the earphone **10** and the data source **20** time to connect via the infrastructure wireless network.

For example, as shown in FIG. 2B, the infrastructure network may comprise an access point **32** that is in the range of both the data source **20** and the earphone **10**. The access point **32** may be an electronic hardware device that acts as a wireless access point for, and that is connected to, a wired and/or wireless data communication network **33**, such as a LAN or WAN, for example. The data source **20** and the earphone **10** may both communicate wirelessly with the access point **32** using the appropriate network data protocol (a Wi-Fi protocol, for example). The data source **20** and the earphone **10** may both transition automatically to an agreed-upon WLAN **30** that is in the range of both devices when they cannot communicate satisfactorily via the ad hoc wireless network **24**. A procedure for specifying an agreed-upon infrastructure wireless network **30** is described further below. Alternatively, the infrastructure wireless network **30** may have multiple access points **32a-b**, as shown in FIG. 2C. In such an embodiment, the data source **20** may communicate wirelessly with one access point **32b** and the earphone **10** may communicate wirelessly with another access point **32a** of the same infrastructure wireless network **30**. Again, the data source **20** and the earphone **10** may transition to an agreed-upon WLAN.

If there is no suitable common infrastructure wireless network over which the earphone **10** and the data source **20** can communicate, as shown in FIG. 2D, the earphone **10** may transition to communicate with an access point **32a** for an available (first) wireless network (e.g., WLAN) **30a** that is in the range of the earphone **10**. In this mode, the earphone **10** may connect via the wireless network **30a** to a network-enabled host server **40**. The host server **40** may be connected to the wireless network **30a** via an electronic data communication network **42**, such as the Internet. In one mode, the host server **40** may transmit streaming digital audio via the networks **33a**, **42** to the earphone **10**. In another mode, the host server **40** may transmit to the earphone **10** a network address, such as an Internet Protocol (IP) address, for a streaming digital audio content server **70** on the network **42**. Using the received IP address, the earphone **10** may connect to the streaming digital audio content server **70** via the networks **30a**, **42** to receive and process digital audio from the streaming digital audio content server **70**.

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The digital audio content server **70** may be, for example, an Internet radio station server. The digital audio content server **70** may stream digital audio over the network **42** (e.g., the Internet), which the earphone **10** may receive and process. In one embodiment, the streaming digital audio content server **70** may stream digital audio received by the streaming digital audio content server **70** from the data source **20**. For example, where the data source **20** is a wireless-capable device, such as a portable DAP, the data source **20** may connect to the streaming digital audio content server **70** via a wireless network **30b** and the network **42**. Alternatively, where for example the data source **20** is non-wireless-capable device, such as a PC, the data source **20** may have a direct wired connection to the network **42**. After being authenticated by the streaming digital audio content server **70**, the data source **20** may stream digital audio to the streaming digital audio content server **70**, which may broadcast the received digital audio over the network **42** (e.g., the Internet). In such a manner, the user of the earphone **10** may listen to audio from the data source **20** even when (i) the earphone **10** and the data source **20** are not in communication via an ad hoc wireless network **24** and (ii) the earphone **10** and the data source **20** are not in communication via a common local infrastructure wireless network **30**.

FIG. 3 is a block diagram of the earphone **10** according to various embodiments of the present invention. In the illustrated embodiment, the earphone **10** comprises a transceiver circuit **100** and related peripheral components. As shown in FIG. 3, the peripheral components of the earphone **10** may comprise a power source **102**, a microphone **104**, one or more acoustic transducers **106** (e.g., speakers), and an antenna **108**. The transceiver circuit **100** and some of the peripheral components (such as the power source **102** and the acoustic transducers **106**) may be housed within the body **12** of the earphone **10** (see FIG. 1). Other peripheral components, such as the microphone **104** and the antenna **108** may be external to the body **12** of the earphone **10**. In addition, some of the peripheral components, such as the microphone **104**, are optional in various embodiments.

In various embodiments, the transceiver circuit **100** may be implemented as a single integrated circuit (IC), such as a system-on-chip (SoC), which is conducive to miniaturizing the components of the earphone **10**, which is advantageous if the earphone **10** is to be relatively small in size, such as an in-ear earphone (see FIGS. 1A-1B for example). In alternative embodiments, however, the components of the transceiver circuit **100** could be realized with two or more discrete ICs or other components, such as separate ICs for the processors, memory, and RF (e.g., Wi-Fi) module, for example.

The power source **102** may comprise, for example, a rechargeable or non-rechargeable battery (or batteries). In other embodiments, the power source **102** may comprise one or more ultracapacitors (sometimes referred to as supercapacitors) that are charged by a primary power source. In embodiments where the power source **102** comprises a rechargeable battery cell or an ultracapacitor, the battery cell or ultracapacitor, as the case may be, may be charged for use, for example, when the earphone **10** is connected to a docking station or computer. The docking station may be connected to or part of a computer device, such as a laptop computer or PC. In addition to charging the rechargeable power source **102**, the docking station and/or computer may facilitate downloading of data to and/or from the earphone **10**. In other embodiments, the power source **102** may comprise capacitors passively charged with RF radiation,

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such as described in U.S. Pat. No. 7,027,311. The power source **102** may be coupled to a power source control module **103** of transceiver circuit **100** that controls and monitors the power source **102**.

The acoustic transducer(s) **106** may be the speaker element(s) for conveying the sound to the user of the earphone **10**. According to various embodiments, the earphone **10** may comprise one or more acoustic transducers **106**. For embodiments having more than one transducer, one transducer may be larger than the other transducer, and a crossover circuit (not shown) may transmit the higher frequencies to the smaller transducer and may transmit the lower frequencies to the larger transducer. More details regarding dual element earphones are provided in U.S. Pat. No. 5,333,206, assigned to Koss Corporation, which is incorporated herein by reference in its entirety.

The antenna **108** may receive and transmit the wireless signals from and to the wireless networks **24**, **30**. A RF (e.g., Wi-Fi) module **110** of the transceiver circuit **100** in communication with the antenna **108** may, among other things, modulate and demodulate the signals transmitted from and received by the antenna **108**. The RF module **110** communicates with a baseband processor **112**, which performs other functions necessary for the earphone **10** to communicate using the Wi-Fi (or other communication) protocol.

The baseband processor **112** may be in communication with a processor unit **114**, which may comprise a microprocessor **116** and a digital signal processor (DSP) **118**. The microprocessor **116** may control the various components of the transceiver circuit **100**. The DSP **114** may, for example, perform various sound quality enhancements to the digital audio received by the baseband processor **112**, including noise cancellation and sound equalization. The processor unit **114** may be in communication with a volatile memory unit **120** and a non-volatile memory unit **122**. A memory management unit **124** may control the processor unit's access to the memory units **120**, **122**. The volatile memory **122** may comprise, for example, a random access memory (RAM) circuit. The non-volatile memory unit **122** may comprise a read only memory (ROM) and/or flash memory circuits. The memory units **120**, **122** may store firmware that is executed by the processor unit **114**. Execution of the firmware by the processor unit **114** may provide various functionality for the earphone **10**, such as the automatic transition between wireless networks as described herein. The memory units **120**, **122** may also cache received digital audio.

A digital-to-analog converter (DAC) **125** may convert the digital audio from the processor unit **114** to analog form for coupling to the acoustic transducer(s) **106**. An I²S interface **126** or other suitable serial or parallel bus interface may provide the interface between the processor unit **114** and the DAC **125**. An analog-to-digital converter (ADC) **128**, which also communicates with the I²S interface **126**, may convert analog audio signals picked up by the microphone **104** for processing by the processor unit **114**.

The transceiver circuit **100** also may comprise a USB or other suitable interface **130** that allows the earphone **10** to be connected to an external device via a USB cable or other suitable link. As shown in FIG. 4A, the external device may be a docking station **200** connected to a computer device **202**. Also, in various embodiments, the earphone **10** could be connected directly to the computer **202** without the docking station **200**. In addition, the external device may be a DAP **210**, as shown in FIG. 4B. In that way, the earphone **10** could connect directly to a data source **20**, such as the DAP **210** or the computer **202**, through the USB port **130**.

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In addition, through the USB port **130**, the earphone **10** may connect to a PC **202** or docking station **202** to charge up the power source **102** and/or to get downloads (e.g., data or firmware).

According to various embodiments, the earphone **10** may have an associated web page that a user may access through the host server **40** (see FIG. 2D) or some other server. An authenticated user could log onto the website from a client computing device **50** (e.g., laptop, PC, handheld computer device, etc.), including the data source **20** (see FIG. 2D) to access the web page for the earphone **10** to set various profile values for the earphone **10**. For example, at the web site, the user could set various content features and filters, as well as adjust various sound control features, such as treble, bass, frequency settings, noise cancellation settings, etc. In addition, the user could set preferred streaming audio stations, such as preferred Internet radio stations or other streaming audio broadcasts. That way, instead of listening to streaming audio from the data source **20**, the user could listen to Internet radio stations or other streaming audio broadcasts received by the earphone **10**. In such an operating mode, the earphone user, via the web site, may prioritize a number of Internet radio stations or other broadcast sources (hosted by streaming digital audio content servers **70**). With reference to FIG. 7, the host server **40** may send the IP address for the earphone user's desired (e.g., highest priority) Internet radio station to the earphone **10**. A button **11** on the earphone **10**, such as on the rotating dial **16** as shown in the examples of FIGS. 1A and 1B, may allow the user to cycle through the preset preferred Internet radio stations. That is, for example, when the user presses the button **11**, an electronic communication may be transmitted to the host server **40** via the wireless network **30**, and in response to receiving the communication, the host server **40** may send the IP address for the user's next highest rated Internet radio station via the network **42** to the earphone **10**. The earphone **10** may then connect to the streaming digital audio content server **70** for that Internet radio station using the IP address provided by the host server **40**. This process may be repeated, e.g., cycled through, for each preset Internet radio station configured by the user of the earphone **10**.

At the web site for the earphone **10** hosted on the host server **40**, in addition to establishing the identification of digital audio sources (e.g., IDs for the user's DAP or PC) and earphones, the user could set parental or other user controls. For example, the user could restrict certain Internet radio broadcasts based on content or parental ratings, etc. That is, for example, the user could configure a setting through the web site that prevents the host server **40** from sending an IP address for a streaming digital audio content server **70** that broadcasts explicit content based on a rating for the content. In addition, if a number of different earphones **10** are registered to the same user, the user could define separate controls for the different earphones **10** (as well as customize any other preferences or settings particular to the earphones **10**, including Internet radio stations, sound quality settings, etc. that would later be downloaded to the earphones **10**). In addition, in modes where the host server **40** streams audio to the earphone **10**, the host server **40** may log the files or content streamed to the various earphones **10**, and the user could view at the web site the files or content that were played by the earphones **10**. In that way, the user could monitor the files played by the earphones **10**.

In addition, the host server **40** may provide a so-called eavesdropping function according to various embodiments. The eavesdropping service could be activated via the web

site. When the service is activated, the host server **40** may transmit the content that it is delivering to a first earphone **10a** to another, second earphone **10b**, as shown in FIG. **8**. Alternatively, the host server **40** may transmit to the second earphone **10b** the most recent IP address for a streaming digital audio content server **70** that was sent to the first earphone **10a**. The second earphone **10b** may then connect to the streaming digital audio content server **70** that the first earphone **10a** is currently connected. That way, the user of the second earphone **10b**, which may be a parent, for example, may directly monitor the content being received by the first earphone **10a**, which may belong to a child of the parent.

This function also could be present in the earphones **10** themselves, allowing a parent (or other user) to join an ad-hoc wireless network and listen to what their child (or other listener) is hearing. For example, with reference to FIG. **10**, a first earphone **10a** may receive wireless audio, such as from the data source **20** or some other source, such as the host server **40**. The first earphone **10a** may be programmed with firmware to broadcast the received audio to a second earphone **10b** via an ad hoc wireless network **24**. That way, the wearer of the second earphone **10b** can monitor in real-time the content being played by the first earphone **10a**.

At the web site, the user may also specify the identification number ("ID") of their earphone(s) **10**, and the host server **40** may translate the ID to the current internet protocol (IP) addresses for the earphone **10** and for the data source **20**. This allows the user to find his or her data source **20** even when it is behind a firewall or on a changing IP address. That way, the host server **40** can match the audio from the data source **20** to the appropriate earphone **10** based on the specified device ID. The user also could specify a number of different data sources **20**. For example, the user's DAP may have one specified IP address and the user's home (or work) computer may have another specified IP address. Via the web site hosted by the host server **40**, the user could specify or prioritize from which source (e.g., the user's DAP or computer) the earphone **10** is to receive content.

The host server **40** (or some other server) may also push firmware upgrades and/or data updates to the earphone **10** using the IP addresses of the earphone **10** via the networks **30**, **42**. In addition, a user could download the firmware upgrades and/or data updates from the host server **40** to the client computing device **202** (see FIG. **4A**) via the Internet, and then download the firmware upgrades and/or data updates to the earphone **10** when the earphone **10** is connected to the client computer device **202** (such as through a USB port and/or the docking station **200**).

Whether the downloads are transmitted wirelessly to the earphone **10** or via the client computing device **202** may depend on the current data rate of the earphone **10** and the quantity of data to be transmitted to the earphone **10**. For example, according to various embodiments, as shown in the process flow of FIG. **5**, the host server **40** may be programmed, at step **50**, to make a determination, based on the current data rate for the earphone **10** and the size of the update, whether the update should be pushed to the earphone **10** wirelessly (e.g., via the WLAN **30a** in FIG. **2D**). If the update is too large and/or the current data rate is too low that the performance of the earphone **10** will be adversely affected, the host server **40** may refrain from pushing the update to the earphone **10** wirelessly and wait instead to download the update to the client computing device **202** at step **51**. Conversely, if the host server **40** determines that, given the size of the update and the current data rate for the

earphone **10** that the performance of the earphone **10** will not be adversely affected, the host server **40** may transmit the update wirelessly to the earphone **10** at step **52**.

As mentioned above, the processor unit **114** of the speakerphones **14** may be programmed, via firmware stored in the memory **120**, **122**, to have the ability to transition automatically from the ad hoc wireless network **24** to an infrastructure wireless network **30** (such as a WLAN) when the quality of the signal on the ad hoc wireless network **24** degrades below a suitable threshold (such as when the data source **20** is out of range for an ad hoc wireless network). In that case, the earphone **10** and the data source **20** may connect to a common infrastructure wireless network (e.g., WLAN) (see, for example, FIGS. **2B-2C**). Through the web site for the earphone **10**, described above, the user could specify a priority of infrastructure wireless networks **30** for the data source **20** and the earphone **10** to connect to when the ad hoc wireless network **24** is not available. For example, the user could specify a WLAN servicing his/her residence first, a WLAN servicing his/her place of employment second, etc. During the time that the earphone **10** and the data source **20** are connected via the ad hoc wireless network **24**, the earphone **10** and the data source **20** may exchange data regarding which infrastructure networks are in range. When the earphone **10** and the data source **20** are no longer in range for the ad hoc wireless network **24** (that is, for example, the signals between the device degrade below an acceptable level), they may both transition automatically to the highest prioritized infrastructure wireless network whose signal strength is above a certain threshold level. That way, even though the earphone **10** and the data source **20** are out of range for the ad hoc wireless network **24**, the earphone **10** may still receive the streaming audio from the data source **20** via the infrastructure wireless network **30** (see FIGS. **2B-2C**).

When none of the preferred infrastructure networks is in range, the earphone **10** may connect automatically to the host server **40** via an available infrastructure wireless network **30** (see FIG. **2D**), e.g., the infrastructure wireless network **30** having the highest RSSI and to which the earphone **10** is authenticated to use. The host server **40**, as mentioned above, may transmit IP addresses to the earphone **10** for streaming digital audio content servers **70** or the host sever **40** may stream digital audio to the earphone **10** itself when in this communication mode.

FIG. **6** is a diagram of the process flow, according to one embodiment, implemented by the transceiver circuit **100** of the earphone **10**. The process shown in FIG. **6** may be implemented in part by the processor unit **114** executing firmware stored in a memory unit **120**, **122** of the transceiver circuit **100**. At step **61**, the earphone **10** may determine if it can communicate with the data source **20** via an ad hoc wireless network **24**. That is, the earphone **10** may determine if the strength of the wireless signals from the data source **20** exceed some minimum threshold. If so, the data source **20** and the earphone **10** may communicate wirelessly via the ad hoc wireless network **24** (see FIG. **2A**). While in this communication mode, at step **62**, the data source **20** and the earphone **10** also may exchange data regarding the local infrastructure wireless networks, if any, in the range of the data source **20** and the earphone **10**, respectively. For example, the earphone **10** may transmit the ID of local infrastructure wireless networks **30** that the earphone **10** can detect whose signal strength (e.g., RSSI) exceeds some minimum threshold level. Similarly, the data source **20** may transmit the ID the local infrastructure wireless networks **30** that the data source **20** can detect whose signal strength (e.g.,

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RSSI) exceeds some minimum threshold level. The earphone **10** may save this data in a memory unit **120**, **122**. Similarly, the data source **20** may store in memory the wireless networks that the earphone **10** is detected.

The data source **20** and the earphone **10** may continue to communicate via the ad hoc wireless network mode **24** until they are out of range (e.g., the signal strengths degrade below a minimum threshold level). If an ad hoc wireless network **24** is not available at block **61**, the transceiver circuit **100** and the data source **20** may execute a process, shown at block **63**, to connect to the user's highest prioritized infrastructure wireless network **30**. For example, of the infrastructure wireless networks whose signal strength exceeded the minimum threshold for both the earphone **10** and the data source **20** determined at step **62**, the earphone **10** and the data source **20** may both transition to the infrastructure wireless network **30** having the highest priority, as previously set by the user (seen FIGS. **2B-2C**, for example). For example, if the user's highest prioritized infrastructure wireless network **30** is not available, but the user's second highest prioritized infrastructure wireless network **30** is, the earphone **10** and the data source **20** may both transition automatically to the user's second highest prioritized infrastructure wireless network **30** at block **64**. As shown by the loop with block **65**, the earphone **10** and the data source **20** may continue to communicate via one of the user's prioritized infrastructure wireless networks **30** as long as the infrastructure wireless network **30** is available. If the infrastructure wireless network becomes unavailable, the process may return to block **61**.

If, however, no ad hoc wireless network and none of the user's prioritized infrastructure wireless networks are available, the earphone **10** may transition automatically to connect to the host server **40** at block **66** (see FIG. **2D**) using an available infrastructure wireless network **30**. At block **67**, the host server **40** may transmit an IP address to the earphone **10** for one of the streaming digital audio content servers **70**, and at block **68** the earphone **10** may connect to the streaming digital audio content server **70** using the received IP address. At step **69**, as long as the earphone **10** is connected to the streaming digital audio content server **70**, the earphone **10** may continue to communicate in this mode. However, if the earphone **10** loses its connection to the digital audio content server **70**, the process may return to block **61** in one embodiment. As mentioned above, at block **67**, instead of sending an IP address for a streaming digital audio content server **70**, the host server **40** may stream digital audio to the earphone **10**. The user, when configuring their earphone **10** preferences via the web site, may specify and/or prioritize whether the host server **40** is to send IP addresses for the streaming digital audio content servers **70** and/or whether the host server **40** is to stream audio to the earphone **10** itself.

In another embodiment, the earphone **10** may be programmed to transition automatically to the host server **40** when the earphone **10** and the data source **20** are not in communication via the ad hoc wireless network **24**. That is, in such an embodiment, the earphone **10** may not try to connect via a local infrastructure wireless network **30** with the data source **20**, but instead transition automatically to connect to the host server **40** (see FIG. **2D**).

In various embodiments, as shown in FIG. **1B**, the button **11** or other user selection device that allows the wearer of the earphone **10** to indicate approval and/or disapproval of songs or other audio files listened to by the wearer over an Internet radio station. The approval/disapproval rating, along with metadata for the song received by the earphone

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10 with the streaming audio, may be transmitted from the transceiver circuit **100** of the earphone **10** back to the host server **40**, which may log the songs played as well as the ratings for the various songs/audio files. In addition to being able to view the logs at the website, the host server **40** (or some other server) may send an email or other electronic communication to the earphone user, at a user specified email address or other address, which the user might access from their client communication device **50** (see FIG. **2D**). The email or other electronic communication may contain a listing of the song/audio files for which the user gave approval ratings using the button **11** or other user selection device. Further, the email or other electronic communication may provide a URL link for a URL at which the user could download song/audio files that the user rated (presumably song/audio files for which the user gave an approval rating). In some instances, the user may be required to pay a fee to download the song/audio file.

The user song ratings also may be used by the host server **40** to determine the user's musical preferences and offer new music that the user might enjoy. More details about generating user play lists based on song ratings may be found in published U.S. patent application Pub. No. 2006/0212444, Pub. No. 2006/0206487, and Pub. No. 2006/0212442, and U.S. Pat. No. 7,003,515, which are incorporated herein by reference in their entirety.

In addition or alternatively, the user could log onto a web site hosted by the host server **40** (or some other server) to view the approval/disapproval ratings that the user made via the button **11** on the earphone **10**. The web site may provide the user with the option of downloading the rated songs/audio files (for the host server **40** or some other server system) to their client computer device **50**. The user could then have their earphone **10** connect to their client computer device **50** as a data source **20** via an ad hoc wireless network **24** (see FIG. **2A**) or via an infrastructure wireless network (see FIGS. **2B-2D**) to listen to the downloaded songs. In addition, the user could download the song files from their client computer device **50** to their DAP and listen to the downloaded song files from their DAP by using their DAP as the data source **20** in a similar manner.

Another application of the headsets may be in vehicles equipped with Wi-Fi or other wireless network connectivity. Published PCT application WO 2007/136620, which is incorporated herein by reference, discloses a wireless router for providing a Wi-Fi or other local wireless network for a vehicle, such as a car, truck, boat, bus, etc. In a vehicle having a Wi-Fi or other local wireless network, the audio for other media systems in the vehicle could be broadcast over the vehicle's wireless network. For example, if the vehicle comprises a DVD player, the audio from the DVD system could be transmitted to the router and broadcast over the vehicle's network. Similarly, the audio from terrestrial radio stations, a CD player, or an audio cassette player could be broadcast over the vehicle's local wireless network. The vehicle's passengers, equipped with the earphones **10**, could cycle through the various audio broadcasts (including the broadcasts from the vehicle's media system as well as broadcasts from the host server **40**, for example) using a selection button **11** on the earphone **10**. The vehicle may also be equipped with a console or terminal, etc., through which a passenger could mute all of the broadcasts for direct voice communications, for example.

As described above, the earphones **10** may also include a microphone **104**, as shown in the example of FIG. **9**. The headset **90** shown in FIG. **9** includes two earphones **10**, both of which may include a transceiver circuit **100** or only one

of which may include the transceiver circuit, as discussed above. The microphone **104** could be used to broadcast communications from one earphone wearer to another earphone wearer. For example, one wearer could activate the microphone by pressing a button **92** on the headset **90**. The headset **90** may then transmit a communication via an ad hoc wireless network **24** or other wireless network to a nearby recipient (or recipients) equipped with a headset **90** with a transceiver circuit **100** in one or both of the earphones **10**. When such communication is detected by the recipient's headset **90**, the streaming audio received over the wireless network by the recipient's headset **90** may be muted, and the intercom channel may be routed to the transducer(s) of the recipient's headset **90** for playing for the recipient. This functionality may be valuable and useful where multiple wearers of the headsets **90** are in close proximity, such as on motorcycles, for example.

Another exemplary use of the earphones **10** is in a factory, warehouse, construction site, or other environment that might be noisy. Persons (e.g., workers) in the environment could use the earphones **10** for protection from the surrounding noise of the environment. From a console or terminal, a person (e.g., a supervisor) could select a particular recipient for a communication over the Wi-Fi network (or other local wireless network). The console or terminal may have buttons, dials, or switches, etc., for each user/recipient, or it could have one button or dial through which the sender could cycle through the possible recipients. In addition, the console or terminal could have a graphical user interface, through which the sender may select the desired recipient(s).

As mentioned above, the earphones **10** may comprise a USB port. In one embodiment, as shown in FIG. **11**, the user may use an adapter **150** that connects to the USB port of each earphone **10**. The adapter **150** may also have a plug connector **152**, such as a 3.5 mm jack, which allows the user to connect the adapter **150** to devices having a corresponding port for the connector **152**. When the earphones **10** detect a connection via their USB interfaces in such a manner, the Wi-Fi (or other wireless protocol) components may shut down or go into sleep mode, and the earphones **10** will route standard headphone level analog signals to the transducer(s) **106**. This may be convenient in environments where wireless communications are not permitted, such as airplanes, but where there is a convenient source of audio contact. For example, the adapter **150** could plug into a person's DAP. The DSP **118** of the earphone **10** may still be operational in such a non-wireless mode to provide noise cancellation and any applicable equalization.

The examples presented herein are intended to illustrate potential and specific implementations of the embodiments. It can be appreciated that the examples are intended primarily for purposes of illustration for those skilled in the art. No particular aspect of the examples is/are intended to limit the scope of the described embodiments.

According to various embodiments, therefore, the present invention is directed to an earphone **10** that comprises a body **12**, where the body **12** comprises: (i) at least one acoustic transducer **106** for converting an electrical signal to sound; (ii) an antenna **108**; and (iii) a transceiver circuit **100** in communication with the at least one acoustic transducer **106** and the antenna **108**. The transceiver circuit **100** is for receiving and transmitting wireless signals via the antenna **108**, and the transceiver circuit **100** is for outputting the electrical signal to the at least one acoustic transducer **106**. The wireless transceiver circuit also comprises firmware, which when executed by the transceiver circuit, causes the transceiver circuit to: (i) receive digital audio wirelessly

from a data source **20** via an ad hoc wireless network **24** when the data source **20** is in wireless communication range with the earphone **10** via the ad hoc wireless network **24**; and (ii) when the data source **20** is not in wireless communication range with the earphone **10** via the ad hoc wireless network **24**, transition automatically to receive digital audio via an infrastructure wireless network **30**.

According to various implementations, the data source may comprise a portable digital audio player, such as an MP3 player, iPod, or laptop computer, or a nonportable digital audio player, such as a personal computer. In addition, the transceiver circuit **100** may comprise: (i) a wireless communication module **110** (such as a Wi-Fi or other wireless communication protocol module); (ii) a processor unit **114** in communication with the wireless communication module **110**; (iii) a non-volatile memory unit **122** in communication with the processor unit **114**; and (iv) a volatile memory **120** unit in communication with the processor unit **114**. The infrastructure wireless network may comprise a WLAN. The transceiver circuit **100** may receive digital audio from the data source **20** via the infrastructure wireless network **30** when the data source **20** is not in wireless communication range with the earphone **10** via the ad hoc wireless network **24**. The transceiver circuit firmware, when executed by the transceiver circuit **100**, may cause the transceiver circuit **100** of the earphone **10** to transition automatically to a pre-set infrastructure wireless network **30** that the data source **20** transitions to when the data source **20** is not in wireless communication range with the earphone **10** via the ad hoc wireless network **24** and when the pre-set infrastructure wireless network **30** is in range of both the earphone **10** and the data source **20**. In addition, the transceiver circuit firmware, when executed by the transceiver circuit **100** of the earphone **10**, may cause the transceiver circuit **100** of the earphone **10** to transmit data via the ad hoc wireless network **24** to the data source **20** regarding one or more infrastructure wireless networks **30** detected by the transceiver circuit **100** when the earphone **10** and the data source **20** are communicating via the ad hoc wireless network **24**.

In addition, the transceiver circuit firmware, when executed by the transceiver circuit **100**, may cause the transceiver circuit **100** of the earphone **10** to connect to a host server **40** via an available infrastructure wireless network **30** when the data source **20** is not in wireless communication range with the earphone **10** via the ad hoc wireless network **24**. The earphone **10** may receive streaming digital audio from the host server **40** via the infrastructure wireless network **30**. In addition, the earphone **10** may receive a first network address for a first streaming digital audio content server **70** from the host server **40** via the infrastructure wireless network **30**. In addition, the earphone **10** may comprise a user control, such as button **11**, dial, pressure switch, or other type of user control, that, when activated, causes the earphone **10** to transmit an electronic request via the infrastructure wireless network **30** to the host server **40** for a second network address for a second streaming digital audio content server **70**.

In other embodiments, the present invention is directed to a system that comprises: (i) a data source **20** for wirelessly transmitting streaming digital audio; and (ii) a wireless earphone **10** that is in wireless communication with the data source **20**. In yet other embodiments, the present invention is directed to a communication system that comprises: (i) a host server **40**; (ii) a first streaming digital audio content server **70** that is connected to the host server **40** via a data network **42**; and (iii) a wireless earphone **10** that is in communication with the host server **40** via a wireless

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network **30**. The host server **40** is programmed to transmit to the earphone **10** a first network address for the first streaming digital audio content server **70** on the data network **42**. The host server **40** and the streaming digital audio content server(s) **70** each may comprise one or more processor circuits and one or more memory circuits (e.g., ROM circuits and/or RAM circuits).

In yet another embodiment, the present invention is directed to a headset that comprises: (i) a first earphone **10a** that comprises one or more acoustic transducers **10b** for converting a first electrical signal to sound; and (ii) a second earphone **10b**, connected to the first earphone **10a**, wherein the second earphone **10b** comprises one or more acoustic transducers **10b** for converting a second electrical signal to sound. In one embodiment, the first earphone **10a** comprises: (i) a first antenna **108**; and (ii) a first transceiver circuit **100** in communication with the one or more acoustic transducers **106** of the first earphone **10a** and in communication with the first antenna **108**. The first transceiver circuit **100** is for receiving and transmitting wireless signals via the first antenna **108**, and for outputting the first electrical signal to the one or more acoustic transducers **10b** of the first earphone **10a**. The first transceiver circuit **100** also may comprise firmware, which when executed by the first transceiver circuit **100**, causes the first transceiver circuit **100** to: (i) receive digital audio wirelessly from a data source **20** via an ad hoc wireless network **24** when the data source **20** is in wireless communication range with the first earphone **10a** via the ad hoc wireless network **24**; and (ii) when the data source **20** is not in wireless communication range with the first earphone **10a** via the ad hoc wireless network **24**, transition automatically to receive digital audio via an infrastructure wireless network **30**.

In various implementations, the headset further may comprise a head band **19** that is connected to the first and second earphones **10**. In addition, the headset **19** further may comprise a microphone **104** having an output connected to the first transceiver circuit **100**. In one embodiment, the first transceiver circuit **100** is for outputting the second electrical signal to the one or more acoustic transducers **106** of the second earphone **10b**. In another embodiment, the second earphone **10b** comprises: (i) a second antenna **108**; and (ii) a second transceiver circuit **100** in communication with the one or more acoustic transducers **106** of the second earphone **10b** and in communication with the second antenna **108**. The second transceiver circuit **100** is for receiving and transmitting wireless signals via the second antenna **108**, and for outputting the second electrical signal to the one or more acoustic transducers **106** of the second earphone **10b**. The second transceiver circuit **100** may comprise firmware, which when executed by the second transceiver circuit **100**, causes the second transceiver circuit **100** to: (i) receive digital audio wirelessly from the data source **20** via the ad hoc wireless network **24** when the data source **20** is in wireless communication range with the second earphone **10b** via the ad hoc wireless network **24**; and (ii) when the data source **20** is not in wireless communication range with the second earphone **10b** via the ad hoc wireless network **24**, transition automatically to receive digital audio via the infrastructure wireless network **30**.

In addition, according to various embodiments, the first earphone **10a** may comprise a first data port and the second earphone **10b** may comprise a second data port. In addition, the headset may further comprise an adapter or dongle **150** connected to the first data port of the first earphone **10a** and to the second data port of the second earphone **10b**, wherein

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the adapter **150** comprises an output plug connector **152** for connecting to a remote device.

In addition, according to other embodiments, the present invention is directed to a method that comprises the steps of: (i) receiving, by a wireless earphone, via an ad hoc wireless network, digital audio from a data source when the data source is in wireless communication with the earphone via the ad hoc wireless network; (ii) converting, by the wireless earphone, the digital audio to sound; and (iii) when the data source is not in wireless communication with the earphone, transitioning automatically, by the earphone, to receive digital audio via an infrastructure wireless network.

In various implementations, the step of transitioning automatically by the earphone to receive digital audio via an infrastructure wireless network may comprise transitioning automatically to receive digital audio from the data source via an infrastructure wireless network when the data source is not in wireless communication range with the earphone via the ad hoc wireless network. In addition, the method may further comprise the step of receiving by the wireless earphone from the data source via the ad hoc wireless network data regarding one or more infrastructure wireless networks detected by data source when the earphone and the data source are communicating via the ad hoc wireless network.

In addition, the step of transitioning automatically by the earphone to receive digital audio via an infrastructure wireless network comprises may transitioning automatically to receive digital audio from a host sever via the infrastructure wireless network when the data source is not in wireless communication range with the earphone via the ad hoc wireless network. Additionally, the step of transitioning automatically by the earphone to receive digital audio via an infrastructure wireless network may comprise: (i) receiving, by the wireless earphone via the infrastructure wireless network, from a host server connected to the infrastructure wireless network, a network address for a streaming digital audio content server; and (ii) connecting, by the wireless earphone, to the streaming digital audio content server using the network address received from the host server.

It is to be understood that the figures and descriptions of the embodiments have been simplified to illustrate elements that are relevant for a clear understanding of the embodiments, while eliminating, for purposes of clarity, other elements. For example, certain operating system details for the various computer-related devices and systems are not described herein. Those of ordinary skill in the art will recognize, however, that these and other elements may be desirable in a typical processor or computer system. Because such elements are well known in the art and because they do not facilitate a better understanding of the embodiments, a discussion of such elements is not provided herein.

In general, it will be apparent to one of ordinary skill in the art that at least some of the embodiments described herein may be implemented in many different embodiments of software, firmware and/or hardware. The software and firmware code may be executed by a processor or any other similar computing device. The software code or specialized control hardware that may be used to implement embodiments is not limiting. For example, embodiments described herein may be implemented in computer software using any suitable computer software language type. Such software may be stored on any type of suitable computer-readable medium or media, such as, for example, a magnetic or optical storage medium. The operation and behavior of the embodiments may be described without specific reference to specific software code or specialized hardware components.

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The absence of such specific references is feasible, because it is clearly understood that artisans of ordinary skill would be able to design software and control hardware to implement the embodiments based on the present description with no more than reasonable effort and without undue experimentation.

Moreover, the processes associated with the present embodiments may be executed by programmable equipment, such as computers or computer systems and/or processors. Software that may cause programmable equipment to execute processes may be stored in any storage device, such as, for example, a computer system (nonvolatile) memory, an optical disk, magnetic tape, or magnetic disk. Furthermore, at least some of the processes may be programmed when the computer system is manufactured or stored on various types of computer-readable media.

A “computer,” “computer system,” “host,” “host server,” “server,” or “processor” may be, for example and without limitation, a processor, microcomputer, minicomputer, server, mainframe, laptop, personal data assistant (PDA), wireless e-mail device, cellular phone, pager, processor, fax machine, scanner, or any other programmable device configured to transmit and/or receive data over a network. Such components may comprise: one or more processor circuits; and one more memory circuits, including ROM circuits and RAM circuits. Computer systems and computer-based devices disclosed herein may include memory for storing certain software applications used in obtaining, processing, and communicating information. It can be appreciated that such memory may be internal or external with respect to operation of the disclosed embodiments. The memory may also include any means for storing software, including a hard disk, an optical disk, floppy disk, ROM (read only memory), RAM (random access memory), PROM (programmable ROM), EEPROM (electrically erasable PROM) and/or other computer-readable media.

In various embodiments disclosed herein, a single component may be replaced by multiple components and multiple components may be replaced by a single component to perform a given function or functions. Except where such substitution would not be operative, such substitution is within the intended scope of the embodiments. Any servers described herein, such as the host server 40, for example, may be replaced by a “server farm” or other grouping of networked servers (such as server blades) that are located and configured for cooperative functions. It can be appreciated that a server farm may serve to distribute workload between/among individual components of the farm and may expedite computing processes by harnessing the collective and cooperative power of multiple servers. Such server farms may employ load-balancing software that accomplishes tasks such as, for example, tracking demand for processing power from different machines, prioritizing and scheduling tasks based on network demand and/or providing backup contingency in the event of component failure or reduction in operability.

While various embodiments have been described herein, it should be apparent that various modifications, alterations, and adaptations to those embodiments may occur to persons skilled in the art with attainment of at least some of the advantages. The disclosed embodiments are therefore intended to include all such modifications, alterations, and adaptations without departing from the scope of the embodiments as set forth herein.

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What is claimed is:

1. A system comprising:

a mobile, digital audio player that stores digital audio content; and

a headphone assembly, separate from and in wireless communication with the mobile digital audio player, wherein the headphone assembly comprises:

first and second earphones, wherein each of the first and second earphones comprises an acoustic transducer;

an antenna for receiving wireless signals from the mobile, digital audio player via one or more ad hoc wireless communication links;

a wireless communication circuit connected to the at least one antenna, wherein the at least one wireless communication circuit is for receiving and transmitting wireless signals to and from the headphone assembly;

a processor;

a rechargeable battery for powering the headphone assembly; and

a microphone for picking up utterances by a user of the headphone assembly; and

a remote, network-connected server that is in wireless communication with the mobile, digital audio player; wherein the mobile, digital audio player is for transmitting digital audio content to the headphone assembly via the one or more ad hoc wireless communication links, such that the digital audio content received by the headphone assembly from the mobile, digital audio player is playable by the first and second earphones; and

wherein the processor is for, upon activation of a user-control of the headphone assembly, initiating transmission of a request to the remote, network-connected server.

2. The system of claim 1, wherein:

in a first audio play mode, the first and second earphones play audio content stored on the mobile, digital audio player and transmitted to the headphone assembly from the mobile, digital audio player via the one or more ad hoc wireless communication links; and

in a second audio play mode, the earphones play audio content streamed from the remote, network-connected server.

3. The system of claim 2, wherein the processor of the headphone assembly is further for:

processing audible utterances by the user picked up by the microphone in response to activation of the microphone by the user; and

transmitting a communication based on the audible utterances via the one or more ad hoc wireless communication links.

4. The system of claim 3, wherein:

the mobile, digital audio player is a first digital audio source;

the system further comprises a second digital audio source that is different from the first digital audio source; and the headphone assembly transitions to play digital audio content received wirelessly from the second digital audio source via a second wireless communication link based on, at least, a signal strength level for the second wireless communication link.

5. The system of claim 2, wherein:

the mobile, digital audio player is a first digital audio source;

the system further comprises a second digital audio source that is different from the first digital audio source; and the headphone assembly transitions to play digital audio content received wirelessly from the second digital

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audio source via a second wireless communication link based on, at least, a signal strength level for the second wireless communication link.

6. The system of claim 1, wherein the processor of the headphone assembly is further for:

processing audible utterances by the user picked up by the microphone in response to activation of the microphone by the user; and

transmitting a communication based on the audible utterances via the one or more ad hoc wireless communication links.

7. The system of claim 6, wherein:

the mobile, digital audio player is a first digital audio source;

the system further comprises a second digital audio source that is different from the first digital audio source; and the headphone assembly transitions to play digital audio content received wirelessly from the second digital audio source via a second wireless communication link based on, at least, a signal strength level for the second wireless communication link.

8. The system of claim 1, wherein upon activation of the microphone by the user, data are transmitted about the headphone assembly to a remote device.

9. The system of claim 1, wherein:

the mobile, digital audio player is a first digital audio source;

the system further comprises a second digital audio source that is different from the first digital audio source; and the headphone assembly transitions to play digital audio content received wirelessly from the second digital audio source via a second wireless communication link based on, at least, a signal strength level for the second wireless communication link.

10. The system of claim 1, the remote, network-connected server transmits firmware upgrades to the headphone assembly.

11. The system of claim 1, wherein:

the wireless communication circuit is located in the first earphone; and

the headphone assembly further comprises a connection wire between the first and second earphones to carry the received digital audio content from the first earphone to the second earphone.

12. The system of claim 11, wherein:

in a first audio play mode, the first and second earphones play audio content stored on the mobile, digital audio player and transmitted to the headphone assembly from the mobile, digital audio player via the one or more ad hoc wireless communication links; and

in a second audio play mode, the earphones play audio content streamed from the remote, network-connected server.

13. The system of claim 12, wherein the processor of the headphone assembly is further for:

processing audible utterances by the user picked up by the microphone in response to activation of the microphone by the user; and

transmitting a communication based on the audible utterances via the one or more ad hoc wireless communication links.

14. The system of claim 13, wherein:

the mobile, digital audio player is a first digital audio source;

the system further comprises a second digital audio source that is different from the first digital audio source; and

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the headphone assembly transitions to play digital audio content received wirelessly from the second digital audio source via a second wireless communication link based on, at least, a signal strength level for the second wireless communication link.

15. The system of claim 12, wherein:

the mobile, digital audio player is a first digital audio source;

the system further comprises a second digital audio source that is different from the first digital audio source; and the headphone assembly transitions to play digital audio content received wirelessly from the second digital audio source via a second wireless communication link based on, at least, a signal strength level for the second wireless communication link.

16. The system of claim 11, wherein the processor of the headphone assembly is further for:

processing audible utterances by the user picked up by the microphone in response to activation of the microphone by the user; and

transmitting a communication based on the audible utterances via the one or more ad hoc wireless communication links.

17. The system of claim 16, wherein:

the mobile, digital audio player is a first digital audio source;

the system further comprises a second digital audio source that is different from the first digital audio source; and the headphone assembly transitions to play digital audio content received wirelessly from the second digital audio source via a second wireless communication link based on, at least, a signal strength level for the second wireless communication link.

18. The system of claim 11, wherein upon activation of the microphone by the user, data are transmitted about the headphone assembly to a remote device.

19. The system of claim 11, wherein:

the mobile, digital audio player is a first digital audio source;

the system further comprises a second digital audio source that is different from the first digital audio source; and the headphone assembly transitions to play digital audio content received wirelessly from the second digital audio source via a second wireless communication link based on, at least, a signal strength level for the second wireless communication link.

20. The system of claim 11, wherein the headphone assembly further comprises a headband, and wherein the headband carries the connection wire.

21. The system of claim 20, wherein:

in a first audio play mode, the first and second earphones play audio content stored on the mobile, digital audio player and transmitted to the headphone assembly from the mobile, digital audio player via the one or more ad hoc wireless communication links; and

in a second audio play mode, the earphones play audio content streamed from the remote, network-connected server.

22. The system of claim 21, wherein the processor of the headphone assembly is further for:

processing audible utterances by the user picked up by the microphone in response to activation of the microphone by the user; and

transmitting a communication based on the audible utterances via the one or more ad hoc wireless communication links.

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23. The system of claim 22, wherein:
the mobile, digital audio player is a first digital audio source;
the system further comprises a second digital audio source that is different from the first digital audio source; and the headphone assembly transitions to play digital audio content received wirelessly from the second digital audio source via a second wireless communication link based on, at least, a signal strength level for the second wireless communication link.

24. The system of claim 21, wherein:
the mobile, digital audio player is a first digital audio source;
the system further comprises a second digital audio source that is different from the first digital audio source; and the headphone assembly transitions to play digital audio content received wirelessly from the second digital audio source via a second wireless communication link based on, at least, a signal strength level for the second wireless communication link.

25. The system of claim 20, wherein the processor of the headphone assembly is further for:
processing audible utterances by the user picked up by the microphone in response to activation of the microphone by the user; and
transmitting a communication based on the audible utterances via the one or more ad hoc wireless communication links.

26. The system of claim 25, wherein:
the mobile, digital audio player is a first digital audio source;
the system further comprises a second digital audio source that is different from the first digital audio source; and the headphone assembly transitions to play digital audio content received wirelessly from the second digital audio source via a second wireless communication link based on, at least, a signal strength level for the second wireless communication link.

27. The system of claim 20, wherein upon activation of the microphone by the user, data are transmitted about the headphone assembly to a remote device.

28. The system of claim 20, wherein:
the mobile, digital audio player is a first digital audio source;
the system further comprises a second digital audio source that is different from the first digital audio source; and the headphone assembly transitions to play digital audio content received wirelessly from the second digital audio source via a second wireless communication link based on, at least, a signal strength level for the second wireless communication link.

29. The system of claim 11, wherein each of the first and second earphones comprises:
an adjustable, curved hanger bar that sits upon an upper external curvature of a user's ear, behind the an upper portion of an auricula of the user's ear, when the headphone assembly is worn by the user; and
a body connected to the hanger bar, wherein the earphone extends from the body into the user's ear when the headphone assembly is worn by the user.

30. The system of claim 29, wherein:
in a first audio play mode, the first and second earphones play audio content stored on the mobile, digital audio player and transmitted to the headphone assembly from the mobile, digital audio player via the one or more ad hoc wireless communication links; and

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in a second audio play mode, the earphones play audio content streamed from the remote, network-connected server.

31. The system of claim 30, wherein the processor of the headphone assembly is further for:
processing audible utterances by the user picked up by the microphone in response to activation of the microphone by the user; and
transmitting a communication based on the audible utterances via the one or more ad hoc wireless communication links.

32. The system of claim 31, wherein:
the mobile, digital audio player is a first digital audio source;
the system further comprises a second digital audio source that is different from the first digital audio source; and the headphone assembly transitions to play digital audio content received wirelessly from the second digital audio source via a second wireless communication link based on, at least, a signal strength level for the second wireless communication link.

33. The system of claim 30, wherein:
the mobile, digital audio player is a first digital audio source;
the system further comprises a second digital audio source that is different from the first digital audio source; and the headphone assembly transitions to play digital audio content received wirelessly from the second digital audio source via a second wireless communication link based on, at least, a signal strength level for the second wireless communication link.

34. The system of claim 29, wherein the processor of the headphone assembly is further for:
processing audible utterances by the user picked up by the microphone in response to activation of the microphone by the user; and
transmitting a communication based on the audible utterances via the one or more ad hoc wireless communication links.

35. The system of claim 34, wherein:
the mobile, digital audio player is a first digital audio source;
the system further comprises a second digital audio source that is different from the first digital audio source; and the headphone assembly transitions to play digital audio content received wirelessly from the second digital audio source via a second wireless communication link based on, at least, a signal strength level for the second wireless communication link.

36. The system of claim 29, wherein upon activation of the microphone by the user, data are transmitted about the headphone assembly to a remote device.

37. The system of claim 29, wherein:
the mobile, digital audio player is a first digital audio source;
the system further comprises a second digital audio source that is different from the first digital audio source; and the headphone assembly transitions to play digital audio content received wirelessly from the second digital audio source via a second wireless communication link based on, at least, a signal strength level for the second wireless communication link.

38. The system of claim 11, wherein the remote, network-connected server transmits firmware upgrades to the headphone assembly.

39. The system of claim 11, wherein each of the first and second earphones comprise earbuds.

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40. The system of claim 1, wherein each of the first and second earphones comprises:

- at least one acoustic transducer;
- a wireless communication circuit;
- a body portion that sits at least partially in an ear of the user when the headphone assembly is worn by the user; and

an elongated portion that extends from the body portion.

41. The system of claim 40, further comprising a docking station for charging at least one of the first and second earphones.

42. The system of claim 41, wherein:

- in a first audio play mode, the first and second earphones play audio content stored on the mobile, digital audio player and transmitted to the headphone assembly from the mobile, digital audio player via the one or more ad hoc wireless communication links; and

in a second audio play mode, the earphones play audio content streamed from the remote, network-connected server.

43. The system of claim 42, wherein the processor of the headphone assembly is further for:

- processing audible utterances by the user picked up by the microphone in response to activation of the microphone by the user; and

transmitting a communication based on the audible utterances via the one or more ad hoc wireless communication links.

44. The system of claim 43, wherein:

- the mobile, digital audio player is a first digital audio source;

the system further comprises a second digital audio source that is different from the first digital audio source; and the headphone assembly transitions to play digital audio content received wirelessly from the second digital audio source via a second wireless communication link based on, at least, a signal strength level for the second wireless communication link.

45. The system of claim 42, wherein:

- the mobile, digital audio player is a first digital audio source;

the system further comprises a second digital audio source that is different from the first digital audio source; and the headphone assembly transitions to play digital audio content received wirelessly from the second digital audio source via a second wireless communication link based on, at least, a signal strength level for the second wireless communication link.

46. The system of claim 41, wherein the processor of the headphone assembly is further for:

- processing audible utterances by the user picked up by the microphone in response to activation of the microphone by the user; and

transmitting a communication based on the audible utterances via the one or more ad hoc wireless communication links.

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47. The system of claim 46, wherein:

- the mobile, digital audio player is a first digital audio source;

the system further comprises a second digital audio source that is different from the first digital audio source; and the headphone assembly transitions to play digital audio content received wirelessly from the second digital audio source via a second wireless communication link based on, at least, a signal strength level for the second wireless communication link.

48. The system of claim 41, wherein upon activation of the microphone by the user, data are transmitted about the headphone assembly to a remote device.

49. The system of claim 48, wherein:

- the mobile, digital audio player is a first digital audio source;

the system further comprises a second digital audio source that is different from the first digital audio source; and the headphone assembly transitions to play digital audio content received wirelessly from the second digital audio source via a second wireless communication link based on, at least, a signal strength level for the second wireless communication link.

50. The system of claim 41, wherein:

- the mobile, digital audio player is a first digital audio source;

the system further comprises a second digital audio source that is different from the first digital audio source; and the headphone assembly transitions to play digital audio content received wirelessly from the second digital audio source via a second wireless communication link based on, at least, a signal strength level for the second wireless communication link.

51. The system of claim 40, wherein the remote, network-connected server transmits firmware upgrades to the headphone assembly.

52. The system of claim 1, wherein the headphone assembly further comprises first and second integrated circuits, wherein the first integrated circuit comprises the wireless communication circuit and the second integrated circuit, which is separate from the first integrated circuit, comprises the processor.

53. The system of claim 1, wherein each of the first and second earphones comprises:

- an adjustable, curved hanger bar that sits upon an upper external curvature of a user's ear, behind the an upper portion of an auricula of the user's ear, when the headphone assembly is worn by the user; and

a body connected to the hanger bar, wherein the earphone extends from the body into the user's ear when the headphone assembly is worn by the user.

54. The system of claim 1, wherein each of the first and second earphones comprise earbuds.

55. The system of claim 1, wherein each of the first and second earphones comprise on-ear speaker elements.

56. The system of claim 1, wherein each of the first and second earphones comprise over-ear speaker elements.

* * * * *

EXHIBIT B



US010368155B2

(12) **United States Patent**
Koss et al.

(10) **Patent No.:** **US 10,368,155 B2**
 (45) **Date of Patent:** ***Jul. 30, 2019**

(54) **SYSTEM WITH WIRELESS EARPHONES**

(71) Applicant: **Koss Corporation**, Milwaukee, WI (US)

(72) Inventors: **Michael J. Koss**, Milwaukee, WI (US); **Michael J. Pelland**, Princeton, WI (US); **Michael Sagan**, Fairfield, CA (US); **Steven R. Reckamp**, Crystal Lake, IL (US); **Gregory J. Hallingstad**, Deforest, WI (US); **Jeffery K. Bovee**, Sterling, IL (US); **Morgan J. Lowery**, Deforest, WI (US)

(73) Assignee: **Koss Corporation**, Milwaukee, WI (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.
 This patent is subject to a terminal disclaimer.

(21) Appl. No.: **16/182,927**

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Related U.S. Application Data

(63) Continuation of application No. 15/962,305, filed on Apr. 25, 2018, now Pat. No. 10,206,025, which is a (Continued)

(51) **Int. Cl.**
H04R 3/00 (2006.01)
H04R 1/10 (2006.01)
 (Continued)

(52) **U.S. Cl.**
 CPC **H04R 1/1041** (2013.01); **H03G 3/02** (2013.01); **H03K 17/9622** (2013.01);
 (Continued)

(58) **Field of Classification Search**

CPC H04R 1/1016; H04R 1/1008
 (Continued)

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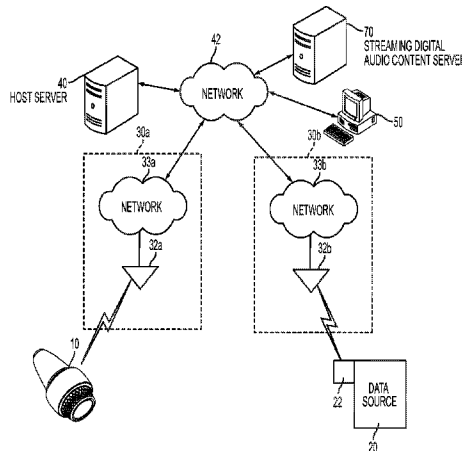
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Primary Examiner — Kiet M Doan

(74) *Attorney, Agent, or Firm* — K&L Gates LLP

(57) **ABSTRACT**

Apparatus comprises adapter and speaker system. Adapter is configured to plug into port of personal digital audio player. Speaker system is in communication with adapter, and comprises multiple acoustic transducers, programmable processor circuit, and wireless communication circuit. In first operational mode, processor circuit receives, via adapter, and processes digital audio content from personal digital audio player into which adapter is plugged, and the multiple acoustic transducers output the received audio content from the personal digital audio player. In second operational mode, wireless communication circuit receives digital audio content from a remote digital audio source over a wireless network, processor circuit processes the digital audio content received from remote digital audio source, and the (Continued)



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Page 2

multiple acoustic transducers output the audio content received from the remote digital audio source.

14 Claims, 16 Drawing Sheets**Related U.S. Application Data**

continuation of application No. 15/650,362, filed on Jul. 14, 2017, now Pat. No. 9,986,325, which is a continuation of application No. 15/293,785, filed on Oct. 14, 2016, now Pat. No. 9,729,959, which is a continuation of application No. 15/082,040, filed on Mar. 28, 2016, now Pat. No. 9,497,535, which is a continuation of application No. 14/695,696, filed on Apr. 24, 2015, now Pat. No. 9,438,987, which is a continuation of application No. 13/609,409, filed on Sep. 11, 2012, now Pat. No. 9,049,502, which is a continuation of application No. 13/459,291, filed on Apr. 30, 2012, now Pat. No. 8,571,544, which is a continuation of application No. 12/936,488, filed as application No. PCT/US2009/039754 on Apr. 7, 2009, now Pat. No. 8,190,203.

(60) Provisional application No. 61/123,265, filed on Apr. 7, 2008.

(51) Int. Cl.

H04M 1/02 (2006.01)
H04R 5/033 (2006.01)
H04R 5/04 (2006.01)
H04W 48/20 (2009.01)
H03G 3/02 (2006.01)
H03K 17/96 (2006.01)
H04R 1/02 (2006.01)
H04H 20/95 (2008.01)
H04L 29/12 (2006.01)
H04W 4/80 (2018.01)
H04R 25/00 (2006.01)
H04W 84/18 (2009.01)
H04W 84/12 (2009.01)

(52) U.S. Cl.

CPC **H04H 20/95** (2013.01); **H04L 61/6068** (2013.01); **H04M 1/0254** (2013.01); **H04R 1/02** (2013.01); **H04R 1/1091** (2013.01); **H04R 3/00** (2013.01); **H04R 5/033** (2013.01); **H04R 5/04** (2013.01); **H04W 4/80** (2018.02); **H04W 48/20** (2013.01); **H03K 2217/960785** (2013.01); **H04R 25/554** (2013.01); **H04R 2201/103** (2013.01); **H04R 2201/107** (2013.01); **H04R 2225/55** (2013.01); **H04R 2420/07** (2013.01); **H04W 84/12** (2013.01); **H04W 84/18** (2013.01)

(58) Field of Classification Search

USPC 381/74, 80, 311; 455/556.1, 41.2, 343.2, 455/569.1, 553.1, 575.2, 412.2; 345/8, 345/156, 7

See application file for complete search history.

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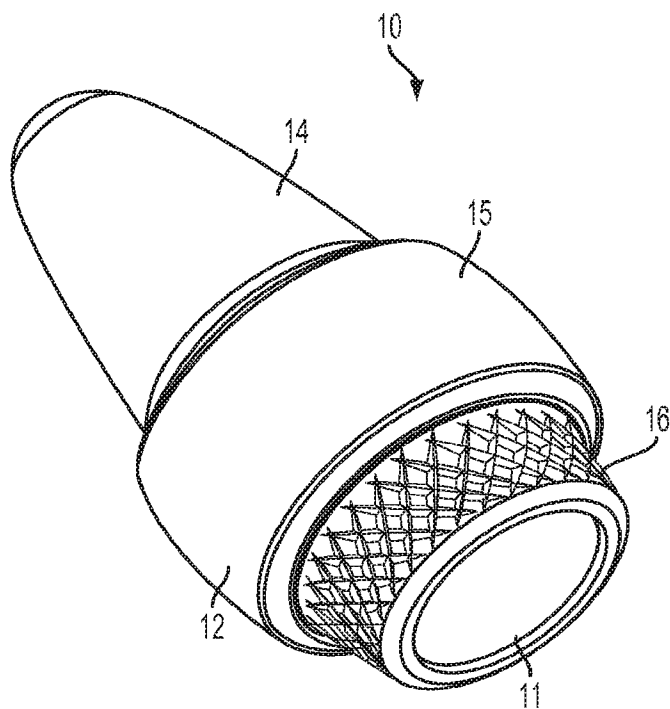


FIG. 1A

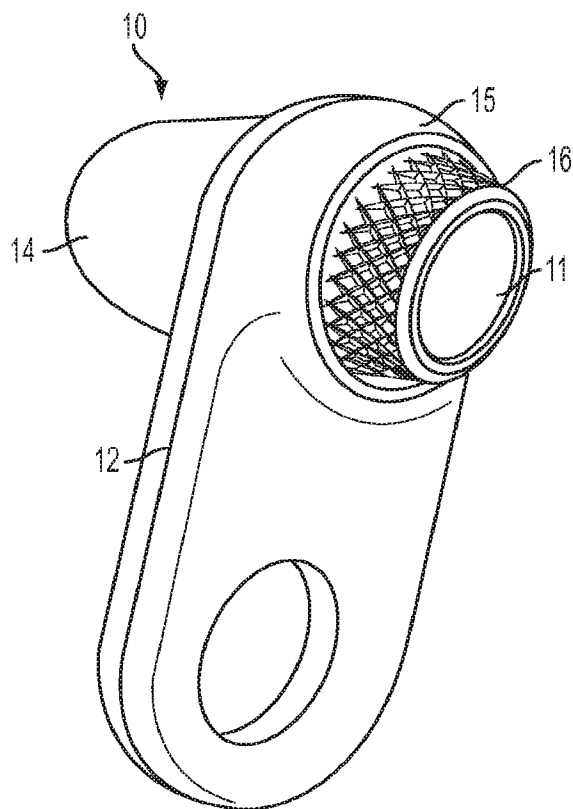


FIG. 1B

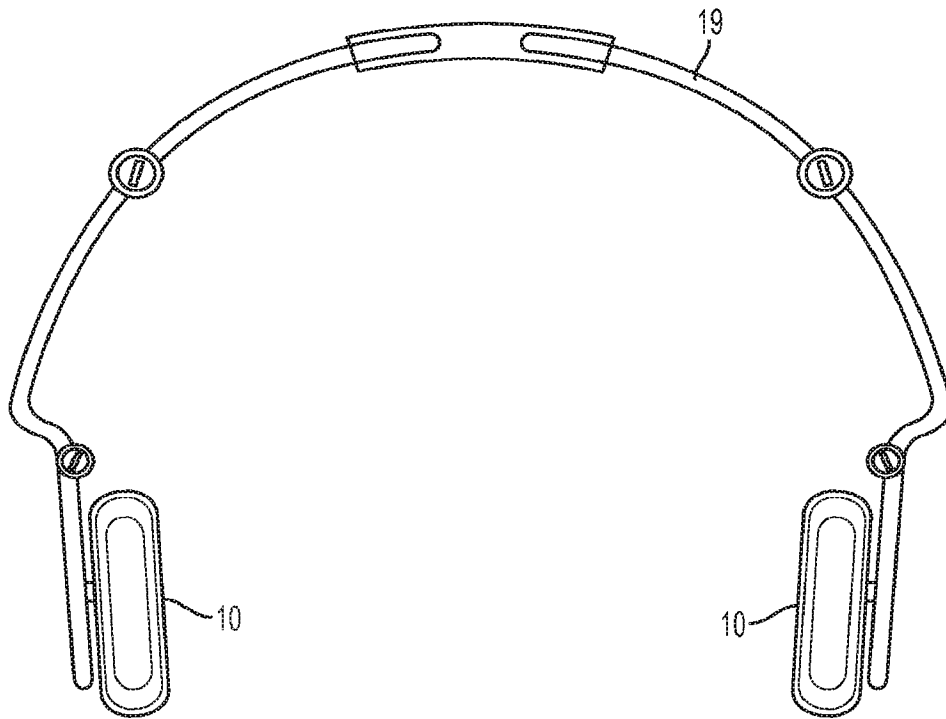


FIG. 1C

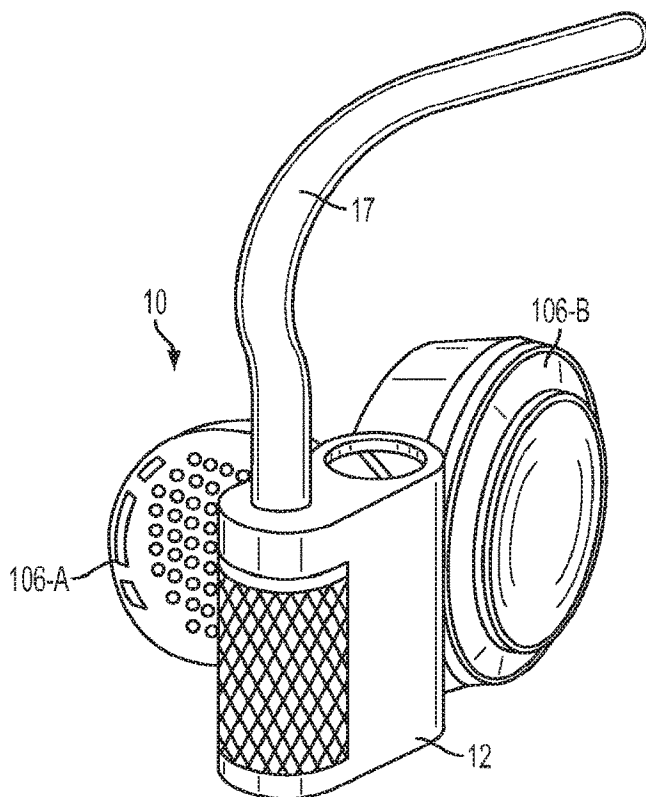


FIG. 1D

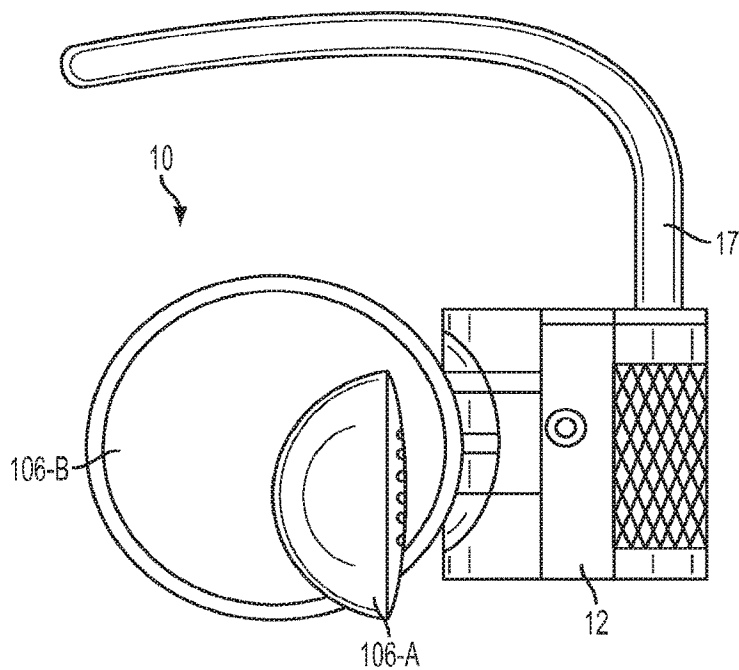


FIG. 1E

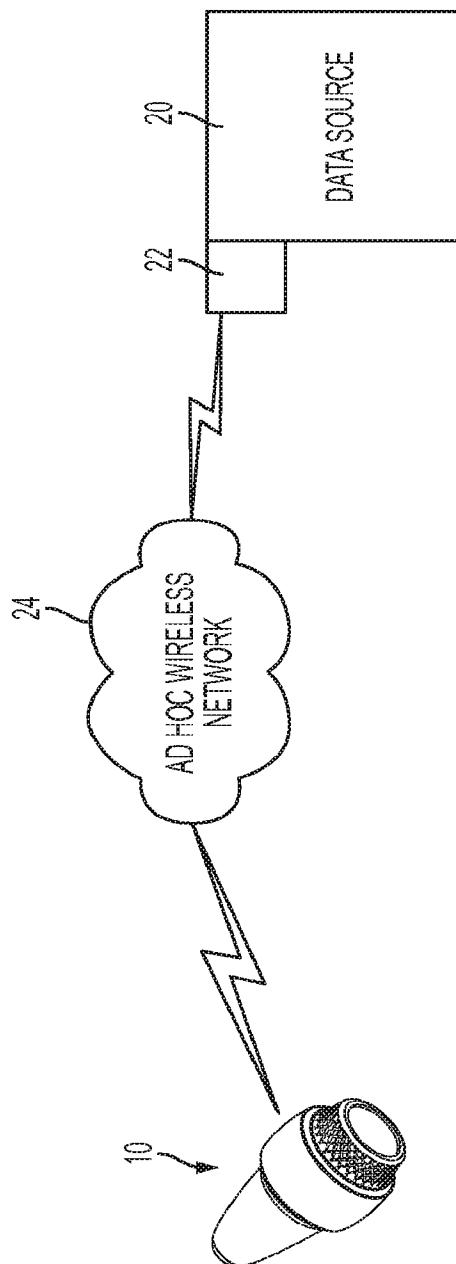


FIG. 2A

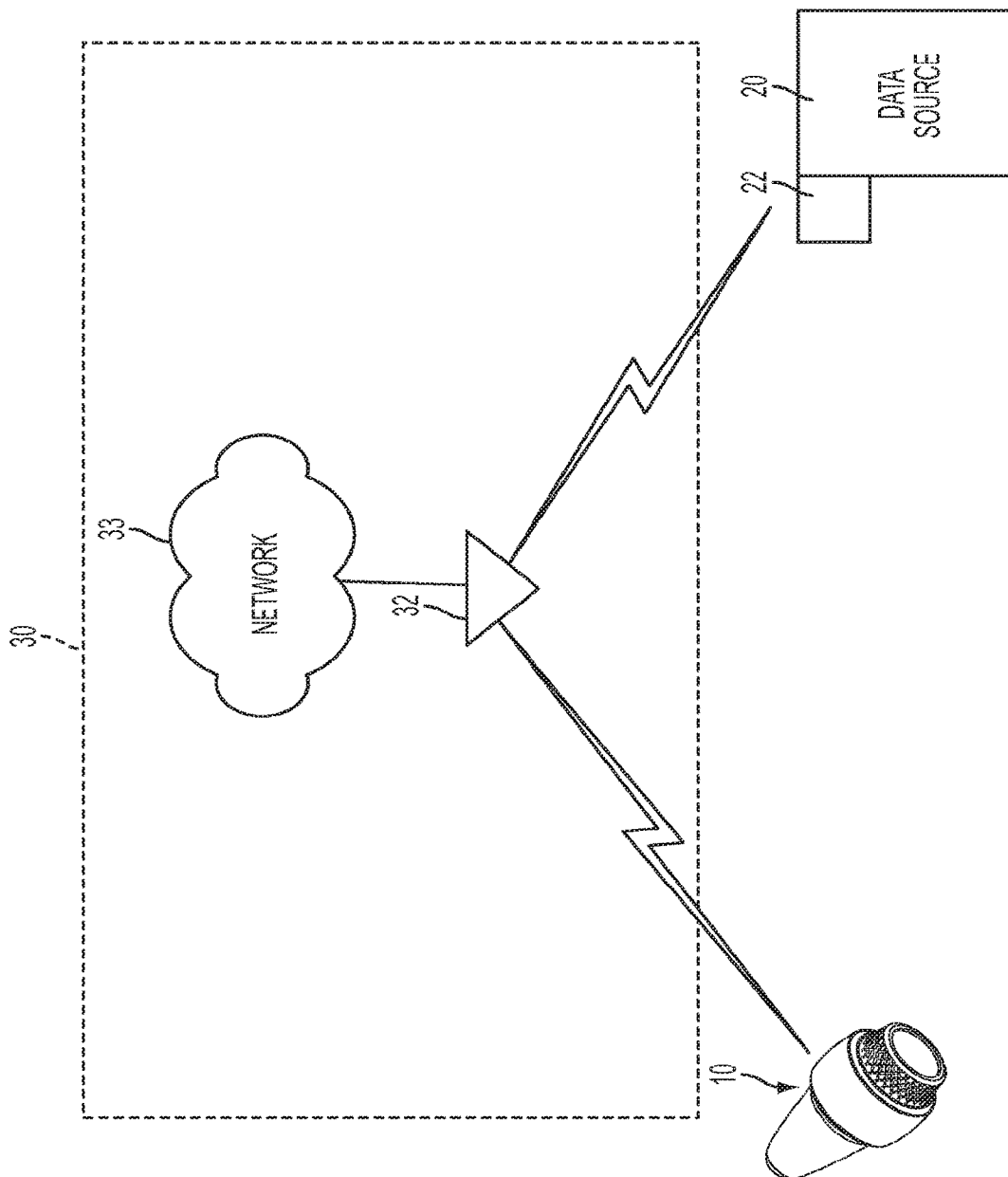


FIG. 2B

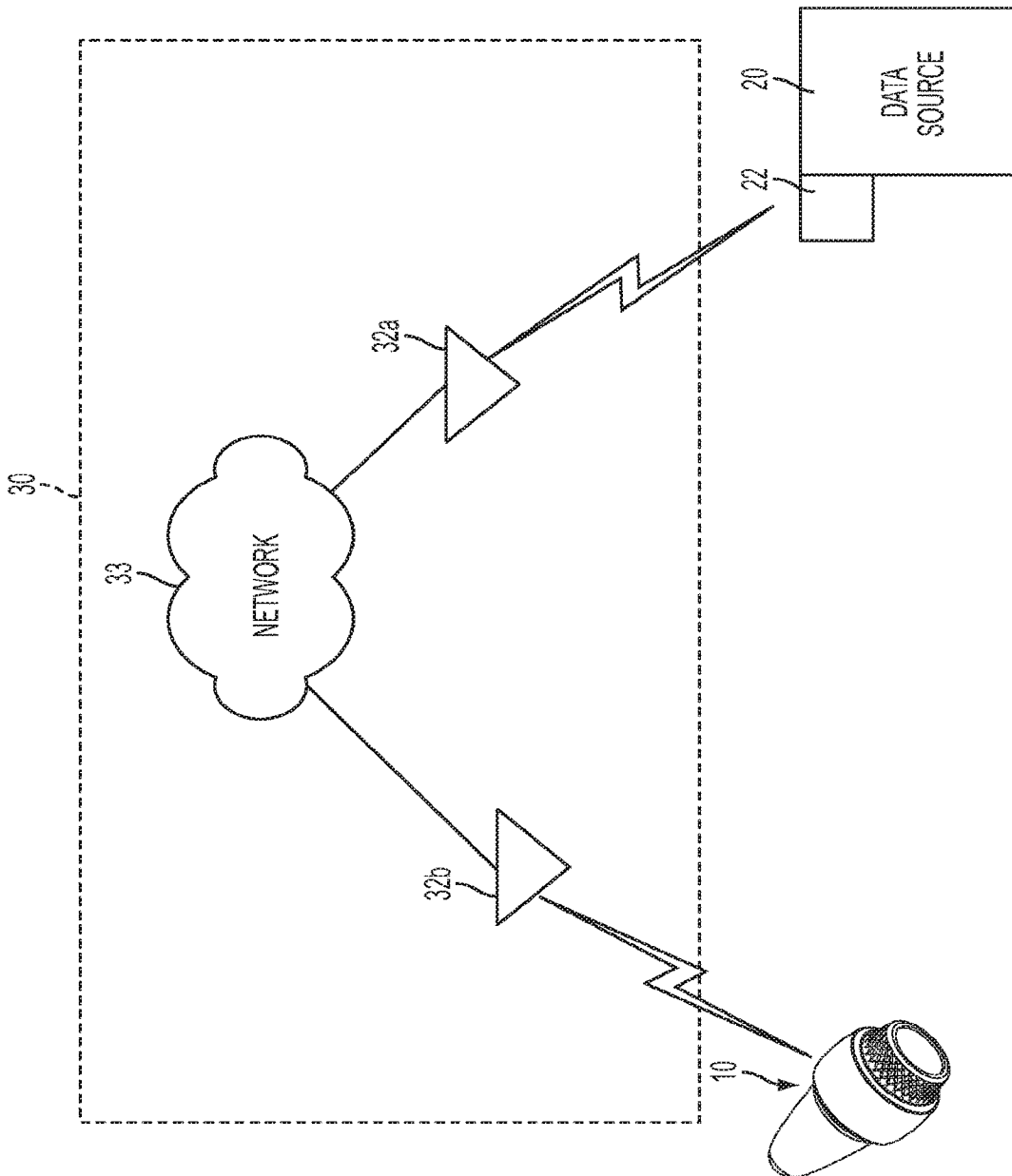


FIG. 2C

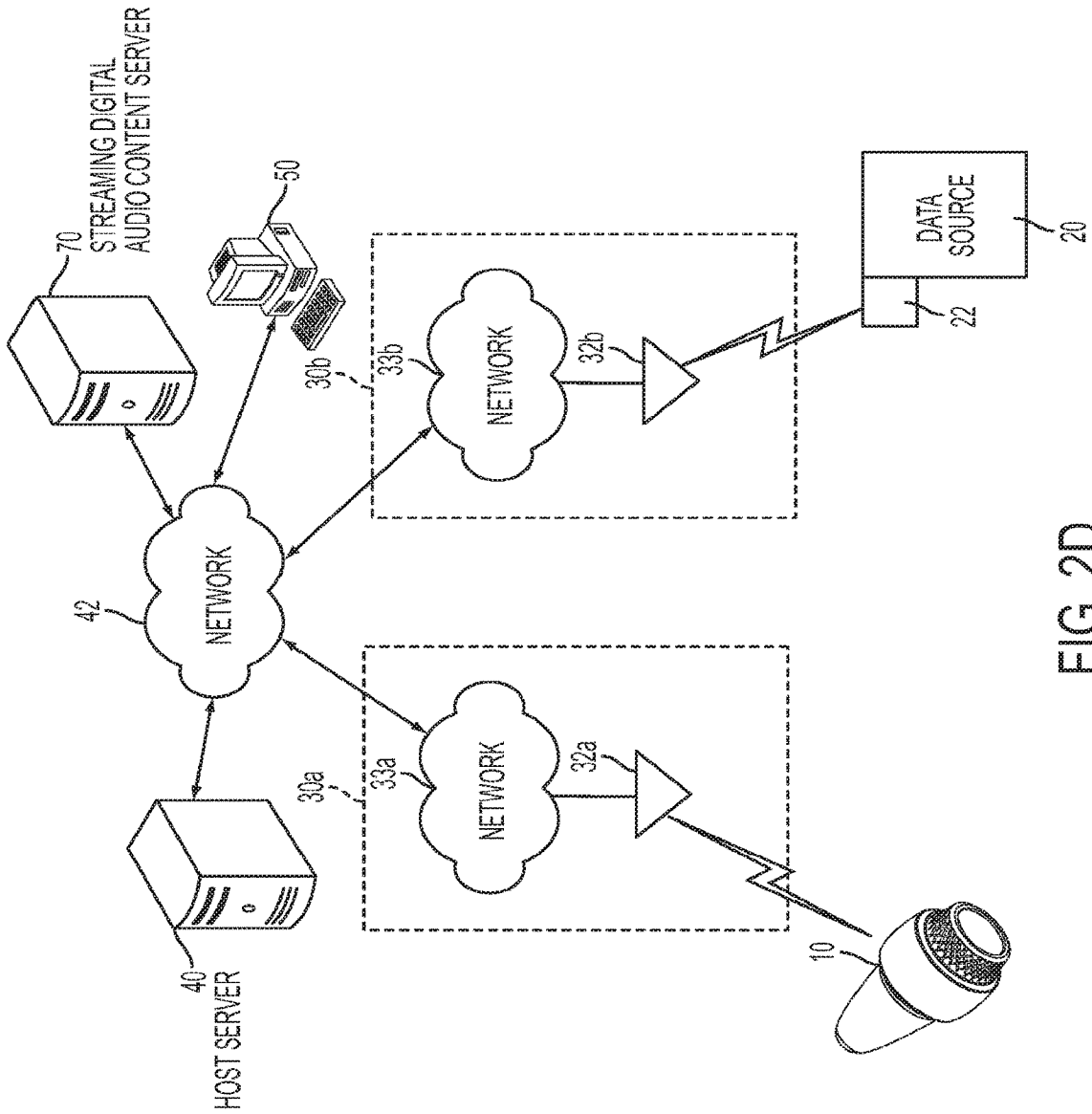


FIG. 2D

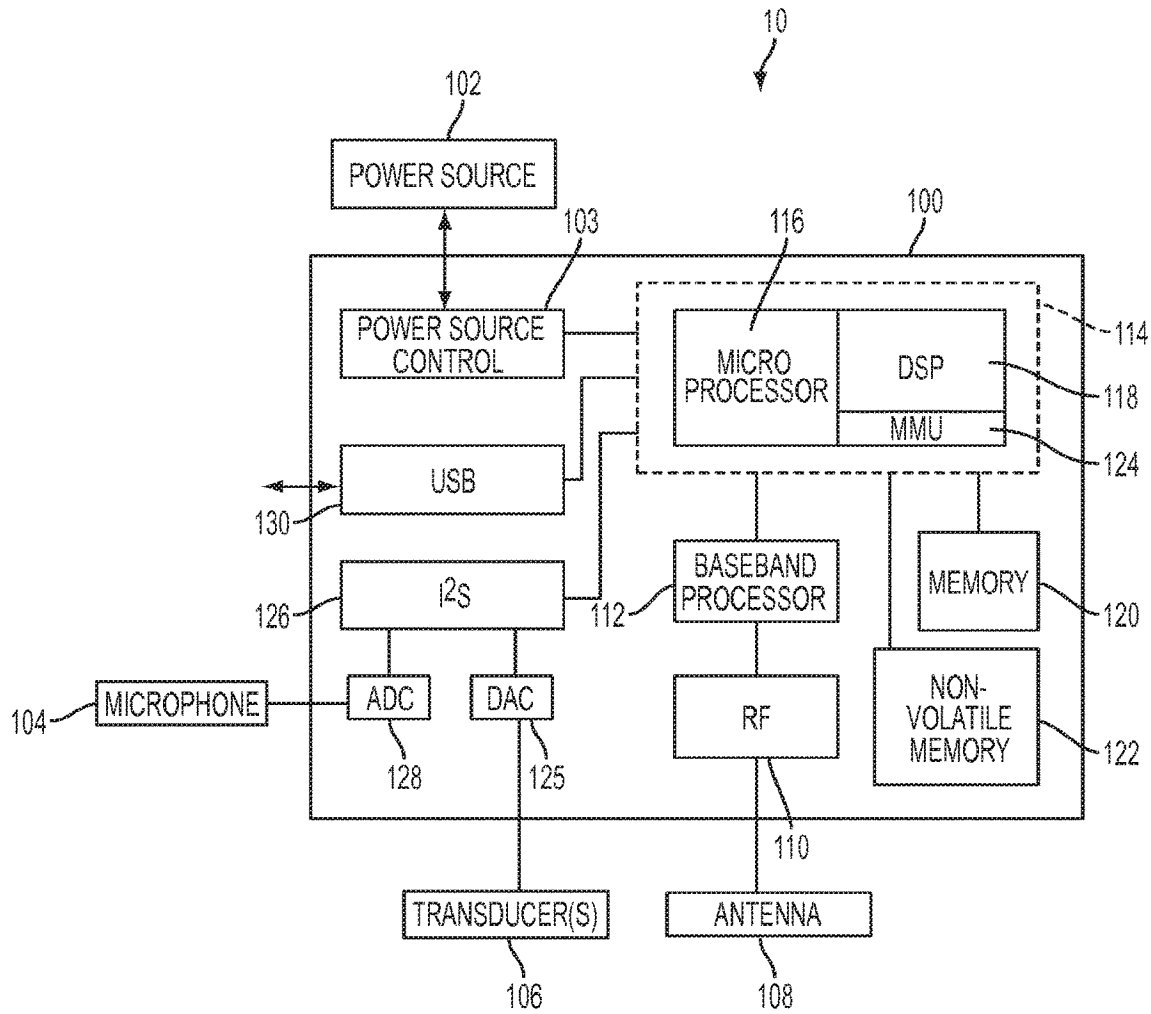


FIG. 3

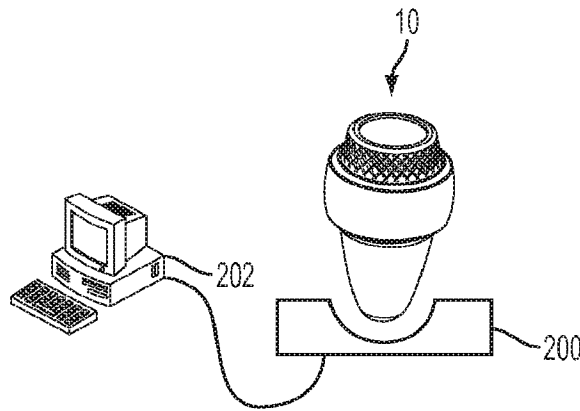


FIG. 4A

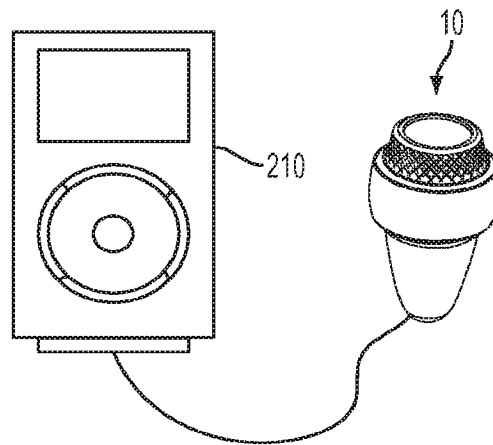


FIG. 4B

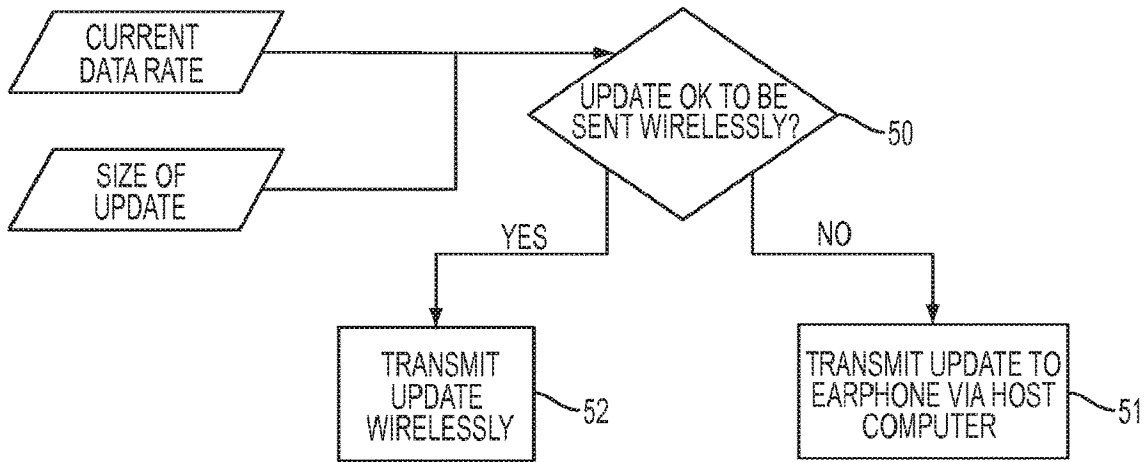


FIG. 5

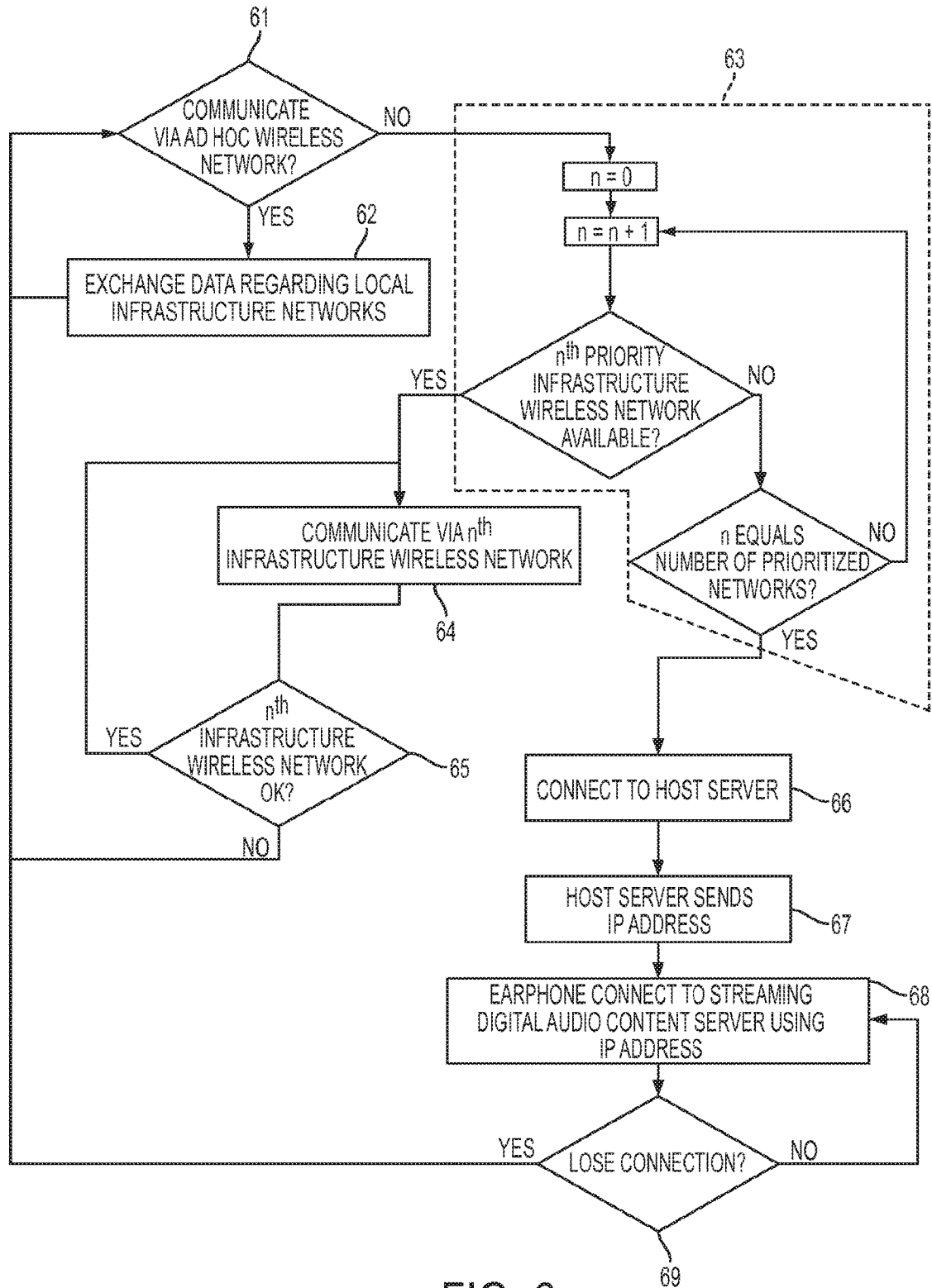


FIG. 6

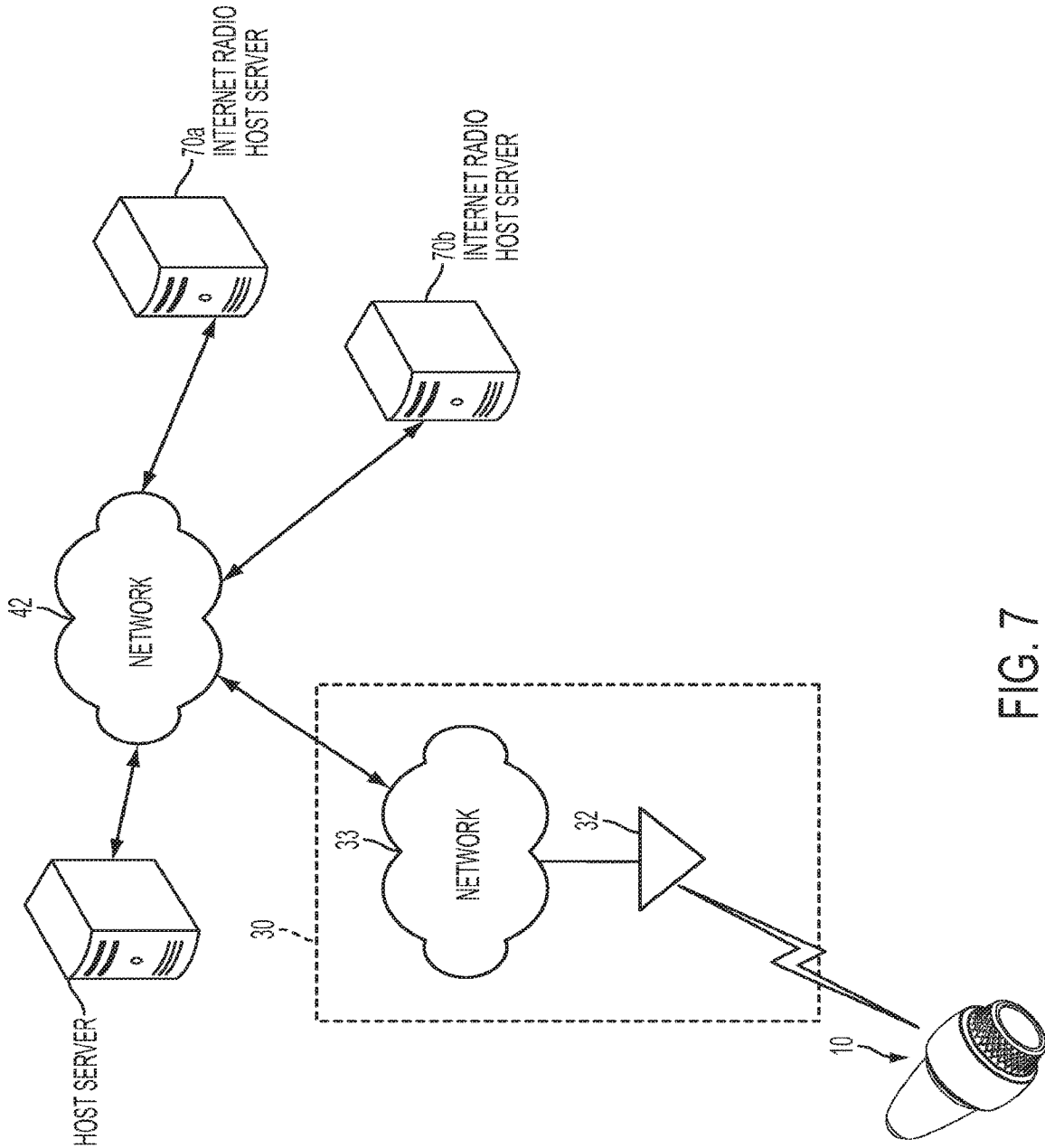


FIG. 7

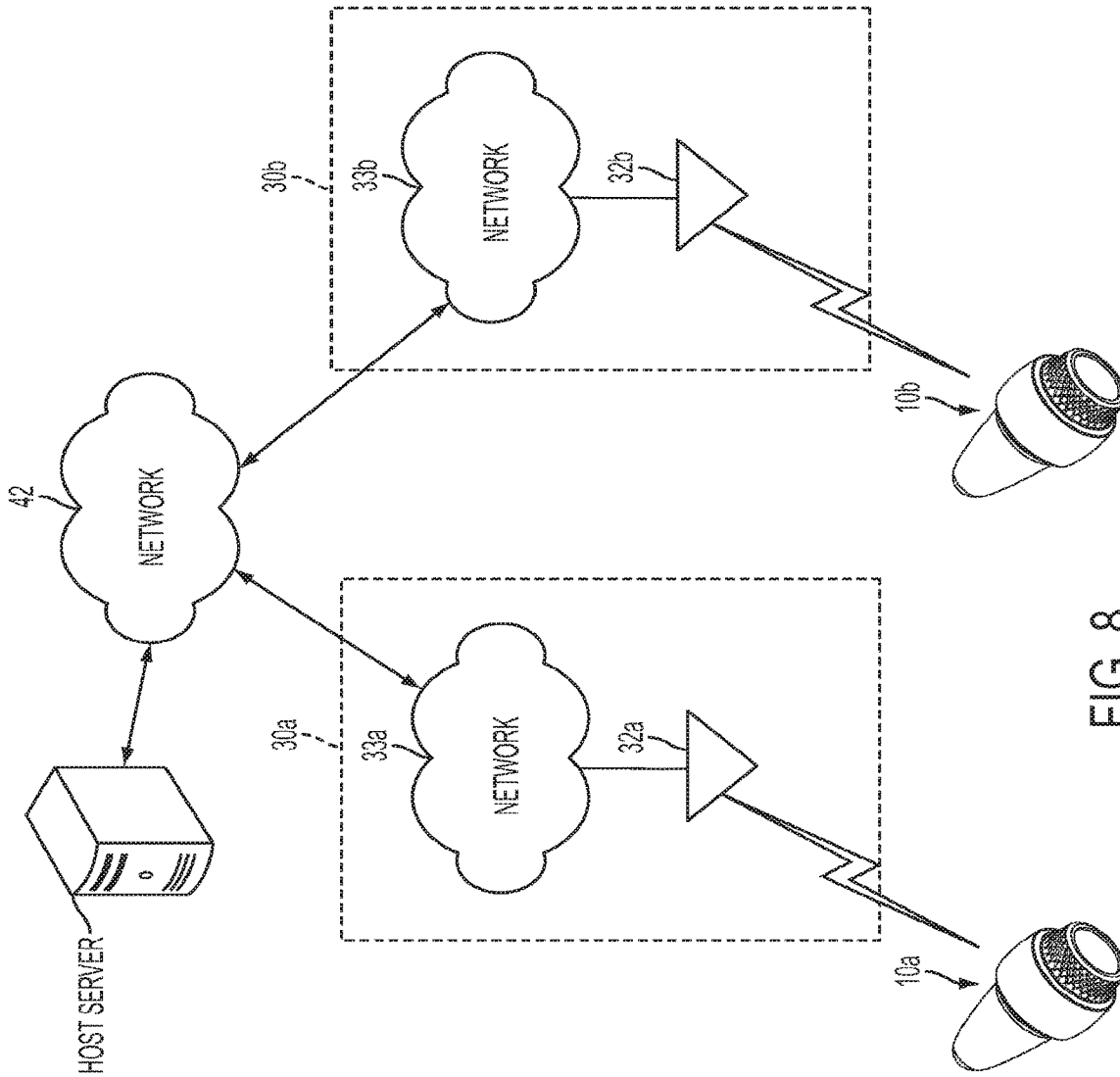


FIG. 8

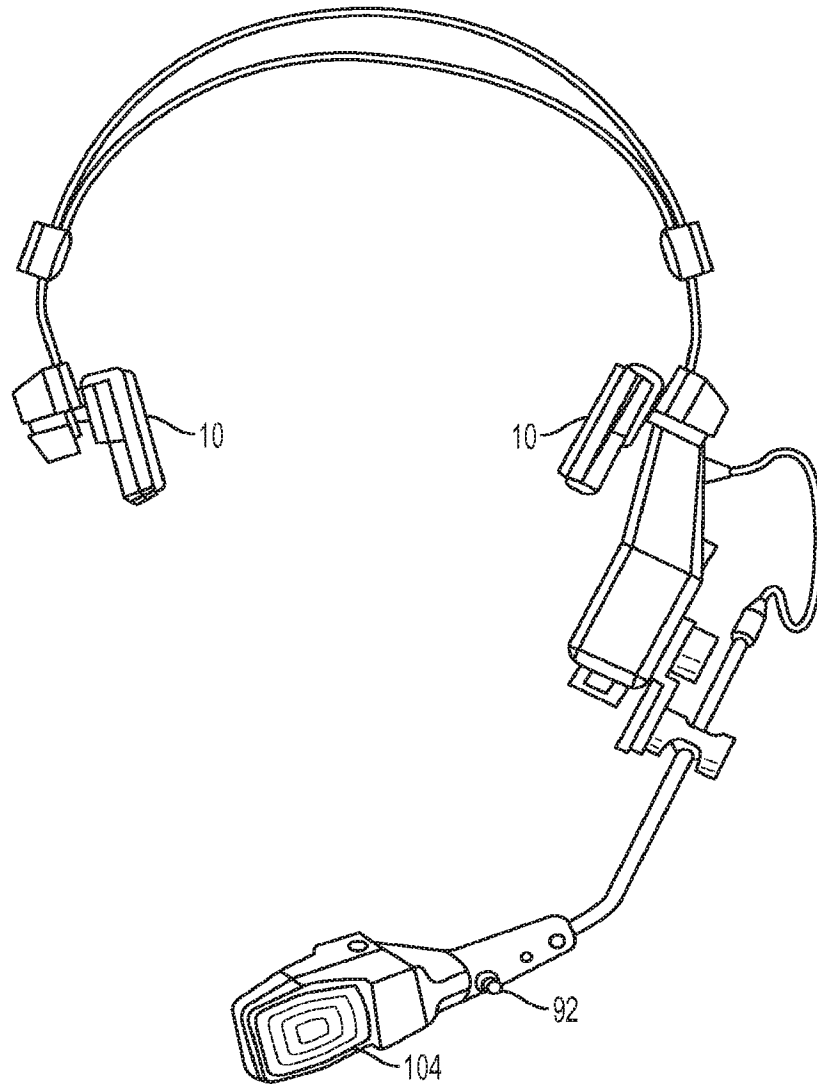


FIG. 9

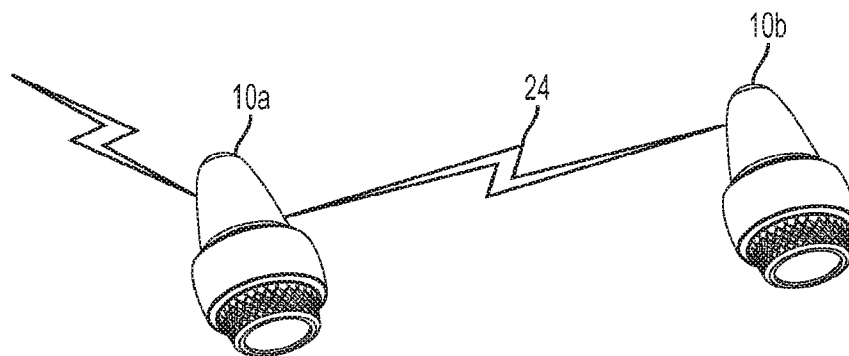


FIG. 10

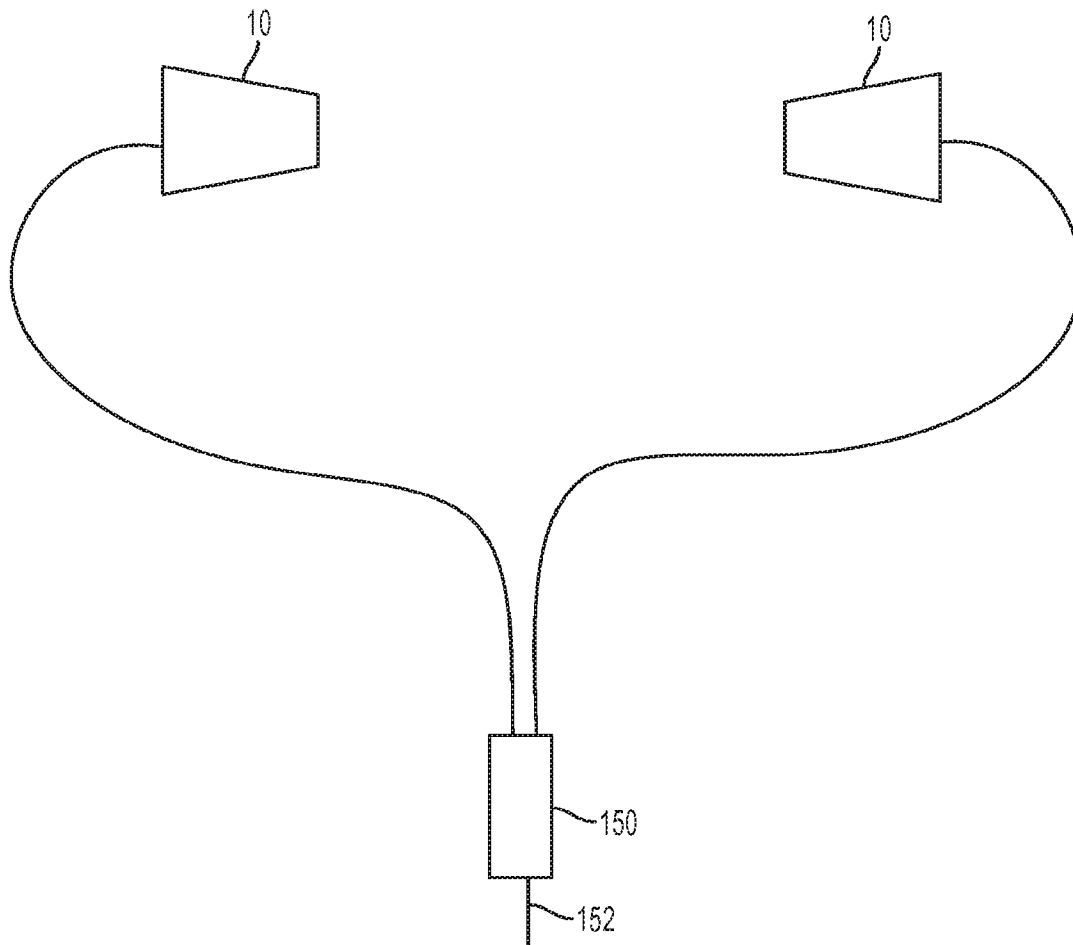


FIG. 11

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SYSTEM WITH WIRELESS EARPHONES**PRIORITY CLAIM**

The present application claims priority as a continuation to U.S. nonprovisional patent application Ser. No. 15/962,305, filed Apr. 25, 2018, which is a continuation of U.S. nonprovisional patent application Ser. No. 15/650,362, filed Jul. 14, 2017, now U.S. Pat. No. 9,986,325, issued May 29, 2018, which is a continuation of U.S. nonprovisional patent application Ser. No. 15/293,785, filed Oct. 14, 2016, now U.S. Pat. No. 9,729,959, issued Aug. 8, 2017, which is a continuation of U.S. nonprovisional patent application Ser. No. 15/082,040, filed Mar. 28, 2016, now U.S. Pat. No. 9,497,535, issued Nov. 15, 2016, which is a continuation of U.S. nonprovisional patent application Ser. No. 14/695,696, filed Apr. 24, 2015, now U.S. Pat. No. 9,438,987, issued on Sep. 6, 2016, which is a continuation of U.S. nonprovisional patent application Ser. No. 13/609,409, filed Sep. 11, 2012, now U.S. Pat. No. 9,049,502, issued Jun. 2, 2015, which is a continuation of U.S. nonprovisional patent application Ser. No. 13/459,291, filed Apr. 30, 2012, now U.S. Pat. No. 8,571,544, issued Oct. 29, 2013, which is a continuation of U.S. patent application Ser. No. 12/936,488, filed Dec. 20, 2010, now U.S. Pat. No. 8,190,203, issued May 29, 2012, which is a national stage entry of PCT/US2009/039754, filed Apr. 7, 2009, which claims priority to U.S. provisional patent application Ser. No. 61/123,265, filed Apr. 7, 2008, all of which are incorporated herein by reference in their entireties.

CROSS-REFERENCE TO RELATED APPLICATIONS

U.S. nonprovisional patent application Ser. No. 14/031,938, filed Sep. 13, 2013, now U.S. Pat. No. 8,655,420, issued Feb. 18, 2014, is also a continuation of U.S. nonprovisional patent application Ser. No. 13/609,409, filed Sep. 11, 2012, now U.S. Pat. No. 9,049,502, mentioned above.

BACKGROUND

Digital audio players, such as MP3 players and iPods, that store and play digital audio files, are very popular. Such devices typically comprise a data storage unit for storing and playing the digital audio, and a headphone set that connects to the data storage unit, usually with a ¼" or a 3.5 mm jack and associated cord. Often the headphones are in-ear type headphones. The cord, however, between the headphones and the data storage unit can be cumbersome and annoying to users, and the length of the cord limits the physical distance between the data storage unit and the headphones. Accordingly, some cordless headphones have been proposed, such as the Monster iFreePlay cordless headphones from Apple Inc., which include a docking port on one of the earphones that can connect directly to an iPod Shuffle. Because they have the docking port, however, the Monster iFreePlay cordless headphones from Apple are quite large and are not in-ear type phones. Recently, cordless headphones that connect wirelessly via IEEE 802.11 to a WLAN-ready laptop or personal computer (PC) have been proposed, but such headphones are also quite large and not in-ear type phones.

SUMMARY

In one general aspect, the present invention is directed to a wireless earphone that comprises a transceiver circuit for

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receiving streaming audio from a data source, such as a digital audio player or a computer, over an ad hoc wireless network. When the data source and the earphone are out of range via the ad hoc wireless network, they may transition automatically to a common infrastructure wireless network (e.g., a wireless LAN). If there is no common infrastructure wireless network for both the data source and the earphone, the earphone may connect via an available infrastructure wireless network to a host server. The host server may, for example, broadcast streaming audio to the earphone and/or transmit to the earphone a network address (e.g., an Internet Protocol (IP) address) for a network-connected content server that streams digital audio. The earphone may then connect to the content server using the IP address. The content server may be an Internet radio server, including, for example, an Internet radio server that broadcasts streaming audio from the data source or some other content.

These and other advantageous, unique aspects of the wireless earphone are described below.

FIGURES

Various embodiments of the present invention are described herein by way of example in conjunction with the following figures, wherein:

FIGS. 1A-1E are views of a wireless earphone according to various embodiments of the present invention;

FIGS. 2A-2D illustrate various communication modes for a wireless earphone according to various embodiments of the present invention;

FIG. 3 is a block diagram of a wireless earphone according to various embodiments of the present invention;

FIGS. 4A-4B show the wireless earphone connected to another device according to various embodiments of the present invention;

FIG. 5 is a diagram of a process implemented by a host server according to various embodiments of the present invention;

FIG. 6 is a diagram of a process implemented by the wireless earphone to transition automatically between wireless networks according to various embodiments of the present invention;

FIGS. 7, 8 and 10 illustrate communication systems involving the wireless earphone according to various embodiments of the present invention;

FIG. 9 is a diagram of a headset including a wireless earphone and a microphone according to various embodiments of the present invention; and

FIG. 11 is a diagram of a pair of wireless earphones with a dongle according to various embodiments of the present invention.

DESCRIPTION

In one general aspect, the present invention is directed to a wireless earphone that receives streaming audio data via ad hoc wireless networks and infrastructure wireless networks, and that transitions seamlessly between wireless networks. The earphone may comprise one or more in-ear, on-ear, or over-ear speaker elements. Two exemplary in-ear earphone shapes for the wireless earphone 10 are shown in FIGS. 1A and 1B, respectively, although in other embodiments the earphone may take different shapes and the exemplary shapes shown in FIGS. 1A and 1B are not intended to be limiting. In one embodiment, the earphone transitions automatically and seamlessly, without user intervention, between communication modes. That is, the earphone may

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transition automatically from an ad hoc wireless network to an infrastructure wireless network, without user intervention. As used herein, an “ad hoc wireless network” is a network where two (or more) wireless-capable devices, such as the earphone and a data source, communicate directly and wirelessly, without using an access point. An “infrastructure wireless network,” on the other hand, is a wireless network that uses one or more access points to allow a wireless-capable device, such as the wireless earphone, to connect to a computer network, such as a LAN or WAN (including the Internet).

FIGS. 1A and 1B show example configurations for a wireless earphone 10 according to various embodiments of the present invention. The examples shown in FIGS. 1A and 1B are not limiting and other configurations are within the scope of the present invention. As shown in FIGS. 1A and 1B, the earphone 10 may comprise a body 12. The body 12 may comprise an ear canal portion 14 that is inserted in the ear canal of the user of the earphone 10. In various embodiments, the body 12 also may comprise an exterior portion 15 that is not inserted into user’s ear canal. The exterior portion 15 may comprise a knob 16 or some other user control (such as a dial, a pressure-activated switch, lever, etc.) for adjusting the shape of the ear canal portion 14. That is, in various embodiments, activation (e.g. rotation) of the knob 16 may cause the ear canal portion 14 to change shape so as to, for example, radially expand to fit snugly against all sides of the user’s ear canal. Further details regarding such a shape-changing earbud earphone are described in application PCT/US08/88656, filed 31 Dec. 2008, entitled “Adjustable Shape Earphone,” which is incorporated herein by reference in its entirety. The earphone 10 also may comprise a transceiver circuit housed within the body 12. The transceiver circuit, described further below, may transmit and receive the wireless signals, including receive streaming audio for playing by the earphone 10. The transceiver circuit may be housed in the exterior portion 15 of the earphone 10 and/or in the ear canal portion 14.

Although the example earphones 10 shown in FIGS. 1A and 1B include a knob 16 for adjusting the shape of the ear canal portion 14, the present invention is not so limited, and in other embodiments, different means besides a knob 16 may be used to adjust the ear canal portion 14. In addition, in other embodiments, the earphone 10 may not comprise a shape-changing ear canal portion 14.

In various embodiments, the user may wear two discrete wireless earphones 10: one in each ear. In such embodiments, each earphone 10 may comprise a transceiver circuit. In such embodiments, the earphones 10 may be connected by a string or some other cord-type connector to keep the earphones 10 from being separated.

In other embodiments, as shown in FIG. 1C, a headband 19 may connect the two (left and right) earphones 10. The headband 19 may be an over-the-head band, as shown in the example of FIG. 1C, or the headband may be a behind-the-head band. In embodiments comprising a headband 19, each earphone 10 may comprise a transceiver circuit; hence, each earphone 10 may receive and transmit separately the wireless communication signals. In other embodiments comprising a headband 19, only one earphone 10 may comprise the transceiver circuit, and a wire may run along the headband 19 to the other earphone 10 to connect thereby the transceiver circuit to the acoustic transducer in the earphone that does not comprise the transceiver circuit. The embodiment shown in FIG. 1C comprises on-ear earphones 10; in other embodiments, in-ear or over-ear earphones may be used.

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In other embodiments, the earphone 10 may comprise a hanger bar 17 that allows the earphone 10 to clip to, or hang on, the user’s ear, as shown in the illustrated embodiment of FIGS. 1D-1E. FIG. 1D is a perspective view of the earphone and FIG. 1E is a side view according to one embodiment. As shown in the illustrated embodiment, the earphone 10 may comprise dual speaker elements 106-A, 106-B. One of the speaker elements (the smaller one) 106-A is sized to fit into the cavum concha of the listener’s ear and the other element (the larger one) 106-B is not. The listener may use the hanger bar to position the earphone on the listener’s ear. In that connection, the hanger bar may comprise a horizontal section that rests upon the upper external curvature of the listener’s ear behind the upper portion of the auricula (or pinna). The earphone may comprise a knurled knob that allows the user to adjust finely the distance between the horizontal section of the hanger bar and the speaker elements, thereby providing, in such embodiments, another measure of adjustability for the user. More details regarding such a dual element, adjustable earphone may be found in U.S. provisional patent application Ser. No. 61/054,238, which is incorporated herein by reference in its entirety.

FIGS. 2A-2D illustrate various communication modes for a wireless data communication system involving the earphone 10 according to embodiments of the present invention. As shown in FIG. 2A, the system comprises a data source 20 in communication with the earphone 10 via an ad hoc wireless network 24. The earphone 10, via its transceiver circuit (described in more detail below), may communicate wirelessly with a data source 20, which may comprise a wireless network adapter 22 for transmitting the digital audio wirelessly. For example, the data source 20 may be a digital audio player (DAP), such as an mp3 player or an iPod, or any other suitable digital audio playing device, such as a laptop or personal computer, that stores and/or plays digital audio files. In other embodiments, the data source 20 may generate analog audio, and the wireless network adapter 22 may encode the analog audio into digital format for transmission to the earphone 10.

The wireless network adapter 22 may be an integral part of the data source 20, or it may be a separate device that is connected to the data source 20 to provide wireless connectivity for the data source 20. For example, the wireless network adapter 22 may comprise a wireless network interface card (WNIC) or other suitable transceiver that plugs into a USB port or other port or jack of the data source 20 (such as a TRS connector) to stream data, e.g., digital audio files, via a wireless network (e.g., the ad hoc wireless network 24 or an infrastructure wireless network). The digital audio transmitted from the data source 20 to the earphone 10 via the wireless networks may comprise compressed or uncompressed audio. Any suitable file format may be used for the audio, including mp3, lossy or lossless WMA, Vorbis, Musepack, FLAC, WAV, AIFF, AU, or any other suitable file format.

When in range, the data source 20 may communicate with the earphone 10 via the ad hoc wireless network 24 using any suitable wireless communication protocol, including Wi-Fi (e.g., IEEE 802.11a/b/g/n), WiMAX (IEEE 802.16), Bluetooth, Zigbee, UWB, or any other suitable wireless communication protocol. For purposes of the description to follow, it is assumed that the data source 20 and the earphone 10 communicate using a Wi-Fi protocol, although the invention is not so limited and other wireless communication protocols may be used in other embodiments of the invention. The data source 20 and the earphone 10 are considered in range for the ad hoc wireless network 24 when the signal

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strengths (e.g., the RSSI) of the signals received by the two devices are above a threshold minimum signal strength level. For example, the data source **20** and the earphone **10** are likely to be in range for an ad hoc wireless network when then are in close proximity, such as when the wearer of the earphone **10** has the data source **20** on his/her person, such as in a pocket, strapped to their waist or arm, or holding the data source in their hand.

When the earphone **10** and the data source **20** are out of range for the ad hoc wireless network **24**, that is, when the received signals degrade below the threshold minimum signal strength level, both the earphone **10** and the data source **20** may transition automatically to communicate over an infrastructure wireless network (such as a wireless LAN (WLAN)) **30** that is in the range of both the earphone **10** and the data source **20**, as shown in FIG. 2B. The earphone **10** and the data source **20** (e.g., the wireless network adapter **22**) may include firmware, as described further below, that cause the components to make the transition to a common infrastructure wireless network **30** automatically and seamlessly, e.g., without user intervention. The earphone **10** may cache the received audio in a buffer or memory for a time period before playing the audio. The cached audio may be played after the connection over the ad hoc wireless network is lost to give the earphone **10** and the data source **20** time to connect via the infrastructure wireless network.

For example, as shown in FIG. 2B, the infrastructure network may comprise an access point **32** that is in the range of both the data source **20** and the earphone **10**. The access point **32** may be an electronic hardware device that acts as a wireless access point for, and that is connected to, a wired and/or wireless data communication network **33**, such as a LAN or WAN, for example. The data source **20** and the earphone **10** may both communicate wirelessly with the access point **32** using the appropriate network data protocol (a Wi-Fi protocol, for example). The data source **20** and the earphone **10** may both transition automatically to an agreed-upon WLAN **30** that is in the range of both devices when they cannot communicate satisfactorily via the ad hoc wireless network **24**. A procedure for specifying an agreed-upon infrastructure wireless network **30** is described further below. Alternatively, the infrastructure wireless network **30** may have multiple access points **32a-b**, as shown in FIG. 2C. In such an embodiment, the data source **20** may communicate wirelessly with one access point **32b** and the earphone **10** may communicate wirelessly with another access point **32a** of the same infrastructure wireless network **30**. Again, the data source **20** and the earphone **10** may transition to an agreed-upon WLAN.

If there is no suitable common infrastructure wireless network over which the earphone **10** and the data source **20** can communicate, as shown in FIG. 2D, the earphone **10** may transition to communicate with an access point **32a** for an available (first) wireless network (e.g., WLAN) **30a** that is in the range of the earphone **10**. In this mode, the earphone **10** may connect via the wireless network **30a** to a network-enabled host server **40**. The host server **40** may be connected to the wireless network **30a** via an electronic data communication network **42**, such as the Internet. In one mode, the host server **40** may transmit streaming digital audio via the networks **33a**, **42** to the earphone **10**. In another mode, the host server **40** may transmit to the earphone **10** a network address, such as an Internet Protocol (IP) address, for a streaming digital audio content server **70** on the network **42**. Using the received IP address, the earphone **10** may connect to the streaming digital audio content server **70** via the

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networks **30a**, **42** to receive and process digital audio from the streaming digital audio content server **70**.

The digital audio content server **70** may be, for example, an Internet radio station server. The digital audio content server **70** may stream digital audio over the network **42** (e.g., the Internet), which the earphone **10** may receive and process. In one embodiment, the streaming digital audio content server **70** may stream digital audio received by the streaming digital audio content server **70** from the data source **20**. For example, where the data source **20** is a wireless-capable device, such as a portable DAP, the data source **20** may connect to the streaming digital audio content server **70** via a wireless network **30b** and the network **42**. Alternatively, where for example the data source **20** is non-wireless-capable device, such as a PC, the data source **20** may have a direct wired connection to the network **42**. After being authenticated by the streaming digital audio content server **70**, the data source **20** may stream digital audio to the streaming digital audio content server **70**, which may broadcast the received digital audio over the network **42** (e.g., the Internet). In such a manner, the user of the earphone **10** may listen to audio from the data source **20** even when (i) the earphone **10** and the data source **20** are not in communication via an ad hoc wireless network **24** and (ii) the earphone **10** and the data source **20** are not in communication via a common local infrastructure wireless network **30**.

FIG. 3 is a block diagram of the earphone **10** according to various embodiments of the present invention. In the illustrated embodiment, the earphone **10** comprises a transceiver circuit **100** and related peripheral components. As shown in FIG. 3, the peripheral components of the earphone **10** may comprise a power source **102**, a microphone **104**, one or more acoustic transducers **106** (e.g., speakers), and an antenna **108**. The transceiver circuit **100** and some of the peripheral components (such as the power source **102** and the acoustic transducers **106**) may be housed within the body **12** of the earphone **10** (see FIG. 1). Other peripheral components, such as the microphone **104** and the antenna **108** may be external to the body **12** of the earphone **10**. In addition, some of the peripheral components, such as the microphone **104**, are optional in various embodiments.

In various embodiments, the transceiver circuit **100** may be implemented as a single integrated circuit (IC), such as a system-on-chip (SoC), which is conducive to miniaturizing the components of the earphone **10**, which is advantageous if the earphone **10** is to be relatively small in size, such as an in-ear earphone (see FIGS. 1A-1B for example). In alternative embodiments, however, the components of the transceiver circuit **100** could be realized with two or more discrete ICs or other components, such as separate ICs for the processors, memory, and RF (e.g., Wi-Fi) module, for example.

The power source **102** may comprise, for example, a rechargeable or non-rechargeable battery (or batteries). In other embodiments, the power source **102** may comprise one or more ultracapacitors (sometimes referred to as supercapacitors) that are charged by a primary power source. In embodiments where the power source **102** comprises a rechargeable battery cell or an ultracapacitor, the battery cell or ultracapacitor, as the case may be, may be charged for use, for example, when the earphone **10** is connected to a docking station or computer. The docking station may be connected to or part of a computer device, such as a laptop computer or PC. In addition to charging the rechargeable power source **102**, the docking station and/or computer may facilitate downloading of data to and/or from the earphone

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10. In other embodiments, the power source 102 may comprise capacitors passively charged with RF radiation, such as described in U.S. Pat. No. 7,027,311. The power source 102 may be coupled to a power source control module 103 of transceiver circuit 100 that controls and monitors the power source 102.

The acoustic transducer(s) 106 may be the speaker element(s) for conveying the sound to the user of the earphone 10. According to various embodiments, the earphone 10 may comprise one or more acoustic transducers 106. For embodiments having more than one transducer, one transducer may be larger than the other transducer, and a crossover circuit (not shown) may transmit the higher frequencies to the smaller transducer and may transmit the lower frequencies to the larger transducer. More details regarding dual element earphones are provided in U.S. Pat. No. 5,333,206, assigned to Koss Corporation, which is incorporated herein by reference in its entirety.

The antenna 108 may receive and transmit the wireless signals from and to the wireless networks 24, 30. A RF (e.g., Wi-Fi) module 110 of the transceiver circuit 100 in communication with the antenna 108 may, among other things, modulate and demodulate the signals transmitted from and received by the antenna 108. The RF module 110 communicates with a baseband processor 112, which performs other functions necessary for the earphone 10 to communicate using the Wi-Fi (or other communication) protocol.

The baseband processor 112 may be in communication with a processor unit 114, which may comprise a microprocessor 116 and a digital signal processor (DSP) 118. The microprocessor 116 may control the various components of the transceiver circuit 100. The DSP 114 may, for example, perform various sound quality enhancements to the digital audio received by the baseband processor 112, including noise cancellation and sound equalization. The processor unit 114 may be in communication with a volatile memory unit 120 and a non-volatile memory unit 122. A memory management unit 124 may control the processor unit's access to the memory units 120, 122. The volatile memory 122 may comprise, for example, a random access memory (RAM) circuit. The non-volatile memory unit 122 may comprise a read only memory (ROM) and/or flash memory circuits. The memory units 120, 122 may store firmware that is executed by the processor unit 114. Execution of the firmware by the processor unit 114 may provide various functionality for the earphone 10, such as the automatic transition between wireless networks as described herein. The memory units 120, 122 may also cache received digital audio.

A digital-to-analog converter (DAC) 125 may convert the digital audio from the processor unit 114 to analog form for coupling to the acoustic transducer(s) 106. An I²S interface 126 or other suitable serial or parallel bus interface may provide the interface between the processor unit 114 and the DAC 125. An analog-to-digital converter (ADC) 128, which also communicates with the I²S interface 126, may convert analog audio signals picked up by the microphone 104 for processing by the processor unit 114.

The transceiver circuit 100 also may comprise a USB or other suitable interface 130 that allows the earphone 10 to be connected to an external device via a USB cable or other suitable link. As shown in FIG. 4A, the external device may be a docking station 200 connected to a computer device 202. Also, in various embodiments, the earphone 10 could be connected directly to the computer 202 without the docking station 200. In addition, the external device may be a DAP 210, as shown in FIG. 4B. In that way, the earphone

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10 could connect directly to a data source 20, such as the DAP 210 or the computer 202, through the USB port 130. In addition, through the USB port 130, the earphone 10 may connect to a PC 202 or docking station 202 to charge up the power source 102 and/or to get downloads (e.g., data or firmware).

According to various embodiments, the earphone 10 may have an associated web page that a user may access through the host server 40 (see FIG. 2D) or some other server. An authenticated user could log onto the website from a client computing device 50 (e.g., laptop, PC, handheld computer device, etc., including the data source 20) (see FIG. 2D) to access the web page for the earphone 10 to set various profile values for the earphone 10. For example, at the web site, the user could set various content features and filters, as well as adjust various sound control features, such as treble, bass, frequency settings, noise cancellation settings, etc. In addition, the user could set preferred streaming audio stations, such as preferred Internet radio stations or other streaming audio broadcasts. That way, instead of listening to streaming audio from the data source 20, the user could listen to Internet radio stations or other streaming audio broadcasts received by the earphone 10. In such an operating mode, the earphone user, via the web site, may prioritize a number of Internet radio stations or other broadcast sources (hosted by streaming digital audio content servers 70). With reference to FIG. 7, the host server 40 may send the IP address for the earphone user's desired (e.g., highest priority) Internet radio station to the earphone 10. A button 11 on the earphone 10, such as on the rotating dial 16 as shown in the examples of FIGS. 1A and 1B, may allow the user to cycle through the preset preferred Internet radio stations. That is, for example, when the user presses the button 11, an electronic communication may be transmitted to the host server 40 via the wireless network 30, and in response to receiving the communication, the host server 40 may send the IP address for the user's next highest rated Internet radio station via the network 42 to the earphone 10. The earphone 10 may then connect to the streaming digital audio content server 70 for that Internet radio station using the IP address provided by the host server 40. This process may be repeated, e.g., cycled through, for each preset Internet radio station configured by the user of the earphone 10.

At the web site for the earphone 10 hosted on the host server 40, in addition to establishing the identification of digital audio sources (e.g., IDs for the user's DAP or PC) and earphones, the user could set parental or other user controls. For example, the user could restrict certain Internet radio broadcasts based on content or parental ratings, etc. That is, for example, the user could configure a setting through the web site that prevents the host server 40 from sending an IP address for a streaming digital audio content server 70 that broadcasts explicit content based on a rating for the content. In addition, if a number of different earphones 10 are registered to the same user, the user could define separate controls for the different earphones 10 (as well as customize any other preferences or settings particular to the earphones 10, including Internet radio stations, sound quality settings, etc. that would later be downloaded to the earphones 10). In addition, in modes where the host server 40 streams audio to the earphone 10, the host server 40 may log the files or content streamed to the various earphones 10, and the user could view at the web site the files or content that were played by the earphones 10. In that way, the user could monitor the files played by the earphones 10.

In addition, the host server **40** may provide a so-called eavesdropping function according to various embodiments. The eavesdropping service could be activated via the web site. When the service is activated, the host server **40** may transmit the content that it is delivering to a first earphone **10a** to another, second earphone **10b**, as shown in FIG. **8**. Alternatively, the host server **40** may transmit to the second earphone **10b** the most recent IP address for a streaming digital audio content server **70** that was sent to the first earphone **10a**. The second earphone **10b** may then connect to the streaming digital audio content server **70** that the first earphone **10a** is currently connected. That way, the user of the second earphone **10b**, which may be a parent, for example, may directly monitor the content being received by the first earphone **10a**, which may belong to a child of the parent.

This function also could be present in the earphones **10** themselves, allowing a parent (or other user) to join an ad-hoc wireless network and listen to what their child (or other listener) is hearing. For example, with reference to FIG. **10**, a first earphone **10a** may receive wireless audio, such as from the data source **20** or some other source, such as the host server **40**. The first earphone **10a** may be programmed with firmware to broadcast the received audio to a second earphone **10b** via an ad hoc wireless network **24**. That way, the wearer of the second earphone **10b** can monitor in real-time the content being played by the first earphone **10a**.

At the web site, the user may also specify the identification number ("ID") of their earphone(s) **10**, and the host server **40** may translate the ID to the current internet protocol (IP) addresses for the earphone **10** and for the data source **20**. This allows the user to find his or her data source **20** even when it is behind a firewall or on a changing IP address. That way, the host server **40** can match the audio from the data source **20** to the appropriate earphone **10** based on the specified device ID. The user also could specify a number of different data sources **20**. For example, the user's DAP may have one specified IP address and the user's home (or work) computer may have another specified IP address. Via the web site hosted by the host server **40**, the user could specify or prioritize from which source (e.g., the user's DAP or computer) the earphone **10** is to receive content.

The host server **40** (or some other server) may also push firmware upgrades and/or data updates to the earphone **10** using the IP addresses of the earphone **10** via the networks **30**, **42**. In addition, a user could download the firmware upgrades and/or data updates from the host server **40** to the client computing device **202** (see FIG. **4A**) via the Internet, and then download the firmware upgrades and/or data updates to the earphone **10** when the earphone **10** is connected to the client computer device **202** (such as through a USB port and/or the docking station **200**).

Whether the downloads are transmitted wirelessly to the earphone **10** or via the client computing device **202** may depend on the current data rate of the earphone **10** and the quantity of data to be transmitted to the earphone **10**. For example, according to various embodiments, as shown in the process flow of FIG. **5**, the host server **40** may be programmed, at step **50**, to make a determination, based on the current data rate for the earphone **10** and the size of the update, whether the update should be pushed to the earphone **10** wirelessly (e.g., via the WLAN **30a** in FIG. **2D**). If the update is too large and/or the current data rate is too low that the performance of the earphone **10** will be adversely affected, the host server **40** may refrain from pushing the update to the earphone **10** wirelessly and wait instead to

download the update to the client computing device **202** at step **51**. Conversely, if the host server **40** determines that, given the size of the update and the current data rate for the earphone **10** that the performance of the earphone **10** will not be adversely affected, the host server **40** may transmit the update wirelessly to the earphone **10** at step **52**.

As mentioned above, the processor unit **114** of the speakerphones **14** may be programmed, via firmware stored in the memory **120**, **122**, to have the ability to transition automatically from the ad hoc wireless network **24** to an infrastructure wireless network **30** (such as a WLAN) when the quality of the signal on the ad hoc wireless network **24** degrades below a suitable threshold (such as when the data source **20** is out of range for an ad hoc wireless network). In that case, the earphone **10** and the data source **20** may connect to a common infrastructure wireless network (e.g., WLAN) (see, for example, FIGS. **2B-2C**). Through the web site for the earphone **10**, described above, the user could specify a priority of infrastructure wireless networks **30** for the data source **20** and the earphone **10** to connect to when the ad hoc wireless network **24** is not available. For example, the user could specify a WLAN servicing his/her residence first, a WLAN servicing his/her place of employment second, etc. During the time that the earphone **10** and the data source **20** are connected via the ad hoc wireless network **24**, the earphone **10** and the data source **20** may exchange data regarding which infrastructure networks are in range. When the earphone **10** and the data source **20** are no longer in range for the ad hoc wireless network **24** (that is, for example, the signals between the device degrade below an acceptable level), they may both transition automatically to the highest prioritized infrastructure wireless network whose signal strength is above a certain threshold level. That way, even though the earphone **10** and the data source **20** are out of range for the ad hoc wireless network **24**, the earphone **10** may still receive the streaming audio from the data source **20** via the infrastructure wireless network **30** (see FIGS. **2B-2C**).

When none of the preferred infrastructure networks is in range, the earphone **10** may connect automatically to the host server **40** via an available infrastructure wireless network **30** (see FIG. **2D**), e.g., the infrastructure wireless network **30** having the highest RSSI and to which the earphone **10** is authenticated to use. The host server **40**, as mentioned above, may transmit IP addresses to the earphone **10** for streaming digital audio content servers **70** or the host sever **40** may stream digital audio to the earphone **10** itself when in this communication mode.

FIG. **6** is a diagram of the process flow, according to one embodiment, implemented by the transceiver circuit **100** of the earphone **10**. The process shown in FIG. **6** may be implemented in part by the processor unit **114** executing firmware stored in a memory unit **120**, **122** of the transceiver circuit **100**. At step **61**, the earphone **10** may determine if it can communicate with the data source **20** via an ad hoc wireless network **24**. That is, the earphone **10** may determine if the strength of the wireless signals from the data source **20** exceed some minimum threshold. If so, the data source **20** and the earphone **10** may communicate wirelessly via the ad hoc wireless network **24** (see FIG. **2A**). While in this communication mode, at step **62**, the data source **20** and the earphone **10** also may exchange data regarding the local infrastructure wireless networks, if any, in the range of the data source **20** and the earphone **10**, respectively. For example, the earphone **10** may transmit the ID of local infrastructure wireless networks **30** that the earphone **10** can detect whose signal strength (e.g., RSSI) exceeds some

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minimum threshold level. Similarly, the data source **20** may transmit the ID the local infrastructure wireless networks **30** that the data source **20** can detect whose signal strength (e.g., RSSI) exceeds some minimum threshold level. The earphone **10** may save this data in a memory unit **120**, **122**. Similarly, the data source **20** may store in memory the wireless networks that the earphone **10** is detected.

The data source **20** and the earphone **10** may continue to communicate via the ad hoc wireless network mode **24** until they are out of range (e.g., the signal strengths degrade below a minimum threshold level). If an ad hoc wireless network **24** is not available at block **61**, the transceiver circuit **100** and the data source **20** may execute a process, shown at block **63**, to connect to the user's highest prioritized infrastructure wireless network **30**. For example, of the infrastructure wireless networks whose signal strength exceeded the minimum threshold for both the earphone **10** and the data source **20** determined at step **62**, the earphone **10** and the data source **20** may both transition to the infrastructure wireless network **30** having the highest priority, as previously set by the user (see FIGS. **2B-2C**, for example). For example, if the user's highest prioritized infrastructure wireless network **30** is not available, but the user's second highest prioritized infrastructure wireless network **30** is, the earphone **10** and the data source **20** may both transition automatically to the user's second highest prioritized infrastructure wireless network **30** at block **64**. As shown by the loop with block **65**, the earphone **10** and the data source **20** may continue to communicate via one of the user's prioritized infrastructure wireless networks **30** as long as the infrastructure wireless network **30** is available. If the infrastructure wireless network becomes unavailable, the process may return to block **61**.

If, however, no ad hoc wireless network and none of the user's prioritized infrastructure wireless networks are available, the earphone **10** may transition automatically to connect to the host server **40** at block **66** (see FIG. **2D**) using an available infrastructure wireless network **30**. At block **67**, the host server **40** may transmit an IP address to the earphone **10** for one of the streaming digital audio content servers **70**, and at block **68** the earphone **10** may connect to the streaming digital audio content server **70** using the received IP address. At step **69**, as long as the earphone **10** is connected to the streaming digital audio content server **70**, the earphone **10** may continue to communicate in this mode. However, if the earphone **10** loses its connection to the digital audio content server **70**, the process may return to block **61** in one embodiment. As mentioned above, at block **67**, instead of sending an IP address for a streaming digital audio content server **70**, the host server **40** may stream digital audio to the earphone **10**. The user, when configuring their earphone **10** preferences via the web site, may specify and/or prioritize whether the host server **40** is to send IP addresses for the streaming digital audio content servers **70** and/or whether the host server **40** is to stream audio to the earphone **10** itself.

In another embodiment, the earphone **10** may be programmed to transition automatically to the host server **40** when the earphone **10** and the data source **20** are not in communication via the ad hoc wireless network **24**. That is, in such an embodiment, the earphone **10** may not try to connect via a local infrastructure wireless network **30** with the data source **20**, but instead transition automatically to connect to the host server **40** (see FIG. **2D**).

In various embodiments, as shown in FIG. **1B**, the button **11** or other user selection device that allows the wearer of the earphone **10** to indicate approval and/or disapproval of

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songs or other audio files listened to by the wearer over an Internet radio station. The approval/disapproval rating, along with metadata for the song received by the earphone **10** with the streaming audio, may be transmitted from the transceiver circuit **100** of the earphone **10** back to the host server **40**, which may log the songs played as well as the ratings for the various songs/audio files. In addition to being able to view the logs at the website, the host server **40** (or some other server) may send an email or other electronic communication to the earphone user, at a user specified email address or other address, which the user might access from their client communication device **50** (see FIG. **2D**). The email or other electronic communication may contain a listing of the song/audio files for which the user gave approval ratings using the button **11** or other user selection device. Further, the email or other electronic communication may provide a URL link for a URL at which the user could download song/audio files that the user rated (presumably song/audio files for which the user gave an approval rating). In some instances, the user may be required to pay a fee to download the song/audio file.

The user song ratings also may be used by the host server **40** to determine the user's musical preferences and offer new music that the user might enjoy. More details about generating user play lists based on song ratings may be found in published U.S. patent applications Pub. No. 2006/0212444, Pub. No. 2006/0206487, and Pub. No. 2006/0212442, and U.S. Pat. No. 7,003,515, which are incorporated herein by reference in their entirety.

In addition or alternatively, the user could log onto a web site hosted by the host server **40** (or some other server) to view the approval/disapproval ratings that the user made via the button **11** on the earphone **10**. The web site may provide the user with the option of downloading the rated songs/audio files (for the host server **40** or some other server system) to their client computer device **50**. The user could then have their earphone **10** connect to their client computer device **50** as a data source **20** via an ad hoc wireless network **24** (see FIG. **2A**) or via an infrastructure wireless network (see FIGS. **2B-2D**) to listen to the downloaded songs. In addition, the user could download the song files from their client computer device **50** to their DAP and listen to the downloaded song files from their DAP by using their DAP as the data source **20** in a similar manner.

Another application of the headsets may be in vehicles equipped with Wi-Fi or other wireless network connectivity. Published PCT application WO 2007/136620, which is incorporated herein by reference, discloses a wireless router for providing a Wi-Fi or other local wireless network for a vehicle, such as a car, truck, boat, bus, etc. In a vehicle having a Wi-Fi or other local wireless network, the audio for other media systems in the vehicle could be broadcast over the vehicle's wireless network. For example, if the vehicle comprises a DVD player, the audio from the DVD system could be transmitted to the router and broadcast over the vehicle's network. Similarly, the audio from terrestrial radio stations, a CD player, or an audio cassette player could be broadcast over the vehicle's local wireless network. The vehicle's passengers, equipped with the earphones **10**, could cycle through the various audio broadcasts (including the broadcasts from the vehicle's media system as well as broadcasts from the host server **40**, for example) using a selection button **11** on the earphone **10**. The vehicle may also be equipped with a console or terminal, etc., through which a passenger could mute all of the broadcasts for direct voice communications, for example.

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As described above, the earphones **10** may also include a microphone **104**, as shown in the example of FIG. **9**. The headset **90** shown in FIG. **9** includes two earphones **10**, both of which may include a transceiver circuit **100** or only one of which may include the transceiver circuit, as discussed above. The microphone **104** could be used to broadcast communications from one earphone wearer to another earphone wearer. For example, one wearer could activate the microphone by pressing a button **92** on the headset **90**. The headset **90** may then transmit a communication via an ad hoc wireless network **24** or other wireless network to a nearby recipient (or recipients) equipped with a headset **90** with a transceiver circuit **100** in one or both of the earphones **10**. When such communication is detected by the recipient's headset **90**, the streaming audio received over the wireless network by the recipient's headset **90** may be muted, and the intercom channel may be routed to the transducer(s) of the recipient's headset **90** for playing for the recipient. This functionality may be valuable and useful where multiple wearers of the headsets **90** are in close proximity, such as on motorcycles, for example.

Another exemplary use of the earphones **10** is in a factory, warehouse, construction site, or other environment that might be noisy. Persons (e.g., workers) in the environment could use the earphones **10** for protection from the surrounding noise of the environment. From a console or terminal, a person (e.g., a supervisor) could select a particular recipient for a communication over the Wi-Fi network (or other local wireless network). The console or terminal may have buttons, dials, or switches, etc., for each user/recipient, or it could have one button or dial through which the sender could cycle through the possible recipients. In addition, the console or terminal could have a graphical user interface, through which the sender may select the desired recipient(s).

As mentioned above, the earphones **10** may comprise a USB port. In one embodiment, as shown in FIG. **11**, the user may use an adapter **150** that connects to the USB port of each earphone **10**. The adapter **150** may also have a plug connector **152**, such as a 3.5 mm jack, which allows the user to connect the adapter **150** to devices having a corresponding port for the connector **152**. When the earphones **10** detect a connection via their USB interfaces in such a manner, the Wi-Fi (or other wireless protocol) components may shut down or go into sleep mode, and the earphones **10** will route standard headphone level analog signals to the transducer(s) **106**. This may be convenient in environments where wireless communications are not permitted, such as airplanes, but where there is a convenient source of audio contact. For example, the adapter **150** could plug into a person's DAP. The DSP **118** of the earphone **10** may still be operational in such a non-wireless mode to provide noise cancellation and any applicable equalization.

The examples presented herein are intended to illustrate potential and specific implementations of the embodiments. It can be appreciated that the examples are intended primarily for purposes of illustration for those skilled in the art. No particular aspect of the examples is/are intended to limit the scope of the described embodiments.

According to various embodiments, therefore, the present invention is directed to an earphone **10** that comprises a body **12**, where the body **12** comprises: (i) at least one acoustic transducer **106** for converting an electrical signal to sound; (ii) an antenna **108**; and (iii) a transceiver circuit **100** in communication with the at least one acoustic transducer **106** and the antenna **108**. The transceiver circuit **100** is for receiving and transmitting wireless signals via the antenna **108**, and the transceiver circuit **100** is for outputting the

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electrical signal to the at least one acoustic transducer **106**. The wireless transceiver circuit also comprises firmware, which when executed by the transceiver circuit, causes the transceiver circuit to: (i) receive digital audio wirelessly from a data source **20** via an ad hoc wireless network **24** when the data source **20** is in wireless communication range with the earphone **10** via the ad hoc wireless network **24**; and (ii) when the data source **20** is not in wireless communication range with the earphone **10** via the ad hoc wireless network **24**, transition automatically to receive digital audio via an infrastructure wireless network **30**.

According to various implementations, the data source may comprise a portable digital audio player, such as an MP3 player, iPod, or laptop computer, or a nonportable digital audio player, such as a personal computer. In addition, the transceiver circuit **100** may comprise: (i) a wireless communication module **110** (such as a Wi-Fi or other wireless communication protocol module); (ii) a processor unit **114** in communication with the wireless communication module **110**; (iii) a non-volatile memory unit **122** in communication with the processor unit **114**; and (iv) a volatile memory **120** unit in communication with the processor unit **114**. The infrastructure wireless network may comprise a WLAN. The transceiver circuit **100** may receive digital audio from the data source **20** via the infrastructure wireless network **30** when the data source **20** is not in wireless communication range with the earphone **10** via the ad hoc wireless network **24**. The transceiver circuit firmware, when executed by the transceiver circuit **100**, may cause the transceiver circuit **100** of the earphone **10** to transition automatically to a pre-set infrastructure wireless network **30** that the data source **20** transitions to when the data source **20** is not in wireless communication range with the earphone **10** via the ad hoc wireless network **24** and when the pre-set infrastructure wireless network **30** is in range of both the earphone **10** and the data source **20**. In addition, the transceiver circuit firmware, when executed by the transceiver circuit **100**, may cause the transceiver circuit **100** of the earphone **10** to transmit data via the ad hoc wireless network **24** to the data source **20** regarding one or more infrastructure wireless networks **30** detected by the transceiver circuit **100** when the earphone **10** and the data source **20** are communicating via the ad hoc wireless network **24**.

In addition, the transceiver circuit firmware, when executed by the transceiver circuit **100**, may cause the transceiver circuit **100** of the earphone **10** to connect to a host server **40** via an available infrastructure wireless network **30** when the data source **20** is not in wireless communication range with the earphone **10** via the ad hoc wireless network **24**. The earphone **10** may receive streaming digital audio from the host server **40** via the infrastructure wireless network **30**. In addition, the earphone **10** may receive a first network address for a first streaming digital audio content server **70** from the host server **40** via the infrastructure wireless network **30**. In addition, the earphone **10** may comprise a user control, such as button **11**, dial, pressure switch, or other type of user control, that, when activated, causes the earphone **10** to transmit an electronic request via the infrastructure wireless network **30** to the host server **40** for a second network address for a second streaming digital audio content server **70**.

In other embodiments, the present invention is directed to a system that comprises: (i) a data source **20** for wirelessly transmitting streaming digital audio; and (ii) a wireless earphone **10** that is in wireless communication with the data source **20**. In yet other embodiments, the present invention is directed to a communication system that comprises: (i) a

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host server **40**; (ii) a first streaming digital audio content server **70** that is connected to the host server **40** via a data network **42**; and (iii) a wireless earphone **10** that is in communication with the host server **40** via a wireless network **30**. The host server **40** is programmed to transmit to the earphone **10** a first network address for the first streaming digital audio content server **70** on the data network **42**. The host server **40** and the streaming digital audio content server(s) **70** each may comprise one or more processor circuits and one or more memory circuits (e.g., ROM circuits and/or RAM circuits).

In yet another embodiment, the present invention is directed to a headset that comprises: (i) a first earphone **10a** that comprises one or more acoustic transducers **10b** for converting a first electrical signal to sound; and (ii) a second earphone **10b**, connected to the first earphone **10a**, wherein the second earphone **10b** comprises one or more acoustic transducers **10b** for converting a second electrical signal to sound. In one embodiment, the first earphone **10a** comprises: (i) a first antenna **108**; and (ii) a first transceiver circuit **100** in communication with the one or more acoustic transducers **106** of the first earphone **10a** and in communication with the first antenna **108**. The first transceiver circuit **100** is for receiving and transmitting wireless signals via the first antenna **108**, and for outputting the first electrical signal to the one or more acoustic transducers **10b** of the first earphone **10a**. The first transceiver circuit **100** also may comprise firmware, which when executed by the first transceiver circuit **100**, causes the first transceiver circuit **100** to: (i) receive digital audio wirelessly from a data source **20** via an ad hoc wireless network **24** when the data source **20** is in wireless communication range with the first earphone **10a** via the ad hoc wireless network **24**; and (ii) when the data source **20** is not in wireless communication range with the first earphone **10a** via the ad hoc wireless network **24**, transition automatically to receive digital audio via an infrastructure wireless network **30**.

In various implementations, the headset further may comprise a head band **19** that is connected to the first and second earphones **10**. In addition, the headset **19** further may comprise a microphone **104** having an output connected to the first transceiver circuit **100**. In one embodiment, the first transceiver circuit **100** is for outputting the second electrical signal to the one or more acoustic transducers **106** of the second earphone **10b**. In another embodiment, the second earphone **10b** comprises: (i) a second antenna **108**; and (ii) a second transceiver circuit **100** in communication with the one or more acoustic transducers **106** of the second earphone **10b** and in communication with the second antenna **108**. The second transceiver circuit **100** is for receiving and transmitting wireless signals via the second antenna **108**, and for outputting the second electrical signal to the one or more acoustic transducers **106** of the second earphone **10b**. The second transceiver circuit **100** may comprise firmware, which when executed by the second transceiver circuit **100**, causes the second transceiver circuit **100** to: (i) receive digital audio wirelessly from the data source **20** via the ad hoc wireless network **24** when the data source **20** is in wireless communication range with the second earphone **10b** via the ad hoc wireless network **24**; and (ii) when the data source **20** is not in wireless communication range with the second earphone **10b** via the ad hoc wireless network **24**, transition automatically to receive digital audio via the infrastructure wireless network **30**.

In addition, according to various embodiments, the first earphone **10a** may comprise a first data port and the second earphone **10b** may comprise a second data port. In addition,

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the headset may further comprise an adapter or dongle **150** connected to the first data port of the first earphone **10a** and to the second data port of the second earphone **10b**, wherein the adapter **150** comprises an output plug connector **152** for connecting to a remote device.

In addition, according to other embodiments, the present invention is directed to a method that comprises the steps of: (i) receiving, by a wireless earphone, via an ad hoc wireless network, digital audio from a data source when the data source is in wireless communication with the earphone via the ad hoc wireless network; (ii) converting, by the wireless earphone, the digital audio to sound; and (iii) when the data source is not in wireless communication with the earphone, transitioning automatically, by the earphone, to receive digital audio via an infrastructure wireless network.

In various implementations, the step of transitioning automatically by the earphone to receive digital audio via an infrastructure wireless network may comprise transitioning automatically to receive digital audio from the data source via an infrastructure wireless network when the data source is not in wireless communication range with the earphone via the ad hoc wireless network. In addition, the method may further comprise the step of receiving by the wireless earphone from the data source via the ad hoc wireless network data regarding one or more infrastructure wireless networks detected by data source when the earphone and the data source are communicating via the ad hoc wireless network.

In addition, the step of transitioning automatically by the earphone to receive digital audio via an infrastructure wireless network may comprise transitioning automatically to receive digital audio from a host sever via the infrastructure wireless network when the data source is not in wireless communication range with the earphone via the ad hoc wireless network. Additionally, the step of transitioning automatically by the earphone to receive digital audio via an infrastructure wireless network may comprise: (i) receiving, by the wireless earphone via the infrastructure wireless network, from a host server connected to the infrastructure wireless network, a network address for a streaming digital audio content server; and (ii) connecting, by the wireless earphone, to the streaming digital audio content server using the network address received from the host server.

It is to be understood that the figures and descriptions of the embodiments have been simplified to illustrate elements that are relevant for a clear understanding of the embodiments, while eliminating, for purposes of clarity, other elements. For example, certain operating system details for the various computer-related devices and systems are not described herein. Those of ordinary skill in the art will recognize, however, that these and other elements may be desirable in a typical processor or computer system. Because such elements are well known in the art and because they do not facilitate a better understanding of the embodiments, a discussion of such elements is not provided herein.

In general, it will be apparent to one of ordinary skill in the art that at least some of the embodiments described herein may be implemented in many different embodiments of software, firmware and/or hardware. The software and firmware code may be executed by a processor or any other similar computing device. The software code or specialized control hardware that may be used to implement embodiments is not limiting. For example, embodiments described herein may be implemented in computer software using any suitable computer software language type. Such software may be stored on any type of suitable computer-readable medium or media, such as, for example, a magnetic or

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optical storage medium. The operation and behavior of the embodiments may be described without specific reference to specific software code or specialized hardware components. The absence of such specific references is feasible, because it is clearly understood that artisans of ordinary skill would

5 be able to design software and control hardware to implement the embodiments based on the present description with no more than reasonable effort and without undue experimentation.

Moreover, the processes associated with the present embodiments may be executed by programmable equipment, such as computers or computer systems and/or processors. Software that may cause programmable equipment to execute processes may be stored in any storage device, such as, for example, a computer system (nonvolatile) memory, an optical disk, magnetic tape, or magnetic disk. Furthermore, at least some of the processes may be programmed when the computer system is manufactured or stored on various types of computer-readable media.

A “computer,” “computer system,” “host,” “host server,” “server,” or “processor” may be, for example and without limitation, a processor, microcomputer, minicomputer, server, mainframe, laptop, personal data assistant (PDA), wireless e-mail device, cellular phone, pager, processor, fax machine, scanner, or any other programmable device configured to transmit and/or receive data over a network. Such components may comprise: one or more processor circuits; and one or more memory circuits, including ROM circuits and RAM circuits. Computer systems and computer-based devices disclosed herein may include memory for storing certain software applications used in obtaining, processing, and communicating information. It can be appreciated that such memory may be internal or external with respect to operation of the disclosed embodiments. The memory may also include any means for storing software, including a hard disk, an optical disk, floppy disk, ROM (read only memory), RAM (random access memory), PROM (programmable ROM), EEPROM (electrically erasable PROM) and/or other computer-readable media.

In various embodiments disclosed herein, a single component may be replaced by multiple components and multiple components may be replaced by a single component to perform a given function or functions. Except where such substitution would not be operative, such substitution is within the intended scope of the embodiments. Any servers described herein, such as the host server 40, for example, may be replaced by a “server farm” or other grouping of networked servers (such as server blades) that are located and configured for cooperative functions. It can be appreciated that a server farm may serve to distribute workload between/among individual components of the farm and may expedite computing processes by harnessing the collective and cooperative power of multiple servers. Such server farms may employ load-balancing software that accomplishes tasks such as, for example, tracking demand for processing power from different machines, prioritizing and scheduling tasks based on network demand and/or providing backup contingency in the event of component failure or reduction in operability.

While various embodiments have been described herein, it should be apparent that various modifications, alterations, and adaptations to those embodiments may occur to persons skilled in the art with attainment of at least some of the advantages. The disclosed embodiments are therefore intended to include all such modifications, alterations, and adaptations without departing from the scope of the embodiments as set forth herein.

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What is claimed is:

1. A wireless headphone assembly comprising:
 - first and second earphones, wherein each of the first and second earphones comprises an acoustic transducer;
 - an antenna for receiving wireless signals;
 - a wireless communication circuit connected to the antenna, wherein the wireless communication circuit is for receiving and transmitting wireless signals to and from the wireless headphone assembly;
 - a processor in communication with the wireless communication circuit; and
 - a rechargeable battery for powering the wireless headphone assembly,
 wherein the headphone assembly is configured, with the processor, to transition automatically from playing digital audio content received wirelessly by the headphone assembly via a first wireless network to playing digital audio content received wirelessly by the headphone assembly via a second wireless network.
2. The wireless headphone assembly of claim 1, wherein the processor is further configured to, upon activation of a user-control of the headphone assembly, initiate transmission of a request to a remote network server.
3. The wireless headphone assembly of claim 2, wherein:
 - the headphone assembly further comprises a microphone; and
 - the processor is further configured to:
 - process audible utterances by a user of the headphone assembly picked up by the microphone in response to activation of the microphone by the user; and
 - transmit a communication based on the audible utterances via the first or second wireless networks.
4. The wireless headphone assembly of claim 1, wherein:
 - the first earphone comprises a first earbud; and
 - the second earphone comprises a second earbud.
5. The wireless headphone assembly of claim 4, wherein each of the first and second earphones comprises:
 - an antenna;
 - a wireless communication circuit connected to the at least the antenna;
 - a processor in communication with the wireless communication circuit; and
 - a rechargeable battery for powering the wireless headphone assembly.
6. The wireless headphone assembly of claim 1, further comprising a headband connected between the first and second earphones.
7. The wireless headphone assembly of claim 6, wherein the first and second earphones comprise speaker elements housed in on-ear headphones.
8. The wireless headphone assembly of claim 6, wherein the first and second earphones comprise speaker elements housed in over-ear headphones.
9. The wireless headphone assembly of claim 1, wherein each of the first and second earphones comprises:
 - a hanger bar that sits upon an upper external curvature of a user's ear; and
 - a body connected to the hanger bar, wherein the acoustic transducer is connected to the body.
10. The wireless headphone assembly of claim 1, further comprising a docking station to charge the rechargeable battery when the first and second earphones are connected to the docking station.
11. The wireless headphone assembly of claim 1, wherein the processor is configured to transition automatically from playing digital audio content received wirelessly by the headphone assembly via the first wireless network to playing

digital audio content received wirelessly by the headphone assembly via the second wireless network based on a signal strength level for the second wireless network.

12. The wireless headphone assembly of claim 11, wherein the processor is configured to transition automatically from playing digital audio content received wirelessly by the headphone assembly via the first wireless network to playing digital audio content received wirelessly by the headphone assembly via the second wireless network based on whether the signal strength level for the second wireless network is above a threshold level.

13. The wireless headphone assembly of claim 1, wherein the processor is further configured to receive firmware updates from a remote computer device.

14. The wireless headphone assembly of claim 1, further comprising a memory unit that stores network identifiers for the first and second wireless networks.

* * * * *

EXHIBIT C



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(12) **United States Patent**
Koss et al.

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(54) **SYSTEM WITH WIRELESS EARPHONES**

(71) Applicant: **Koss Corporation**, Milwaukee, WI (US)

(72) Inventors: **Michael J. Koss**, Milwaukee, WI (US); **Michael J. Pelland**, Princeton, WI (US); **Michael Sagan**, Fairfield, CA (US); **Steven R. Reckamp**, Crystal Lake, IL (US); **Gregory J. Hallingstad**, Deforest, WI (US); **Jeffery K. Bovee**, Sterling, IL (US); **Morgan J. Lowery**, Deforest, WI (US)

(73) Assignee: **KOSS CORPORATION**, Milwaukee, WI (US)

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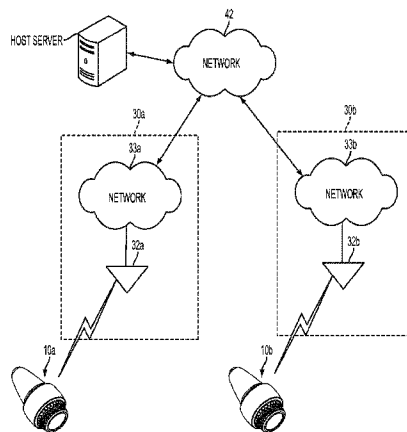
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(57) **ABSTRACT**
 Apparatus comprises adapter and speaker system. Adapter is configured to plug into port of personal digital audio player. Speaker system is in communication with adapter, and comprises multiple acoustic transducers, programmable processor circuit, and wireless communication circuit. In first operational mode, processor circuit receives, via adapter, and processes digital audio content from personal digital audio player into which adapter is plugged, and the multiple acoustic transducers output the received audio content from the personal digital audio player. In second operational mode, wireless communication circuit receives digital audio content from a remote digital audio source over a wireless network, processor circuit processes the digital audio content received from remote digital audio source, and the multiple acoustic transducers output the audio content received from the remote digital audio source.

62 Claims, 16 Drawing Sheets



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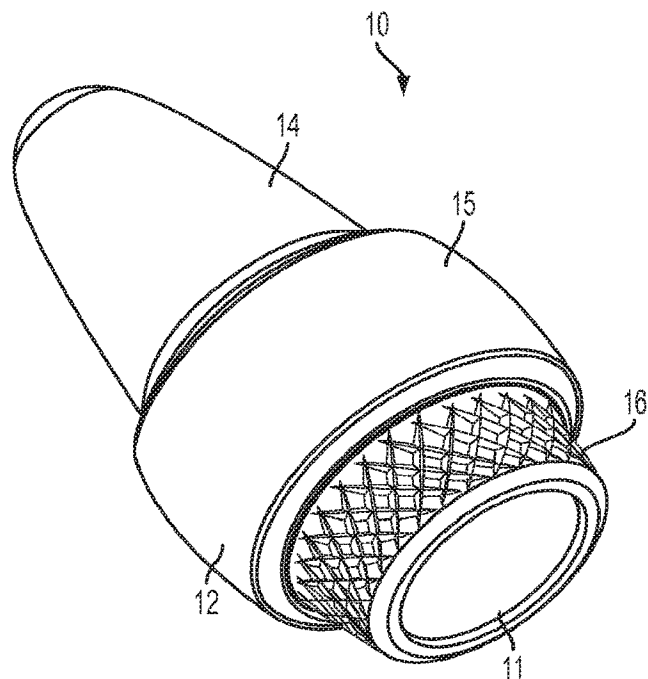


FIG. 1A

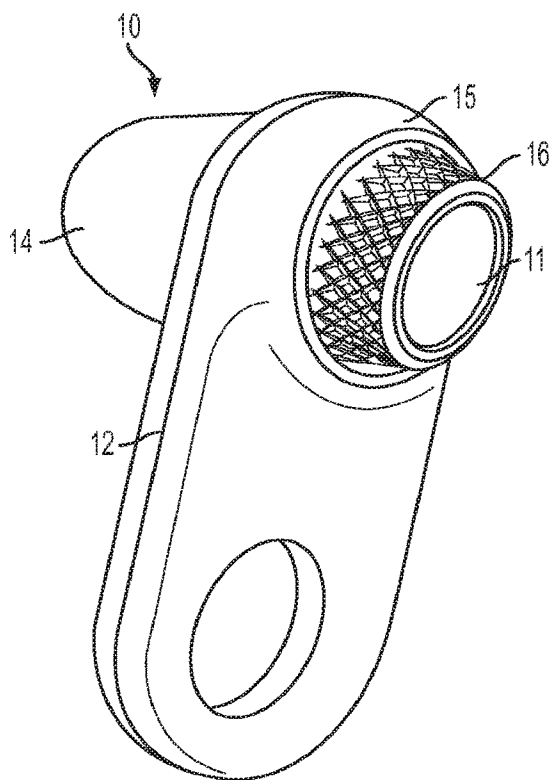


FIG. 1B

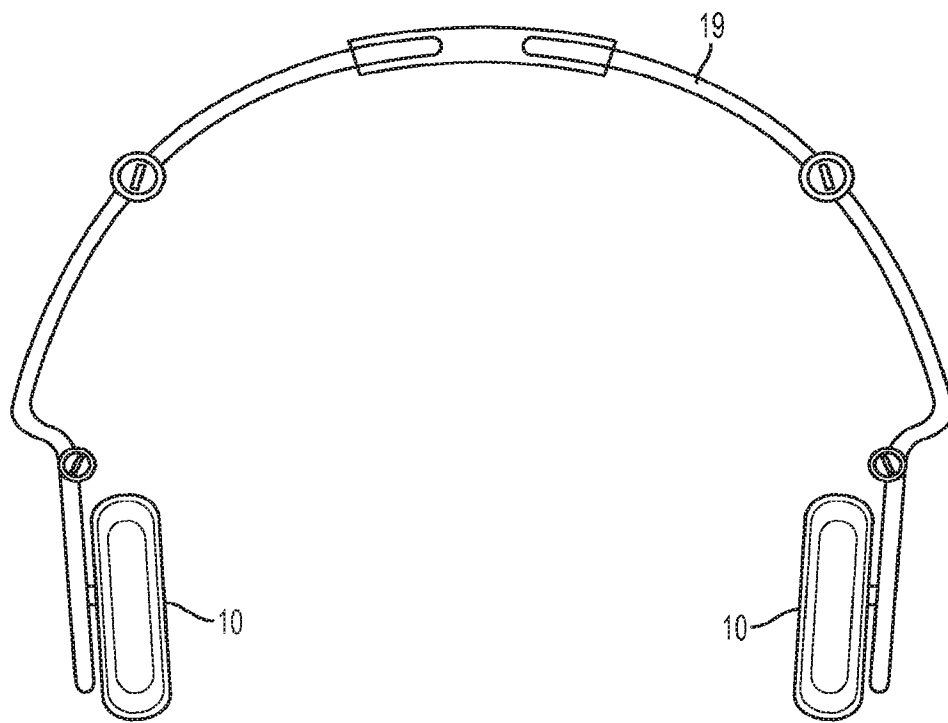


FIG. 1C

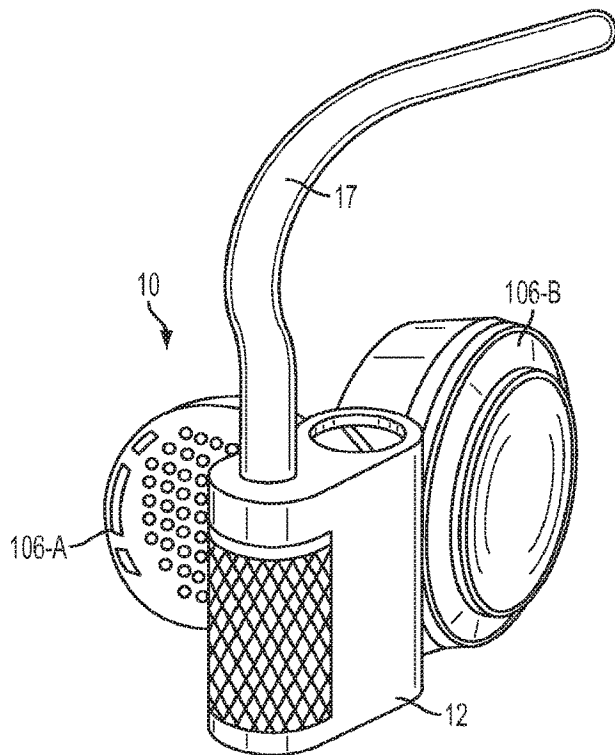


FIG. 1D

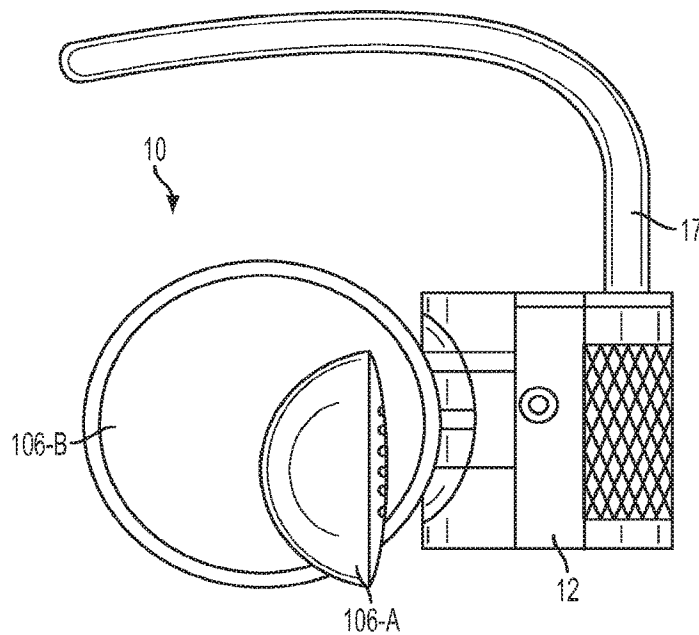


FIG. 1E

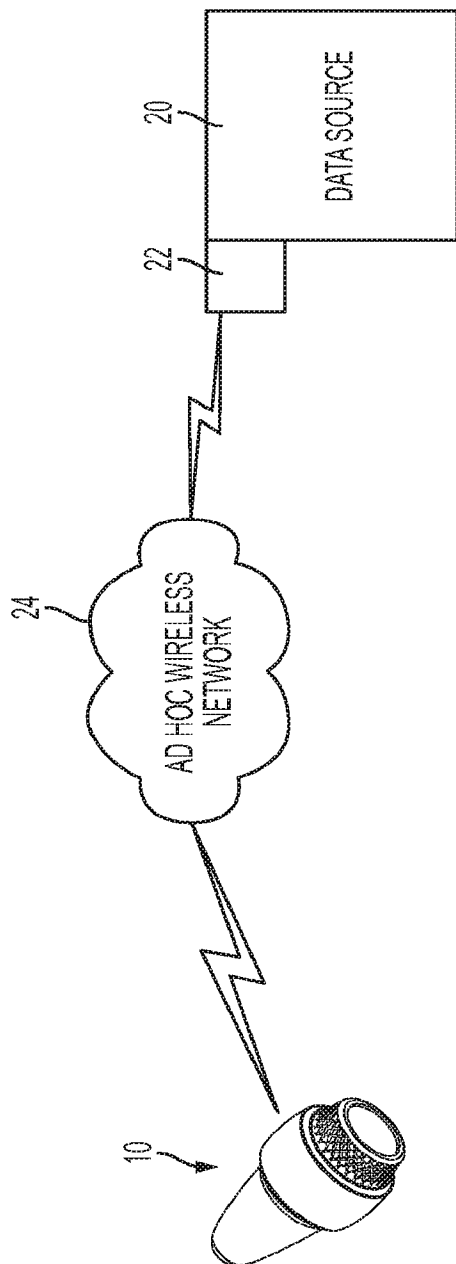


FIG. 2A

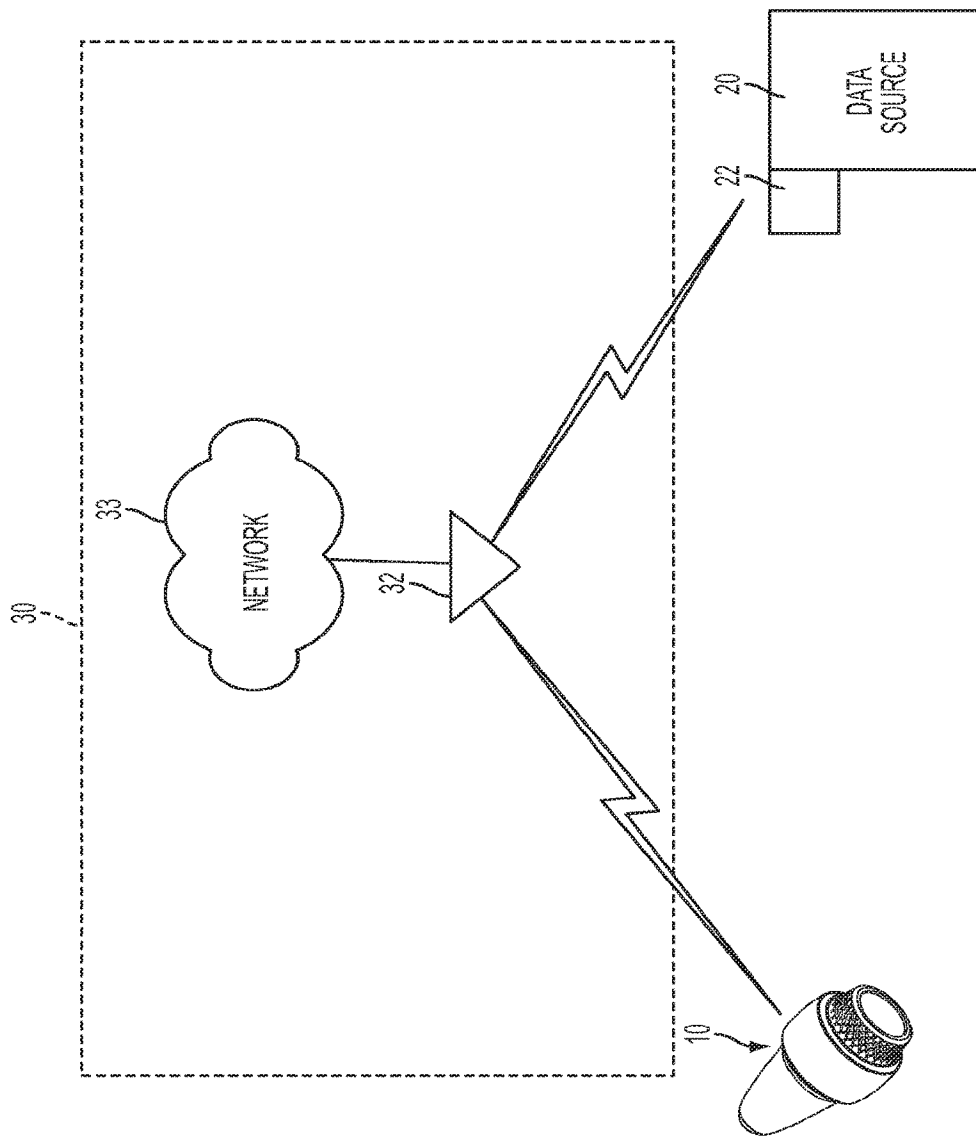


FIG. 2B

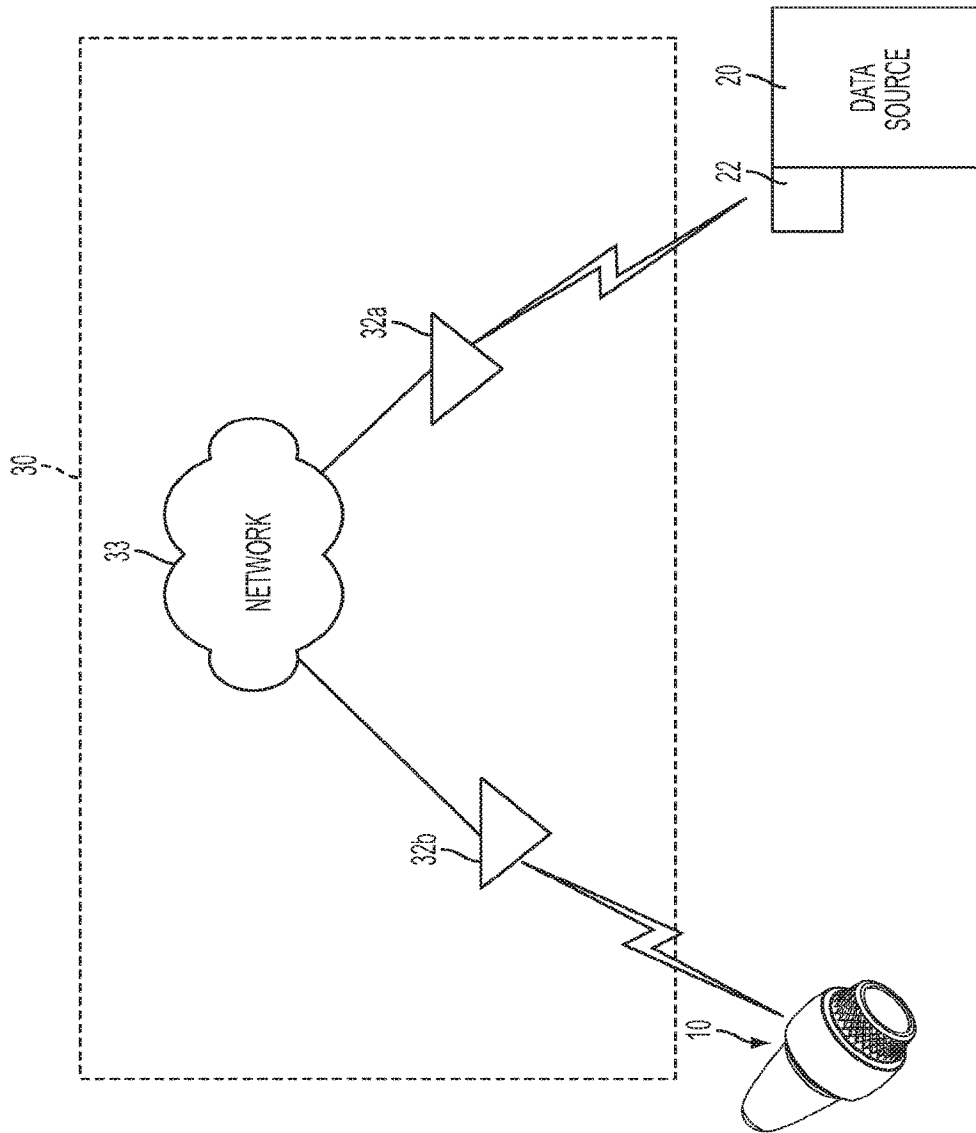


FIG. 2C

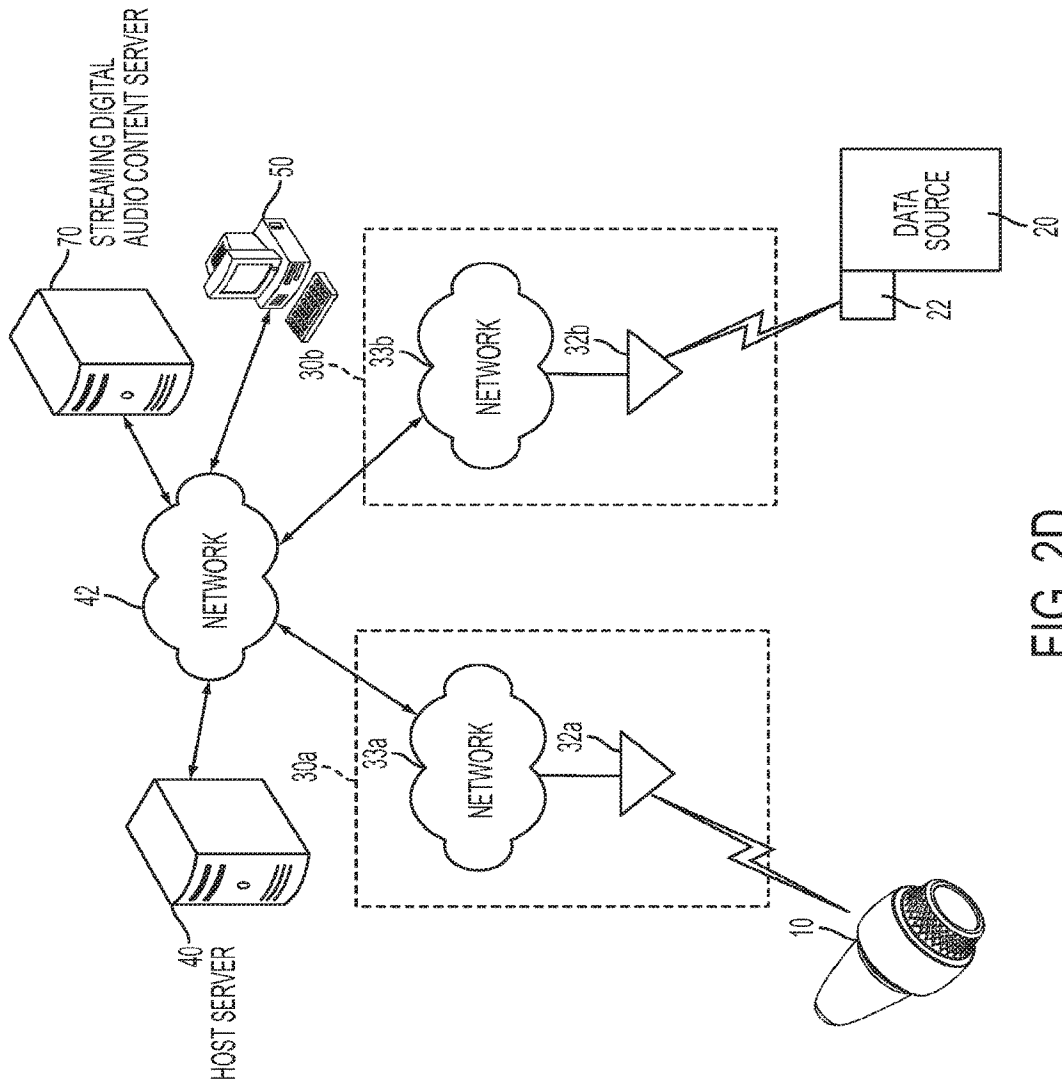


FIG. 2D

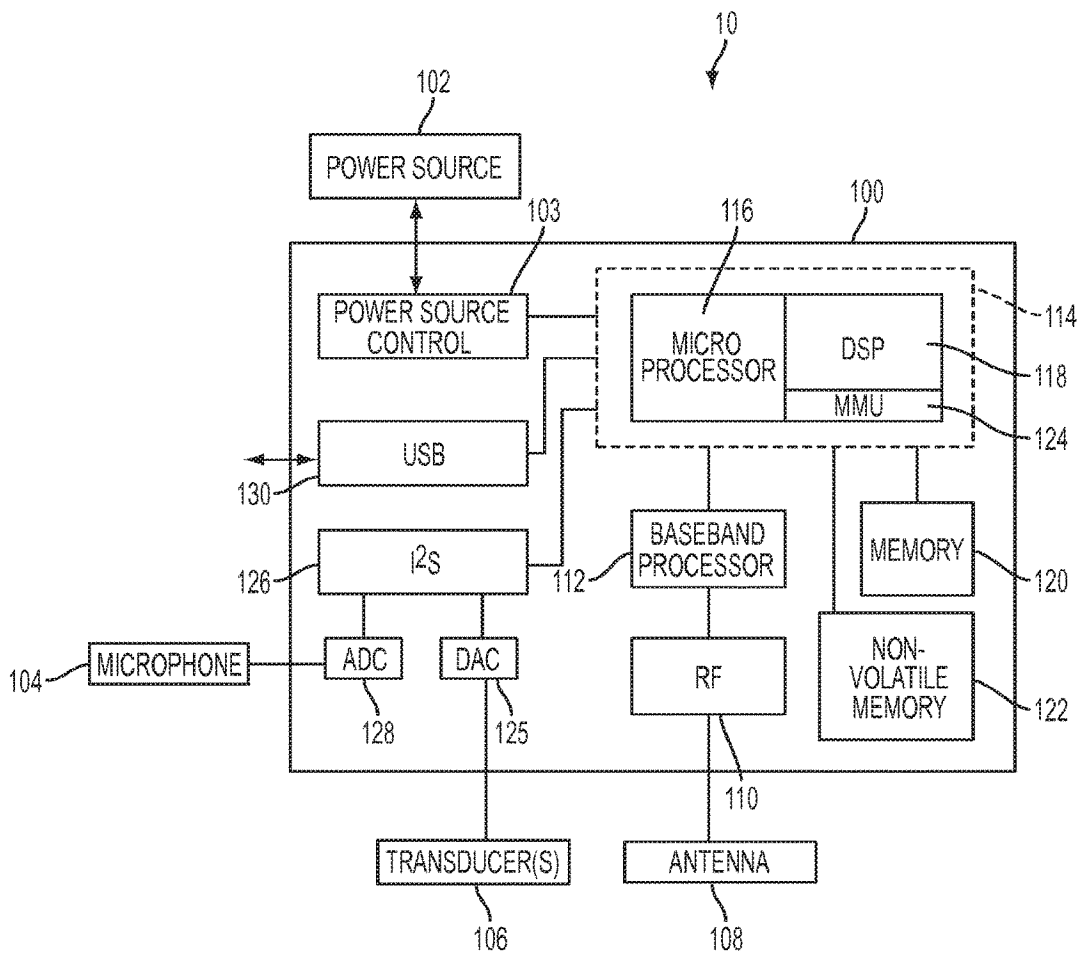


FIG. 3

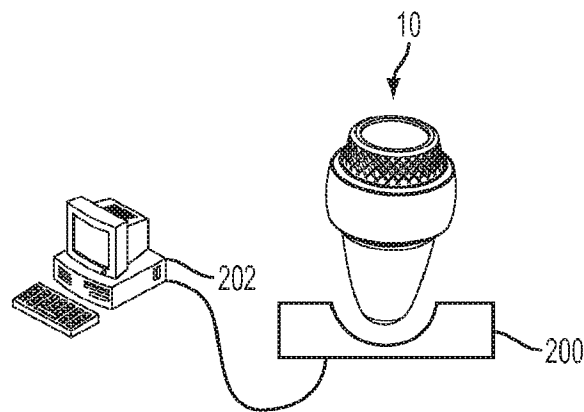


FIG. 4A

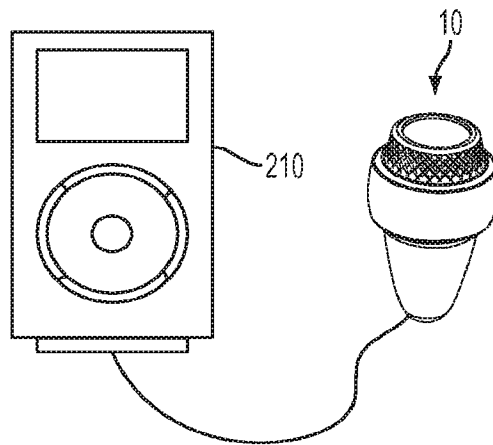


FIG. 4B

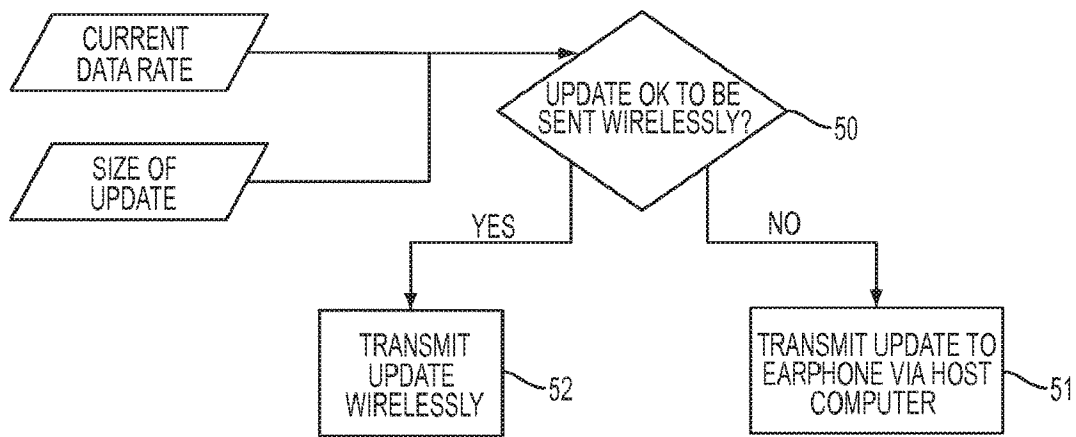


FIG. 5

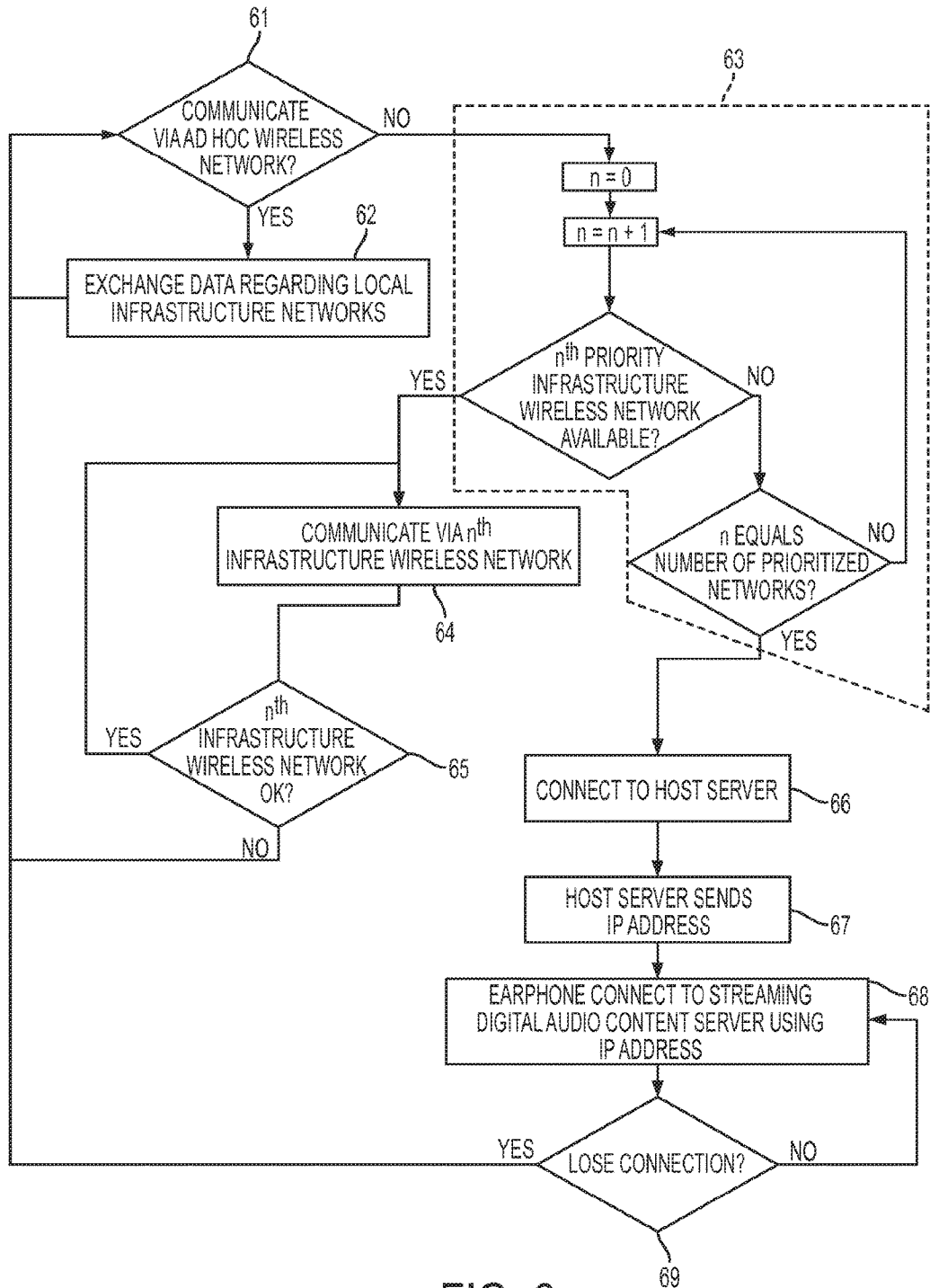


FIG. 6

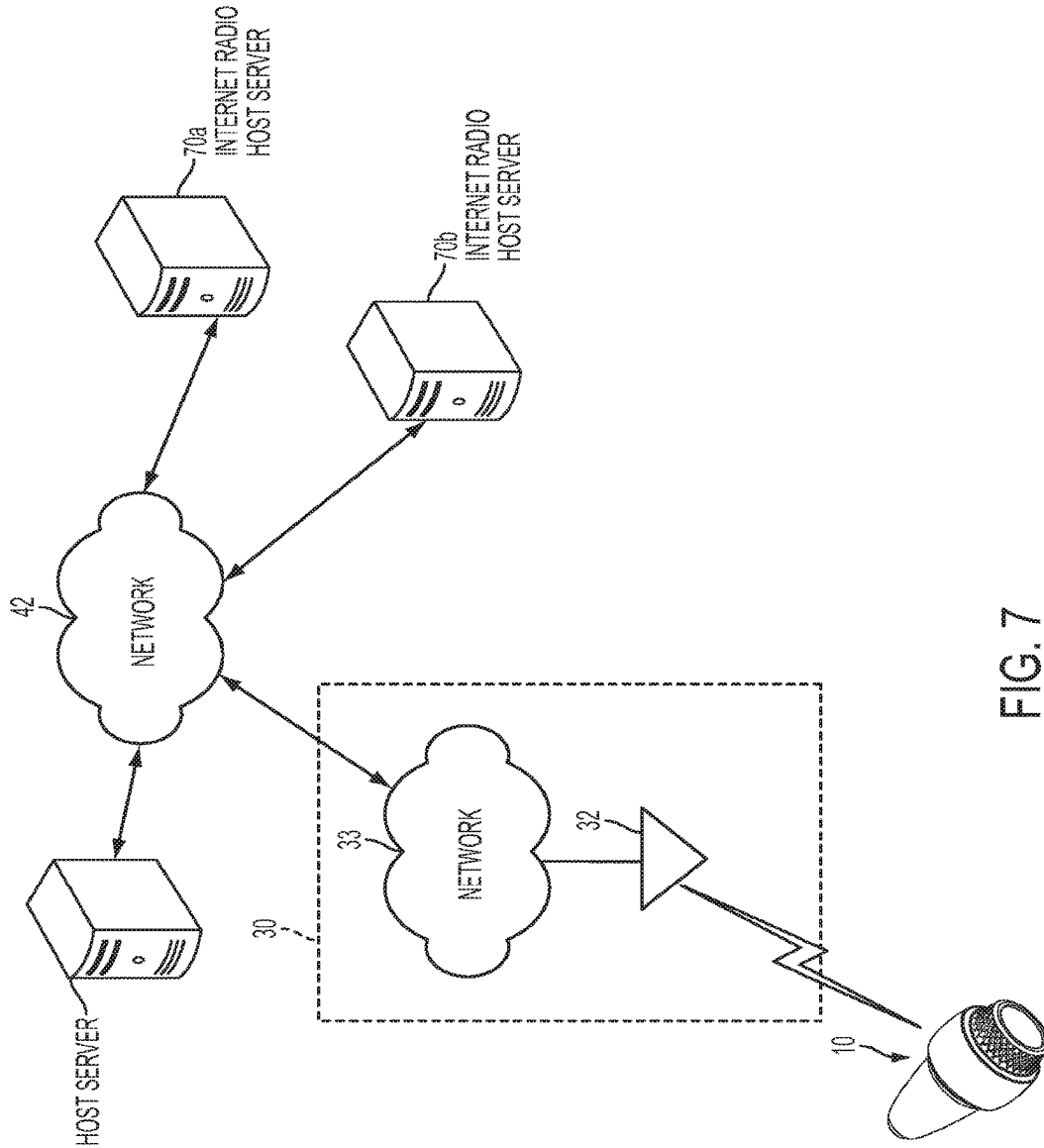


FIG. 7

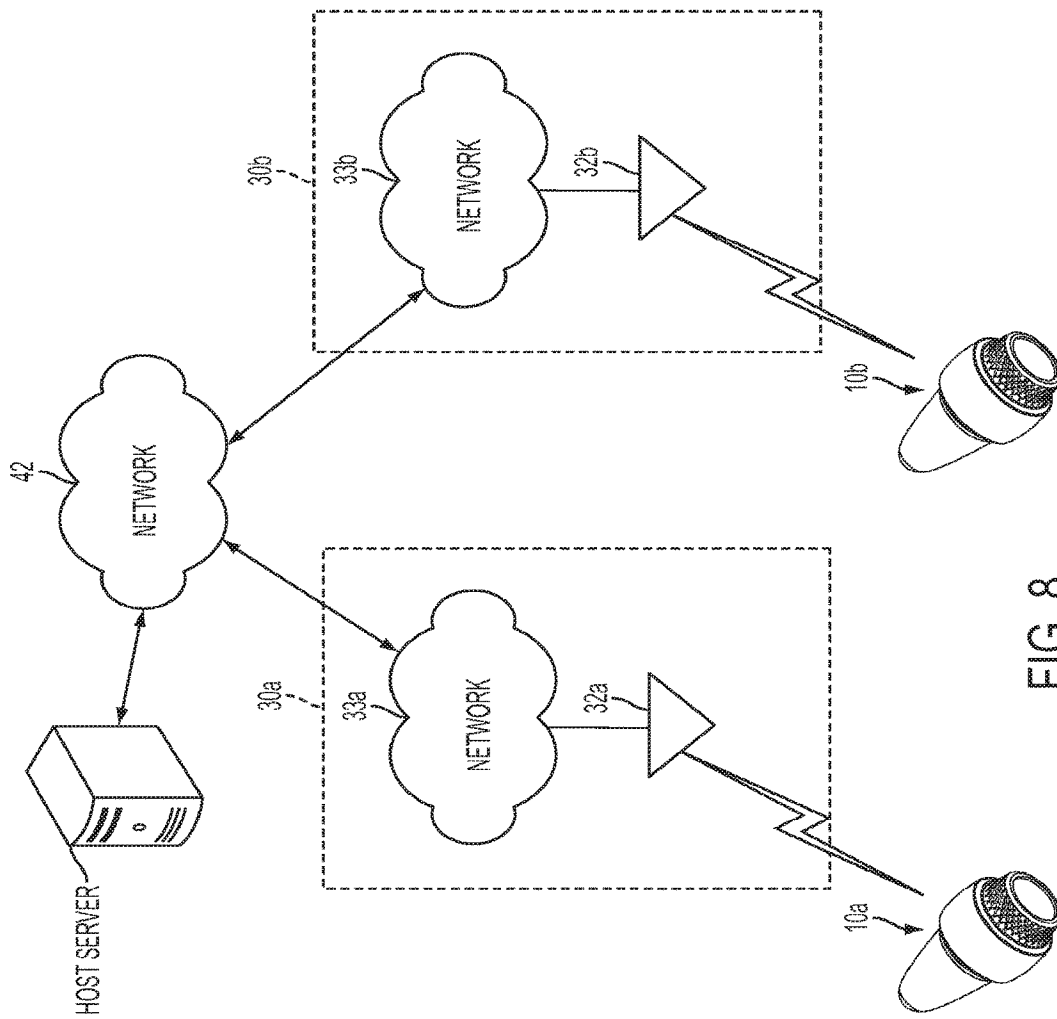


FIG. 8

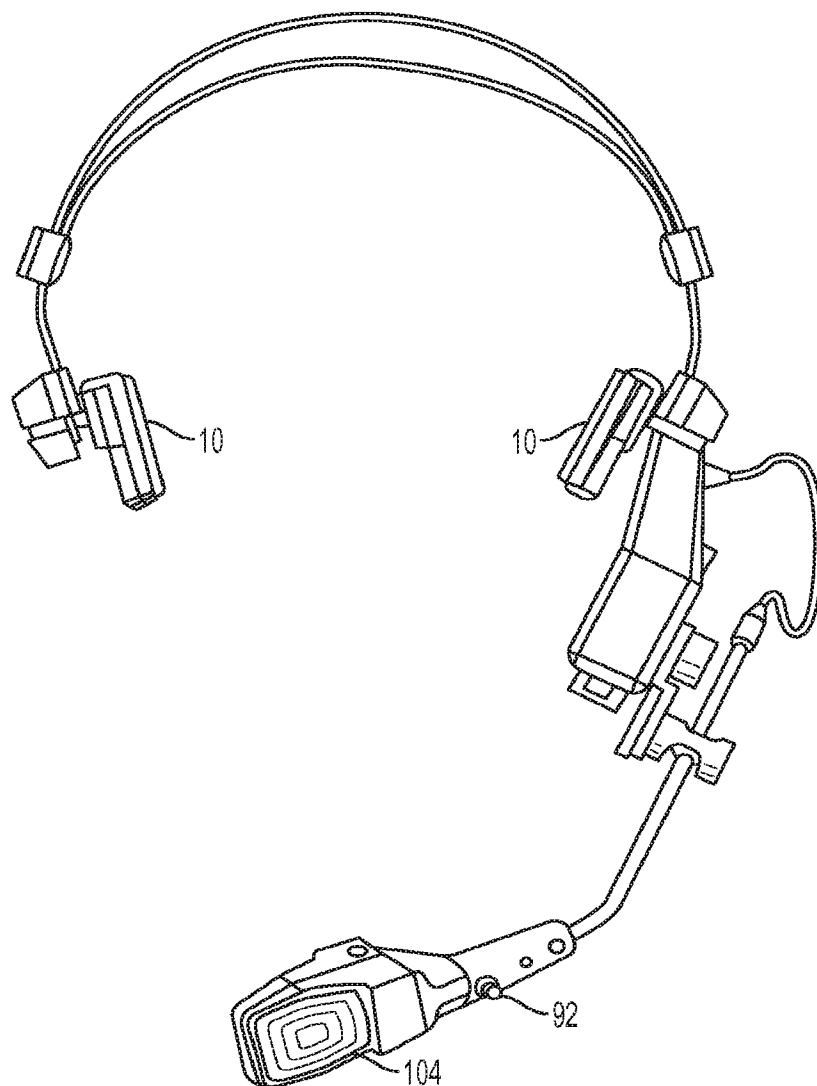


FIG. 9

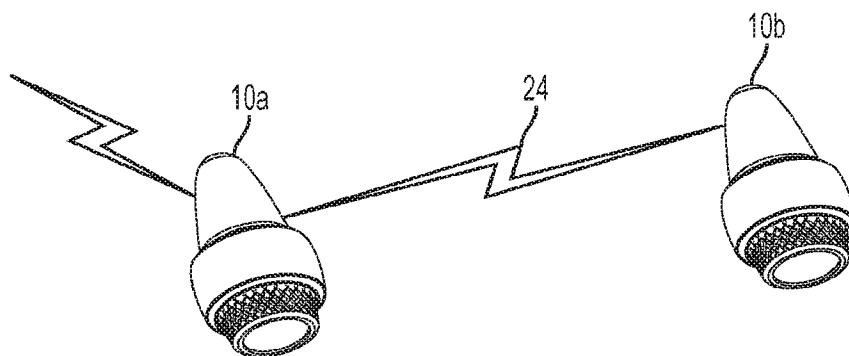


FIG. 10

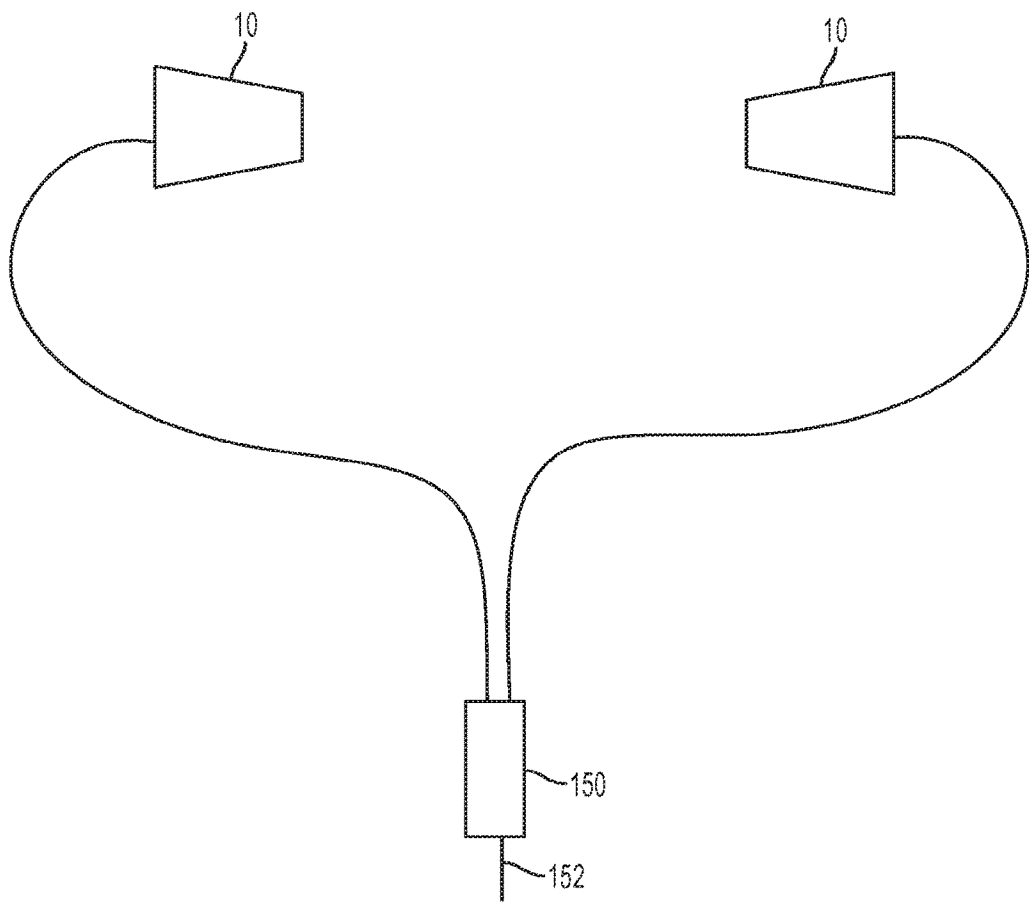


FIG. 11

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SYSTEM WITH WIRELESS EARPHONES**PRIORITY CLAIM**

The present application claims priority as a continuation to U.S. nonprovisional patent application Ser. No. 16/182,927, filed Nov. 7, 2018, which is a continuation of U.S. nonprovisional patent application Ser. No. 15/962,305, filed Apr. 25, 2018, now U.S. Pat. No. 10,206,025, which is a continuation of U.S. nonprovisional patent application Ser. No. 15/650,362, filed Jul. 14, 2017, now U.S. Pat. No. 9,986,325, issued May 29, 2018, which is a continuation of U.S. nonprovisional patent application Ser. No. 15/293,785, filed Oct. 14, 2016, now U.S. Pat. No. 9,729,959, issued Aug. 8, 2017, which is a continuation of U.S. nonprovisional patent application Ser. No. 15/082,040, filed Mar. 28, 2016, now U.S. Pat. No. 9,497,535, issued Nov. 15, 2016, which is a continuation of U.S. nonprovisional patent application Ser. No. 14/695,696, filed Apr. 24, 2015, now U.S. Pat. No. 9,438,987, issued on Sep. 6, 2016, which is a continuation of U.S. nonprovisional patent application Ser. No. 13/609,409, filed Sep. 11, 2012, now U.S. Pat. No. 9,049,502, issued Jun. 2, 2015, which is a continuation of U.S. nonprovisional patent application Ser. No. 13/459,291, filed Apr. 30, 2012, now U.S. Pat. No. 8,571,544, issued Oct. 29, 2013, which is a continuation of U.S. patent application Ser. No. 12/936,488, filed Dec. 20, 2010, now U.S. Pat. No. 8,190,203, issued May 29, 2012, which is a national stage entry of PCT/US2009/039754, filed Apr. 7, 2009, which claims priority to U.S. provisional patent application Ser. No. 61/123,265, filed Apr. 7, 2008, all of which are incorporated herein by reference in their entireties.

CROSS-REFERENCE TO RELATED APPLICATIONS

U.S. nonprovisional patent application Ser. No. 14/031,938, filed Sep. 13, 2013, now U.S. Pat. No. 8,655,420, issued Feb. 18, 2014, is also a continuation of U.S. nonprovisional patent application Ser. No. 13/609,409, filed Sep. 11, 2012, now U.S. Pat. No. 9,049,502, mentioned above.

BACKGROUND

Digital audio players, such as MP3 players and iPods, that store and play digital audio files, are very popular. Such devices typically comprise a data storage unit for storing and playing the digital audio, and a headphone set that connects to the data storage unit, usually with a ¼" or a 3.5 mm jack and associated cord. Often the headphones are in-ear type headphones. The cord, however, between the headphones and the data storage unit can be cumbersome and annoying to users, and the length of the cord limits the physical distance between the data storage unit and the headphones. Accordingly, some cordless headphones have been proposed, such as the Monster iFreePlay cordless headphones from Apple Inc., which include a docking port on one of the earphones that can connect directly to an iPod Shuffle. Because they have the docking port, however, the Monster iFreePlay cordless headphones from Apple are quite large and are not in-ear type phones. Recently, cordless headphones that connect wirelessly via IEEE 802.11 to a WLAN-ready laptop or personal computer (PC) have been proposed, but such headphones are also quite large and not in-ear type phones.

SUMMARY

In one general aspect, the present invention is directed to a wireless earphone that comprises a transceiver circuit for

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receiving streaming audio from a data source, such as a digital audio player or a computer, over an ad hoc wireless network. When the data source and the earphone are out of range via the ad hoc wireless network, they may transition automatically to a common infrastructure wireless network (e.g., a wireless LAN). If there is no common infrastructure wireless network for both the data source and the earphone, the earphone may connect via an available infrastructure wireless network to a host server. The host server may, for example, broadcast streaming audio to the earphone and/or transmit to the earphone a network address (e.g., an Internet Protocol (IP) address) for a network-connected content server that streams digital audio. The earphone may then connect to the content server using the IP address. The content server may be an Internet radio server, including, for example, an Internet radio server that broadcasts streaming audio from the data source or some other content.

These and other advantageous, unique aspects of the wireless earphone are described below.

FIGURES

Various embodiments of the present invention are described herein by way of example in conjunction with the following figures, wherein:

FIGS. 1A-1E are views of a wireless earphone according to various embodiments of the present invention;

FIGS. 2A-2D illustrate various communication modes for a wireless earphone according to various embodiments of the present invention;

FIG. 3 is a block diagram of a wireless earphone according to various embodiments of the present invention;

FIGS. 4A-4B show the wireless earphone connected to another device according to various embodiments of the present invention;

FIG. 5 is a diagram of a process implemented by a host server according to various embodiments of the present invention;

FIG. 6 is a diagram of a process implemented by the wireless earphone to transition automatically between wireless networks according to various embodiments of the present invention;

FIGS. 7, 8 and 10 illustrate communication systems involving the wireless earphone according to various embodiments of the present invention;

FIG. 9 is a diagram of a headset including a wireless earphone and a microphone according to various embodiments of the present invention; and

FIG. 11 is a diagram of a pair of wireless earphones with a dongle according to various embodiments of the present invention.

DESCRIPTION

In one general aspect, the present invention is directed to a wireless earphone that receives streaming audio data via ad hoc wireless networks and infrastructure wireless networks, and that transitions seamlessly between wireless networks. The earphone may comprise one or more in-ear, on-ear, or over-ear speaker elements. Two exemplary in-ear earphone shapes for the wireless earphone 10 are shown in FIGS. 1A and 1B, respectively, although in other embodiments the earphone may take different shapes and the exemplary shapes shown in FIGS. 1A and 1B are not intended to be limiting. In one embodiment, the earphone transitions automatically and seamlessly, without user intervention, between communication modes. That is, the earphone may

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transition automatically from an ad hoc wireless network to an infrastructure wireless network, without user intervention. As used herein, an “ad hoc wireless network” is a network where two (or more) wireless-capable devices, such as the earphone and a data source, communicate directly and wirelessly, without using an access point. An “infrastructure wireless network,” on the other hand, is a wireless network that uses one or more access points to allow a wireless-capable device, such as the wireless earphone, to connect to a computer network, such as a LAN or WAN (including the Internet).

FIGS. 1A and 1B show example configurations for a wireless earphone 10 according to various embodiments of the present invention. The examples shown in FIGS. 1A and 1B are not limiting and other configurations are within the scope of the present invention. As shown in FIGS. 1A and 1B, the earphone 10 may comprise a body 12. The body 12 may comprise an ear canal portion 14 that is inserted in the ear canal of the user of the earphone 10. In various embodiments, the body 12 also may comprise an exterior portion 15 that is not inserted into user’s ear canal. The exterior portion 15 may comprise a knob 16 or some other user control (such as a dial, a pressure-activated switch, lever, etc.) for adjusting the shape of the ear canal portion 14. That is, in various embodiments, activation (e.g. rotation) of the knob 16 may cause the ear canal portion 14 to change shape so as to, for example, radially expand to fit snugly against all sides of the user’s ear canal. Further details regarding such a shape-changing earbud earphone are described in application PCT/US08/88656, filed 31 Dec. 2008, entitled “Adjustable Shape Earphone,” which is incorporated herein by reference in its entirety. The earphone 10 also may comprise a transceiver circuit housed within the body 12. The transceiver circuit, described further below, may transmit and receive the wireless signals, including receive streaming audio for playing by the earphone 10. The transceiver circuit may be housed in the exterior portion 15 of the earphone 10 and/or in the ear canal portion 14.

Although the example earphones 10 shown in FIGS. 1A and 1B include a knob 16 for adjusting the shape of the ear canal portion 14, the present invention is not so limited, and in other embodiments, different means besides a knob 16 may be used to adjust the ear canal portion 14. In addition, in other embodiments, the earphone 10 may not comprise a shape-changing ear canal portion 14.

In various embodiments, the user may wear two discrete wireless earphones 10: one in each ear. In such embodiments, each earphone 10 may comprise a transceiver circuit. In such embodiments, the earphones 10 may be connected by a string or some other cord-type connector to keep the earphones 10 from being separated.

In other embodiments, as shown in FIG. 1C, a headband 19 may connect the two (left and right) earphones 10. The headband 19 may be an over-the-head band, as shown in the example of FIG. 1C, or the headband may be a behind-the-head band. In embodiments comprising a headband 19, each earphone 10 may comprise a transceiver circuit; hence, each earphone 10 may receive and transmit separately the wireless communication signals. In other embodiments comprising a headband 19, only one earphone 10 may comprise the transceiver circuit, and a wire may run along the headband 19 to the other earphone 10 to connect thereby the transceiver circuit to the acoustic transducer in the earphone that does not comprise the transceiver circuit. The embodiment shown in FIG. 1C comprises on-ear earphones 10; in other embodiments, in-ear or over-ear earphones may be used.

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In other embodiments, the earphone 10 may comprise a hanger bar 17 that allows the earphone 10 to clip to, or hang on, the user’s ear, as shown in the illustrated embodiment of FIGS. 1D-1E. FIG. 1D is a perspective view of the earphone and FIG. 1E is a side view according to one embodiment. As shown in the illustrated embodiment, the earphone 10 may comprise dual speaker elements 106-A, 106-B. One of the speaker elements (the smaller one) 106-A is sized to fit into the cavum concha of the listener’s ear and the other element (the larger one) 106-B is not. The listener may use the hanger bar to position the earphone on the listener’s ear. In that connection, the hanger bar may comprise a horizontal section that rests upon the upper external curvature of the listener’s ear behind the upper portion of the auricula (or pinna). The earphone may comprise a knurled knob that allows the user to adjust finely the distance between the horizontal section of the hanger bar and the speaker elements, thereby providing, in such embodiments, another measure of adjustability for the user. More details regarding such a dual element, adjustable earphone may be found in U.S. provisional patent application Ser. No. 61/054,238, which is incorporated herein by reference in its entirety.

FIGS. 2A-2D illustrate various communication modes for a wireless data communication system involving the earphone 10 according to embodiments of the present invention. As shown in FIG. 2A, the system comprises a data source 20 in communication with the earphone 10 via an ad hoc wireless network 24. The earphone 10, via its transceiver circuit (described in more detail below), may communicate wirelessly with a data source 20, which may comprise a wireless network adapter 22 for transmitting the digital audio wirelessly. For example, the data source 20 may be a digital audio player (DAP), such as an mp3 player or an iPod, or any other suitable digital audio playing device, such as a laptop or personal computer, that stores and/or plays digital audio files. In other embodiments, the data source 20 may generate analog audio, and the wireless network adapter 22 may encode the analog audio into digital format for transmission to the earphone 10.

The wireless network adapter 22 may be an integral part of the data source 20, or it may be a separate device that is connected to the data source 20 to provide wireless connectivity for the data source 20. For example, the wireless network adapter 22 may comprise a wireless network interface card (WNIC) or other suitable transceiver that plugs into a USB port or other port or jack of the data source 20 (such as a TRS connector) to stream data, e.g., digital audio files, via a wireless network (e.g., the ad hoc wireless network 24 or an infrastructure wireless network). The digital audio transmitted from the data source 20 to the earphone 10 via the wireless networks may comprise compressed or uncompressed audio. Any suitable file format may be used for the audio, including mp3, lossy or lossless WMA, Vorbis, Musepack, FLAC, WAV, AIFF, AU, or any other suitable file format.

When in range, the data source 20 may communicate with the earphone 10 via the ad hoc wireless network 24 using any suitable wireless communication protocol, including Wi-Fi (e.g., IEEE 802.11a/b/g/n), WiMAX (IEEE 802.16), Bluetooth, Zigbee, UWB, or any other suitable wireless communication protocol. For purposes of the description to follow, it is assumed that the data source 20 and the earphone 10 communicate using a Wi-Fi protocol, although the invention is not so limited and other wireless communication protocols may be used in other embodiments of the invention. The data source 20 and the earphone 10 are considered in range for the ad hoc wireless network 24 when the signal

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strengths (e.g., the RSSI) of the signals received by the two devices are above a threshold minimum signal strength level. For example, the data source **20** and the earphone **10** are likely to be in range for an ad hoc wireless network when then are in close proximity, such as when the wearer of the earphone **10** has the data source **20** on his/her person, such as in a pocket, strapped to their waist or arm, or holding the data source in their hand.

When the earphone **10** and the data source **20** are out of range for the ad hoc wireless network **24**, that is, when the received signals degrade below the threshold minimum signal strength level, both the earphone **10** and the data source **20** may transition automatically to communicate over an infrastructure wireless network (such as a wireless LAN (WLAN)) **30** that is in the range of both the earphone **10** and the data source **20**, as shown in FIG. 2B. The earphone **10** and the data source **20** (e.g., the wireless network adapter **22**) may include firmware, as described further below, that cause the components to make the transition to a common infrastructure wireless network **30** automatically and seamlessly, e.g., without user intervention. The earphone **10** may cache the received audio in a buffer or memory for a time period before playing the audio. The cached audio may be played after the connection over the ad hoc wireless network is lost to give the earphone **10** and the data source **20** time to connect via the infrastructure wireless network.

For example, as shown in FIG. 2B, the infrastructure network may comprise an access point **32** that is in the range of both the data source **20** and the earphone **10**. The access point **32** may be an electronic hardware device that acts as a wireless access point for, and that is connected to, a wired and/or wireless data communication network **33**, such as a LAN or WAN, for example. The data source **20** and the earphone **10** may both communicate wirelessly with the access point **32** using the appropriate network data protocol (a Wi-Fi protocol, for example). The data source **20** and the earphone **10** may both transition automatically to an agreed-upon WLAN **30** that is in the range of both devices when they cannot communicate satisfactorily via the ad hoc wireless network **24**. A procedure for specifying an agreed-upon infrastructure wireless network **30** is described further below. Alternatively, the infrastructure wireless network **30** may have multiple access points **32a-b**, as shown in FIG. 2C. In such an embodiment, the data source **20** may communicate wirelessly with one access point **32b** and the earphone **10** may communicate wirelessly with another access point **32a** of the same infrastructure wireless network **30**. Again, the data source **20** and the earphone **10** may transition to an agreed-upon WLAN.

If there is no suitable common infrastructure wireless network over which the earphone **10** and the data source **20** can communicate, as shown in FIG. 2D, the earphone **10** may transition to communicate with an access point **32a** for an available (first) wireless network (e.g., WLAN) **30a** that is in the range of the earphone **10**. In this mode, the earphone **10** may connect via the wireless network **30a** to a network-enabled host server **40**. The host server **40** may be connected to the wireless network **30a** via an electronic data communication network **42**, such as the Internet. In one mode, the host server **40** may transmit streaming digital audio via the networks **33a**, **42** to the earphone **10**. In another mode, the host server **40** may transmit to the earphone **10** a network address, such as an Internet Protocol (IP) address, for a streaming digital audio content server **70** on the network **42**. Using the received IP address, the earphone **10** may connect to the streaming digital audio content server **70** via the

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networks **30a**, **42** to receive and process digital audio from the streaming digital audio content server **70**.

The digital audio content server **70** may be, for example, an Internet radio station server. The digital audio content server **70** may stream digital audio over the network **42** (e.g., the Internet), which the earphone **10** may receive and process. In one embodiment, the streaming digital audio content server **70** may stream digital audio received by the streaming digital audio content server **70** from the data source **20**. For example, where the data source **20** is a wireless-capable device, such as a portable DAP, the data source **20** may connect to the streaming digital audio content server **70** via a wireless network **30b** and the network **42**. Alternatively, where for example the data source **20** is non-wireless-capable device, such as a PC, the data source **20** may have a direct wired connection to the network **42**. After being authenticated by the streaming digital audio content server **70**, the data source **20** may stream digital audio to the streaming digital audio content server **70**, which may broadcast the received digital audio over the network **42** (e.g., the Internet). In such a manner, the user of the earphone **10** may listen to audio from the data source **20** even when (i) the earphone **10** and the data source **20** are not in communication via an ad hoc wireless network **24** and (ii) the earphone **10** and the data source **20** are not in communication via a common local infrastructure wireless network **30**.

FIG. 3 is a block diagram of the earphone **10** according to various embodiments of the present invention. In the illustrated embodiment, the earphone **10** comprises a transceiver circuit **100** and related peripheral components. As shown in FIG. 3, the peripheral components of the earphone **10** may comprise a power source **102**, a microphone **104**, one or more acoustic transducers **106** (e.g., speakers), and an antenna **108**. The transceiver circuit **100** and some of the peripheral components (such as the power source **102** and the acoustic transducers **106**) may be housed within the body **12** of the earphone **10** (see FIG. 1). Other peripheral components, such as the microphone **104** and the antenna **108** may be external to the body **12** of the earphone **10**. In addition, some of the peripheral components, such as the microphone **104**, are optional in various embodiments.

In various embodiments, the transceiver circuit **100** may be implemented as a single integrated circuit (IC), such as a system-on-chip (SoC), which is conducive to miniaturizing the components of the earphone **10**, which is advantageous if the earphone **10** is to be relatively small in size, such as an in-ear earphone (see FIGS. 1A-1B for example). In alternative embodiments, however, the components of the transceiver circuit **100** could be realized with two or more discrete ICs or other components, such as separate ICs for the processors, memory, and RF (e.g., Wi-Fi) module, for example.

The power source **102** may comprise, for example, a rechargeable or non-rechargeable battery (or batteries). In other embodiments, the power source **102** may comprise one or more ultracapacitors (sometimes referred to as supercapacitors) that are charged by a primary power source. In embodiments where the power source **102** comprises a rechargeable battery cell or an ultracapacitor, the battery cell or ultracapacitor, as the case may be, may be charged for use, for example, when the earphone **10** is connected to a docking station or computer. The docking station may be connected to or part of a computer device, such as a laptop computer or PC. In addition to charging the rechargeable power source **102**, the docking station and/or computer may facilitate downloading of data to and/or from the earphone

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10. In other embodiments, the power source 102 may comprise capacitors passively charged with RF radiation, such as described in U.S. Pat. No. 7,027,311. The power source 102 may be coupled to a power source control module 103 of transceiver circuit 100 that controls and monitors the power source 102.

The acoustic transducer(s) 106 may be the speaker element(s) for conveying the sound to the user of the earphone 10. According to various embodiments, the earphone 10 may comprise one or more acoustic transducers 106. For embodiments having more than one transducer, one transducer may be larger than the other transducer, and a crossover circuit (not shown) may transmit the higher frequencies to the smaller transducer and may transmit the lower frequencies to the larger transducer. More details regarding dual element earphones are provided in U.S. Pat. No. 5,333,206, assigned to Koss Corporation, which is incorporated herein by reference in its entirety.

The antenna 108 may receive and transmit the wireless signals from and to the wireless networks 24, 30. A RF (e.g., Wi-Fi) module 110 of the transceiver circuit 100 in communication with the antenna 108 may, among other things, modulate and demodulate the signals transmitted from and received by the antenna 108. The RF module 110 communicates with a baseband processor 112, which performs other functions necessary for the earphone 10 to communicate using the Wi-Fi (or other communication) protocol.

The baseband processor 112 may be in communication with a processor unit 114, which may comprise a microprocessor 116 and a digital signal processor (DSP) 118. The microprocessor 116 may control the various components of the transceiver circuit 100. The DSP 114 may, for example, perform various sound quality enhancements to the digital audio received by the baseband processor 112, including noise cancellation and sound equalization. The processor unit 114 may be in communication with a volatile memory unit 120 and a non-volatile memory unit 122. A memory management unit 124 may control the processor unit's access to the memory units 120, 122. The volatile memory 122 may comprise, for example, a random access memory (RAM) circuit. The non-volatile memory unit 122 may comprise a read only memory (ROM) and/or flash memory circuits. The memory units 120, 122 may store firmware that is executed by the processor unit 114. Execution of the firmware by the processor unit 114 may provide various functionality for the earphone 10, such as the automatic transition between wireless networks as described herein. The memory units 120, 122 may also cache received digital audio.

A digital-to-analog converter (DAC) 125 may convert the digital audio from the processor unit 114 to analog form for coupling to the acoustic transducer(s) 106. An I²S interface 126 or other suitable serial or parallel bus interface may provide the interface between the processor unit 114 and the DAC 125. An analog-to-digital converter (ADC) 128, which also communicates with the I²S interface 126, may convert analog audio signals picked up by the microphone 104 for processing by the processor unit 114.

The transceiver circuit 100 also may comprise a USB or other suitable interface 130 that allows the earphone 10 to be connected to an external device via a USB cable or other suitable link. As shown in FIG. 4A, the external device may be a docking station 200 connected to a computer device 202. Also, in various embodiments, the earphone 10 could be connected directly to the computer 202 without the docking station 200. In addition, the external device may be a DAP 210, as shown in FIG. 4B. In that way, the earphone

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10 could connect directly to a data source 20, such as the DAP 210 or the computer 202, through the USB port 130. In addition, through the USB port 130, the earphone 10 may connect to a PC 202 or docking station 202 to charge up the power source 102 and/or to get downloads (e.g., data or firmware).

According to various embodiments, the earphone 10 may have an associated web page that a user may access through the host server 40 (see FIG. 2D) or some other server. An authenticated user could log onto the website from a client computing device 50 (e.g., laptop, PC, handheld computer device, etc., including the data source 20) (see FIG. 2D) to access the web page for the earphone 10 to set various profile values for the earphone 10. For example, at the web site, the user could set various content features and filters, as well as adjust various sound control features, such as treble, bass, frequency settings, noise cancellation settings, etc. In addition, the user could set preferred streaming audio stations, such as preferred Internet radio stations or other streaming audio broadcasts. That way, instead of listening to streaming audio from the data source 20, the user could listen to Internet radio stations or other streaming audio broadcasts received by the earphone 10. In such an operating mode, the earphone user, via the web site, may prioritize a number of Internet radio stations or other broadcast sources (hosted by streaming digital audio content servers 70). With reference to FIG. 7, the host server 40 may send the IP address for the earphone user's desired (e.g., highest priority) Internet radio station to the earphone 10. A button 11 on the earphone 10, such as on the rotating dial 16 as shown in the examples of FIGS. 1A and 1B, may allow the user to cycle through the preset preferred Internet radio stations. That is, for example, when the user presses the button 11, an electronic communication may be transmitted to the host server 40 via the wireless network 30, and in response to receiving the communication, the host server 40 may send the IP address for the user's next highest rated Internet radio station via the network 42 to the earphone 10. The earphone 10 may then connect to the streaming digital audio content server 70 for that Internet radio station using the IP address provided by the host server 40. This process may be repeated, e.g., cycled through, for each preset Internet radio station configured by the user of the earphone 10.

At the web site for the earphone 10 hosted on the host server 40, in addition to establishing the identification of digital audio sources (e.g., IDs for the user's DAP or PC) and earphones, the user could set parental or other user controls. For example, the user could restrict certain Internet radio broadcasts based on content or parental ratings, etc. That is, for example, the user could configure a setting through the web site that prevents the host server 40 from sending an IP address for a streaming digital audio content server 70 that broadcasts explicit content based on a rating for the content. In addition, if a number of different earphones 10 are registered to the same user, the user could define separate controls for the different earphones 10 (as well as customize any other preferences or settings particular to the earphones 10, including Internet radio stations, sound quality settings, etc. that would later be downloaded to the earphones 10). In addition, in modes where the host server 40 streams audio to the earphone 10, the host server 40 may log the files or content streamed to the various earphones 10, and the user could view at the web site the files or content that were played by the earphones 10. In that way, the user could monitor the files played by the earphones 10.

In addition, the host server **40** may provide a so-called eavesdropping function according to various embodiments. The eavesdropping service could be activated via the web site. When the service is activated, the host server **40** may transmit the content that it is delivering to a first earphone **10a** to another, second earphone **10b**, as shown in FIG. **8**. Alternatively, the host server **40** may transmit to the second earphone **10b** the most recent IP address for a streaming digital audio content server **70** that was sent to the first earphone **10a**. The second earphone **10b** may then connect to the streaming digital audio content server **70** that the first earphone **10a** is currently connected. That way, the user of the second earphone **10b**, which may be a parent, for example, may directly monitor the content being received by the first earphone **10a**, which may belong to a child of the parent.

This function also could be present in the earphones **10** themselves, allowing a parent (or other user) to join an ad-hoc wireless network and listen to what their child (or other listener) is hearing. For example, with reference to FIG. **10**, a first earphone **10a** may receive wireless audio, such as from the data source **20** or some other source, such as the host server **40**. The first earphone **10a** may be programmed with firmware to broadcast the received audio to a second earphone **10b** via an ad hoc wireless network **24**. That way, the wearer of the second earphone **10b** can monitor in real-time the content being played by the first earphone **10a**.

At the web site, the user may also specify the identification number ("ID") of their earphone(s) **10**, and the host server **40** may translate the ID to the current internet protocol (IP) addresses for the earphone **10** and for the data source **20**. This allows the user to find his or her data source **20** even when it is behind a firewall or on a changing IP address. That way, the host server **40** can match the audio from the data source **20** to the appropriate earphone **10** based on the specified device ID. The user also could specify a number of different data sources **20**. For example, the user's DAP may have one specified IP address and the user's home (or work) computer may have another specified IP address. Via the web site hosted by the host server **40**, the user could specify or prioritize from which source (e.g., the user's DAP or computer) the earphone **10** is to receive content.

The host server **40** (or some other server) may also push firmware upgrades and/or data updates to the earphone **10** using the IP addresses of the earphone **10** via the networks **30**, **42**. In addition, a user could download the firmware upgrades and/or data updates from the host server **40** to the client computing device **202** (see FIG. **4A**) via the Internet, and then download the firmware upgrades and/or data updates to the earphone **10** when the earphone **10** is connected to the client computer device **202** (such as through a USB port and/or the docking station **200**).

Whether the downloads are transmitted wirelessly to the earphone **10** or via the client computing device **202** may depend on the current data rate of the earphone **10** and the quantity of data to be transmitted to the earphone **10**. For example, according to various embodiments, as shown in the process flow of FIG. **5**, the host server **40** may be programmed, at step **50**, to make a determination, based on the current data rate for the earphone **10** and the size of the update, whether the update should be pushed to the earphone **10** wirelessly (e.g., via the WLAN **30a** in FIG. **2D**). If the update is too large and/or the current data rate is too low that the performance of the earphone **10** will be adversely affected, the host server **40** may refrain from pushing the update to the earphone **10** wirelessly and wait instead to

download the update to the client computing device **202** at step **51**. Conversely, if the host server **40** determines that, given the size of the update and the current data rate for the earphone **10** that the performance of the earphone **10** will not be adversely affected, the host server **40** may transmit the update wirelessly to the earphone **10** at step **52**.

As mentioned above, the processor unit **114** of the speakerphones **14** may be programmed, via firmware stored in the memory **120**, **122**, to have the ability to transition automatically from the ad hoc wireless network **24** to an infrastructure wireless network **30** (such as a WLAN) when the quality of the signal on the ad hoc wireless network **24** degrades below a suitable threshold (such as when the data source **20** is out of range for an ad hoc wireless network). In that case, the earphone **10** and the data source **20** may connect to a common infrastructure wireless network (e.g., WLAN) (see, for example, FIGS. **2B-2C**). Through the web site for the earphone **10**, described above, the user could specify a priority of infrastructure wireless networks **30** for the data source **20** and the earphone **10** to connect to when the ad hoc wireless network **24** is not available. For example, the user could specify a WLAN servicing his/her residence first, a WLAN servicing his/her place of employment second, etc. During the time that the earphone **10** and the data source **20** are connected via the ad hoc wireless network **24**, the earphone **10** and the data source **20** may exchange data regarding which infrastructure networks are in range. When the earphone **10** and the data source **20** are no longer in range for the ad hoc wireless network **24** (that is, for example, the signals between the device degrade below an acceptable level), they may both transition automatically to the highest prioritized infrastructure wireless network whose signal strength is above a certain threshold level. That way, even though the earphone **10** and the data source **20** are out of range for the ad hoc wireless network **24**, the earphone **10** may still receive the streaming audio from the data source **20** via the infrastructure wireless network **30** (see FIGS. **2B-2C**).

When none of the preferred infrastructure networks is in range, the earphone **10** may connect automatically to the host server **40** via an available infrastructure wireless network **30** (see FIG. **2D**), e.g., the infrastructure wireless network **30** having the highest RSSI and to which the earphone **10** is authenticated to use. The host server **40**, as mentioned above, may transmit IP addresses to the earphone **10** for streaming digital audio content servers **70** or the host sever **40** may stream digital audio to the earphone **10** itself when in this communication mode.

FIG. **6** is a diagram of the process flow, according to one embodiment, implemented by the transceiver circuit **100** of the earphone **10**. The process shown in FIG. **6** may be implemented in part by the processor unit **114** executing firmware stored in a memory unit **120**, **122** of the transceiver circuit **100**. At step **61**, the earphone **10** may determine if it can communicate with the data source **20** via an ad hoc wireless network **24**. That is, the earphone **10** may determine if the strength of the wireless signals from the data source **20** exceed some minimum threshold. If so, the data source **20** and the earphone **10** may communicate wirelessly via the ad hoc wireless network **24** (see FIG. **2A**). While in this communication mode, at step **62**, the data source **20** and the earphone **10** also may exchange data regarding the local infrastructure wireless networks, if any, in the range of the data source **20** and the earphone **10**, respectively. For example, the earphone **10** may transmit the ID of local infrastructure wireless networks **30** that the earphone **10** can detect whose signal strength (e.g., RSSI) exceeds some

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minimum threshold level. Similarly, the data source **20** may transmit the ID the local infrastructure wireless networks **30** that the data source **20** can detect whose signal strength (e.g., RSSI) exceeds some minimum threshold level. The earphone **10** may save this data in a memory unit **120**, **122**. Similarly, the data source **20** may store in memory the wireless networks that the earphone **10** is detected.

The data source **20** and the earphone **10** may continue to communicate via the ad hoc wireless network mode **24** until they are out of range (e.g., the signal strengths degrade below a minimum threshold level). If an ad hoc wireless network **24** is not available at block **61**, the transceiver circuit **100** and the data source **20** may execute a process, shown at block **63**, to connect to the user's highest prioritized infrastructure wireless network **30**. For example, of the infrastructure wireless networks whose signal strength exceeded the minimum threshold for both the earphone **10** and the data source **20** determined at step **62**, the earphone **10** and the data source **20** may both transition to the infrastructure wireless network **30** having the highest priority, as previously set by the user (see FIGS. **2B-2C**, for example). For example, if the user's highest prioritized infrastructure wireless network **30** is not available, but the user's second highest prioritized infrastructure wireless network **30** is, the earphone **10** and the data source **20** may both transition automatically to the user's second highest prioritized infrastructure wireless network **30** at block **64**. As shown by the loop with block **65**, the earphone **10** and the data source **20** may continue to communicate via one of the user's prioritized infrastructure wireless networks **30** as long as the infrastructure wireless network **30** is available. If the infrastructure wireless network becomes unavailable, the process may return to block **61**.

If, however, no ad hoc wireless network and none of the user's prioritized infrastructure wireless networks are available, the earphone **10** may transition automatically to connect to the host server **40** at block **66** (see FIG. **2D**) using an available infrastructure wireless network **30**. At block **67**, the host server **40** may transmit an IP address to the earphone **10** for one of the streaming digital audio content servers **70**, and at block **68** the earphone **10** may connect to the streaming digital audio content server **70** using the received IP address. At step **69**, as long as the earphone **10** is connected to the streaming digital audio content server **70**, the earphone **10** may continue to communicate in this mode. However, if the earphone **10** loses its connection to the digital audio content server **70**, the process may return to block **61** in one embodiment. As mentioned above, at block **67**, instead of sending an IP address for a streaming digital audio content server **70**, the host server **40** may stream digital audio to the earphone **10**. The user, when configuring their earphone **10** preferences via the web site, may specify and/or prioritize whether the host server **40** is to send IP addresses for the streaming digital audio content servers **70** and/or whether the host server **40** is to stream audio to the earphone **10** itself.

In another embodiment, the earphone **10** may be programmed to transition automatically to the host server **40** when the earphone **10** and the data source **20** are not in communication via the ad hoc wireless network **24**. That is, in such an embodiment, the earphone **10** may not try to connect via a local infrastructure wireless network **30** with the data source **20**, but instead transition automatically to connect to the host server **40** (see FIG. **2D**).

In various embodiments, as shown in FIG. **1B**, the button **11** or other user selection device that allows the wearer of the earphone **10** to indicate approval and/or disapproval of

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songs or other audio files listened to by the wearer over an Internet radio station. The approval/disapproval rating, along with metadata for the song received by the earphone **10** with the streaming audio, may be transmitted from the transceiver circuit **100** of the earphone **10** back to the host server **40**, which may log the songs played as well as the ratings for the various songs/audio files. In addition to being able to view the logs at the website, the host server **40** (or some other server) may send an email or other electronic communication to the earphone user, at a user specified email address or other address, which the user might access from their client communication device **50** (see FIG. **2D**). The email or other electronic communication may contain a listing of the song/audio files for which the user gave approval ratings using the button **11** or other user selection device. Further, the email or other electronic communication may provide a URL link for a URL at which the user could download song/audio files that the user rated (presumably song/audio files for which the user gave an approval rating). In some instances, the user may be required to pay a fee to download the song/audio file.

The user song ratings also may be used by the host server **40** to determine the user's musical preferences and offer new music that the user might enjoy. More details about generating user play lists based on song ratings may be found in published U.S. patent applications Pub. No. 2006/0212444, Pub. No. 2006/0206487, and Pub. No. 2006/0212442, and U.S. Pat. No. 7,003,515, which are incorporated herein by reference in their entirety.

In addition or alternatively, the user could log onto a web site hosted by the host server **40** (or some other server) to view the approval/disapproval ratings that the user made via the button **11** on the earphone **10**. The web site may provide the user with the option of downloading the rated songs/audio files (for the host server **40** or some other server system) to their client computer device **50**. The user could then have their earphone **10** connect to their client computer device **50** as a data source **20** via an ad hoc wireless network **24** (see FIG. **2A**) or via an infrastructure wireless network (see FIGS. **2B-2D**) to listen to the downloaded songs. In addition, the user could download the song files from their client computer device **50** to their DAP and listen to the downloaded song files from their DAP by using their DAP as the data source **20** in a similar manner.

Another application of the headsets may be in vehicles equipped with Wi-Fi or other wireless network connectivity. Published PCT application WO 2007/136620, which is incorporated herein by reference, discloses a wireless router for providing a Wi-Fi or other local wireless network for a vehicle, such as a car, truck, boat, bus, etc. In a vehicle having a Wi-Fi or other local wireless network, the audio for other media systems in the vehicle could be broadcast over the vehicle's wireless network. For example, if the vehicle comprises a DVD player, the audio from the DVD system could be transmitted to the router and broadcast over the vehicle's network. Similarly, the audio from terrestrial radio stations, a CD player, or an audio cassette player could be broadcast over the vehicle's local wireless network. The vehicle's passengers, equipped with the earphones **10**, could cycle through the various audio broadcasts (including the broadcasts from the vehicle's media system as well as broadcasts from the host server **40**, for example) using a selection button **11** on the earphone **10**. The vehicle may also be equipped with a console or terminal, etc., through which a passenger could mute all of the broadcasts for direct voice communications, for example.

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As described above, the earphones **10** may also include a microphone **104**, as shown in the example of FIG. **9**. The headset **90** shown in FIG. **9** includes two earphones **10**, both of which may include a transceiver circuit **100** or only one of which may include the transceiver circuit, as discussed above. The microphone **104** could be used to broadcast communications from one earphone wearer to another earphone wearer. For example, one wearer could activate the microphone by pressing a button **92** on the headset **90**. The headset **90** may then transmit a communication via an ad hoc wireless network **24** or other wireless network to a nearby recipient (or recipients) equipped with a headset **90** with a transceiver circuit **100** in one or both of the earphones **10**. When such communication is detected by the recipient's headset **90**, the streaming audio received over the wireless network by the recipient's headset **90** may be muted, and the intercom channel may be routed to the transducer(s) of the recipient's headset **90** for playing for the recipient. This functionality may be valuable and useful where multiple wearers of the headsets **90** are in close proximity, such as on motorcycles, for example.

Another exemplary use of the earphones **10** is in a factory, warehouse, construction site, or other environment that might be noisy. Persons (e.g., workers) in the environment could use the earphones **10** for protection from the surrounding noise of the environment. From a console or terminal, a person (e.g., a supervisor) could select a particular recipient for a communication over the Wi-Fi network (or other local wireless network). The console or terminal may have buttons, dials, or switches, etc., for each user/recipient, or it could have one button or dial through which the sender could cycle through the possible recipients. In addition, the console or terminal could have a graphical user interface, through which the sender may select the desired recipient(s).

As mentioned above, the earphones **10** may comprise a USB port. In one embodiment, as shown in FIG. **11**, the user may use an adapter **150** that connects to the USB port of each earphone **10**. The adapter **150** may also have a plug connector **152**, such as a 3.5 mm jack, which allows the user to connect the adapter **150** to devices having a corresponding port for the connector **152**. When the earphones **10** detect a connection via their USB interfaces in such a manner, the Wi-Fi (or other wireless protocol) components may shut down or go into sleep mode, and the earphones **10** will route standard headphone level analog signals to the transducer(s) **106**. This may be convenient in environments where wireless communications are not permitted, such as airplanes, but where there is a convenient source of audio contact. For example, the adapter **150** could plug into a person's DAP. The DSP **118** of the earphone **10** may still be operational in such a non-wireless mode to provide noise cancellation and any applicable equalization.

The examples presented herein are intended to illustrate potential and specific implementations of the embodiments. It can be appreciated that the examples are intended primarily for purposes of illustration for those skilled in the art. No particular aspect of the examples is/are intended to limit the scope of the described embodiments.

According to various embodiments, therefore, the present invention is directed to an earphone **10** that comprises a body **12**, where the body **12** comprises: (i) at least one acoustic transducer **106** for converting an electrical signal to sound; (ii) an antenna **108**; and (iii) a transceiver circuit **100** in communication with the at least one acoustic transducer **106** and the antenna **108**. The transceiver circuit **100** is for receiving and transmitting wireless signals via the antenna **108**, and the transceiver circuit **100** is for outputting the

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electrical signal to the at least one acoustic transducer **106**. The wireless transceiver circuit also comprises firmware, which when executed by the transceiver circuit, causes the transceiver circuit to: (i) receive digital audio wirelessly from a data source **20** via an ad hoc wireless network **24** when the data source **20** is in wireless communication range with the earphone **10** via the ad hoc wireless network **24**; and (ii) when the data source **20** is not in wireless communication range with the earphone **10** via the ad hoc wireless network **24**, transition automatically to receive digital audio via an infrastructure wireless network **30**.

According to various implementations, the data source may comprise a portable digital audio player, such as an MP3 player, iPod, or laptop computer, or a nonportable digital audio player, such as a personal computer. In addition, the transceiver circuit **100** may comprise: (i) a wireless communication module **110** (such as a Wi-Fi or other wireless communication protocol module); (ii) a processor unit **114** in communication with the wireless communication module **110**; (iii) a non-volatile memory unit **122** in communication with the processor unit **114**; and (iv) a volatile memory **120** unit in communication with the processor unit **114**. The infrastructure wireless network may comprise a WLAN. The transceiver circuit **100** may receive digital audio from the data source **20** via the infrastructure wireless network **30** when the data source **20** is not in wireless communication range with the earphone **10** via the ad hoc wireless network **24**. The transceiver circuit firmware, when executed by the transceiver circuit **100**, may cause the transceiver circuit **100** of the earphone **10** to transition automatically to a pre-set infrastructure wireless network **30** that the data source **20** transitions to when the data source **20** is not in wireless communication range with the earphone **10** via the ad hoc wireless network **24** and when the pre-set infrastructure wireless network **30** is in range of both the earphone **10** and the data source **20**. In addition, the transceiver circuit firmware, when executed by the transceiver circuit **100**, may cause the transceiver circuit **100** of the earphone **10** to transmit data via the ad hoc wireless network **24** to the data source **20** regarding one or more infrastructure wireless networks **30** detected by the transceiver circuit **100** when the earphone **10** and the data source **20** are communicating via the ad hoc wireless network **24**.

In addition, the transceiver circuit firmware, when executed by the transceiver circuit **100**, may cause the transceiver circuit **100** of the earphone **10** to connect to a host server **40** via an available infrastructure wireless network **30** when the data source **20** is not in wireless communication range with the earphone **10** via the ad hoc wireless network **24**. The earphone **10** may receive streaming digital audio from the host server **40** via the infrastructure wireless network **30**. In addition, the earphone **10** may receive a first network address for a first streaming digital audio content server **70** from the host server **40** via the infrastructure wireless network **30**. In addition, the earphone **10** may comprise a user control, such as button **11**, dial, pressure switch, or other type of user control, that, when activated, causes the earphone **10** to transmit an electronic request via the infrastructure wireless network **30** to the host server **40** for a second network address for a second streaming digital audio content server **70**.

In other embodiments, the present invention is directed to a system that comprises: (i) a data source **20** for wirelessly transmitting streaming digital audio; and (ii) a wireless earphone **10** that is in wireless communication with the data source **20**. In yet other embodiments, the present invention is directed to a communication system that comprises: (i) a

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host server **40**; (ii) a first streaming digital audio content server **70** that is connected to the host server **40** via a data network **42**; and (iii) a wireless earphone **10** that is in communication with the host server **40** via a wireless network **30**. The host server **40** is programmed to transmit to the earphone **10** a first network address for the first streaming digital audio content server **70** on the data network **42**. The host server **40** and the streaming digital audio content server(s) **70** each may comprise one or more processor circuits and one or more memory circuits (e.g., ROM circuits and/or RAM circuits).

In yet another embodiment, the present invention is directed to a headset that comprises: (i) a first earphone **10a** that comprises one or more acoustic transducers **10b** for converting a first electrical signal to sound; and (ii) a second earphone **10b**, connected to the first earphone **10a**, wherein the second earphone **10b** comprises one or more acoustic transducers **10b** for converting a second electrical signal to sound. In one embodiment, the first earphone **10a** comprises: (i) a first antenna **108**; and (ii) a first transceiver circuit **100** in communication with the one or more acoustic transducers **106** of the first earphone **10a** and in communication with the first antenna **108**. The first transceiver circuit **100** is for receiving and transmitting wireless signals via the first antenna **108**, and for outputting the first electrical signal to the one or more acoustic transducers **10b** of the first earphone **10a**. The first transceiver circuit **100** also may comprise firmware, which when executed by the first transceiver circuit **100**, causes the first transceiver circuit **100** to: (i) receive digital audio wirelessly from a data source **20** via an ad hoc wireless network **24** when the data source **20** is in wireless communication range with the first earphone **10a** via the ad hoc wireless network **24**; and (ii) when the data source **20** is not in wireless communication range with the first earphone **10a** via the ad hoc wireless network **24**, transition automatically to receive digital audio via an infrastructure wireless network **30**.

In various implementations, the headset further may comprise a head band **19** that is connected to the first and second earphones **10**. In addition, the headset **19** further may comprise a microphone **104** having an output connected to the first transceiver circuit **100**. In one embodiment, the first transceiver circuit **100** is for outputting the second electrical signal to the one or more acoustic transducers **106** of the second earphone **10b**. In another embodiment, the second earphone **10b** comprises: (i) a second antenna **108**; and (ii) a second transceiver circuit **100** in communication with the one or more acoustic transducers **106** of the second earphone **10b** and in communication with the second antenna **108**. The second transceiver circuit **100** is for receiving and transmitting wireless signals via the second antenna **108**, and for outputting the second electrical signal to the one or more acoustic transducers **106** of the second earphone **10b**. The second transceiver circuit **100** may comprise firmware, which when executed by the second transceiver circuit **100**, causes the second transceiver circuit **100** to: (i) receive digital audio wirelessly from the data source **20** via the ad hoc wireless network **24** when the data source **20** is in wireless communication range with the second earphone **10b** via the ad hoc wireless network **24**; and (ii) when the data source **20** is not in wireless communication range with the second earphone **10b** via the ad hoc wireless network **24**, transition automatically to receive digital audio via the infrastructure wireless network **30**.

In addition, according to various embodiments, the first earphone **10a** may comprise a first data port and the second earphone **10b** may comprise a second data port. In addition,

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the headset may further comprise an adapter or dongle **150** connected to the first data port of the first earphone **10a** and to the second data port of the second earphone **10b**, wherein the adapter **150** comprises an output plug connector **152** for connecting to a remote device.

In addition, according to other embodiments, the present invention is directed to a method that comprises the steps of: (i) receiving, by a wireless earphone, via an ad hoc wireless network, digital audio from a data source when the data source is in wireless communication with the earphone via the ad hoc wireless network; (ii) converting, by the wireless earphone, the digital audio to sound; and (iii) when the data source is not in wireless communication with the earphone, transitioning automatically, by the earphone, to receive digital audio via an infrastructure wireless network.

In various implementations, the step of transitioning automatically by the earphone to receive digital audio via an infrastructure wireless network may comprise transitioning automatically to receive digital audio from the data source via an infrastructure wireless network when the data source is not in wireless communication range with the earphone via the ad hoc wireless network. In addition, the method may further comprise the step of receiving by the wireless earphone from the data source via the ad hoc wireless network data regarding one or more infrastructure wireless networks detected by data source when the earphone and the data source are communicating via the ad hoc wireless network.

In addition, the step of transitioning automatically by the earphone to receive digital audio via an infrastructure wireless network may comprise transitioning automatically to receive digital audio from a host sever via the infrastructure wireless network when the data source is not in wireless communication range with the earphone via the ad hoc wireless network. Additionally, the step of transitioning automatically by the earphone to receive digital audio via an infrastructure wireless network may comprise: (i) receiving, by the wireless earphone via the infrastructure wireless network, from a host server connected to the infrastructure wireless network, a network address for a streaming digital audio content server; and (ii) connecting, by the wireless earphone, to the streaming digital audio content server using the network address received from the host server.

It is to be understood that the figures and descriptions of the embodiments have been simplified to illustrate elements that are relevant for a clear understanding of the embodiments, while eliminating, for purposes of clarity, other elements. For example, certain operating system details for the various computer-related devices and systems are not described herein. Those of ordinary skill in the art will recognize, however, that these and other elements may be desirable in a typical processor or computer system. Because such elements are well known in the art and because they do not facilitate a better understanding of the embodiments, a discussion of such elements is not provided herein.

In general, it will be apparent to one of ordinary skill in the art that at least some of the embodiments described herein may be implemented in many different embodiments of software, firmware and/or hardware. The software and firmware code may be executed by a processor or any other similar computing device. The software code or specialized control hardware that may be used to implement embodiments is not limiting. For example, embodiments described herein may be implemented in computer software using any suitable computer software language type. Such software may be stored on any type of suitable computer-readable medium or media, such as, for example, a magnetic or

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optical storage medium. The operation and behavior of the embodiments may be described without specific reference to specific software code or specialized hardware components. The absence of such specific references is feasible, because it is clearly understood that artisans of ordinary skill would be able to design software and control hardware to implement the embodiments based on the present description with no more than reasonable effort and without undue experimentation.

Moreover, the processes associated with the present embodiments may be executed by programmable equipment, such as computers or computer systems and/or processors. Software that may cause programmable equipment to execute processes may be stored in any storage device, such as, for example, a computer system (nonvolatile) memory, an optical disk, magnetic tape, or magnetic disk. Furthermore, at least some of the processes may be programmed when the computer system is manufactured or stored on various types of computer-readable media.

A “computer,” “computer system,” “host,” “host server,” “server,” or “processor” may be, for example and without limitation, a processor, microcomputer, minicomputer, server, mainframe, laptop, personal data assistant (PDA), wireless e-mail device, cellular phone, pager, processor, fax machine, scanner, or any other programmable device configured to transmit and/or receive data over a network. Such components may comprise: one or more processor circuits; and one more memory circuits, including ROM circuits and RAM circuits. Computer systems and computer-based devices disclosed herein may include memory for storing certain software applications used in obtaining, processing, and communicating information. It can be appreciated that such memory may be internal or external with respect to operation of the disclosed embodiments. The memory may also include any means for storing software, including a hard disk, an optical disk, floppy disk, ROM (read only memory), RAM (random access memory), PROM (programmable ROM), EEPROM (electrically erasable PROM) and/or other computer-readable media.

In various embodiments disclosed herein, a single component may be replaced by multiple components and multiple components may be replaced by a single component to perform a given function or functions. Except where such substitution would not be operative, such substitution is within the intended scope of the embodiments. Any servers described herein, such as the host server 40, for example, may be replaced by a “server farm” or other grouping of networked servers (such as server blades) that are located and configured for cooperative functions. It can be appreciated that a server farm may serve to distribute workload between/among individual components of the farm and may expedite computing processes by harnessing the collective and cooperative power of multiple servers. Such server farms may employ load-balancing software that accomplishes tasks such as, for example, tracking demand for processing power from different machines, prioritizing and scheduling tasks based on network demand and/or providing backup contingency in the event of component failure or reduction in operability.

While various embodiments have been described herein, it should be apparent that various modifications, alterations, and adaptations to those embodiments may occur to persons skilled in the art with attainment of at least some of the advantages. The disclosed embodiments are therefore intended to include all such modifications, alterations, and adaptations without departing from the scope of the embodiments as set forth herein.

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What is claimed is:

1. A headphone assembly comprising:

first and second earphones, wherein each of the first and second earphones comprises an acoustic transducer; and

an antenna for receiving wireless signals from a mobile, digital audio player via one or more ad hoc wireless communication links;

a wireless communication circuit connected to the antenna, wherein the wireless communication circuit is for receiving and transmitting wireless signals to and from the headphone assembly;

a processor;

a memory for storing firmware that is executed by the processor;

a rechargeable battery for powering the headphone assembly; and

a microphone for picking up utterances by a user of the headphone assembly; and

wherein the headphone assembly is configured to play, by the first and second earphones, digital audio content transmitted by the mobile, digital audio player via the one or more ad hoc wireless communication links;

wherein the processor is configured to, upon activation of a user-control of the headphone assembly, initiate transmission of a request to a remote, network-connected server that is in wireless communication with the mobile, digital audio player; and

wherein the headphone assembly is for receiving firmware upgrades transmitted from the remote, network-connected server.

2. The headphone assembly of claim 1, wherein:

in a first audio play mode, the first and second earphones play audio content stored on a mobile, digital audio player and transmitted to the headphone assembly from the mobile, digital audio player via the one or more ad hoc wireless communication links; and

in a second audio play mode, the earphones play audio content streamed from the remote, network-connected server.

3. The headphone assembly of claim 2, wherein the processor is for:

processing audible utterances by the user picked up by the microphone in response to activation of the microphone by the user; and

transmitting a communication based on the audible utterances via the one or more ad hoc wireless communication links.

4. The headphone assembly of claim 3, wherein:

the mobile, digital audio player is a first digital audio source;

the headphone assembly transitions to play digital audio content received wirelessly from a second digital audio source via a second wireless communication link based on, at least, a signal strength level for the second wireless communication link, wherein the second digital audio source is different from the first digital audio source.

5. The headphone assembly of claim 1, wherein the processor is for:

processing audible utterances by the user picked up by the microphone in response to activation of the microphone by the user; and

transmitting a communication based on the audible utterances via the one or more ad hoc wireless communication links.

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6. The headphone assembly of claim 5, wherein: the mobile, digital audio player is a first digital audio source; the headphone assembly transitions to play digital audio content received wirelessly from a second digital audio source via a second wireless communication link based on, at least, a signal strength level for the second wireless communication link, wherein the second digital audio source is different from the first digital audio source.
7. The headphone assembly of claim 1, wherein upon activation of the microphone by the user, data are transmitted about the headphone assembly to a remote device.
8. The headphone assembly of claim 1, wherein: the mobile, digital audio player is a first digital audio source; the headphone assembly transitions to play digital audio content received wirelessly from a second digital audio source via a second wireless communication link based on, at least, a signal strength level for the second wireless communication link, wherein the second digital audio source is different from the first digital audio source.
9. The headphone assembly of claim 1, wherein the headphone assembly is for receiving firmware upgrades wirelessly.
10. The headphone assembly of claim 1, wherein: the wireless communication circuit is located in the first earphone; and the headphone assembly further comprises a connection wire between the first and second earphones to carry the received digital audio content from the first earphone to the second earphone.
11. The headphone assembly of claim 10, wherein the processor is for: processing audible utterances by the user picked up by the microphone in response to activation of the microphone by the user; and transmitting a communication based on the audible utterances via the one or more ad hoc wireless communication links.
12. The headphone assembly of claim 11, wherein: the mobile, digital audio player is a first digital audio source; the headphone assembly transitions to play digital audio content received wirelessly from a second digital audio source via a second wireless communication link based on, at least, a signal strength level for the second wireless communication link, wherein the second digital audio source is different from the first digital audio source.
13. The headphone assembly of claim 10, wherein: the mobile, digital audio player is a first digital audio source; the headphone assembly transitions to play digital audio content received wirelessly from a second digital audio source via a second wireless communication link based on, at least, a signal strength level for the second wireless communication link, wherein the second digital audio source is different from the first digital audio source.
14. The headphone assembly of claim 10, wherein the headphone assembly further comprises a headband, and wherein the headband carries the connection wire.
15. The headphone assembly of claim 14, wherein: in a first audio play mode, the first and second earphones play audio content stored on the mobile, digital audio

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- player and transmitted to the headphone assembly from the mobile, digital audio player via the one or more ad hoc wireless communication links; and in a second audio play mode, the earphones play audio content streamed from the remote, network-connected server.
16. The headphone assembly of claim 15, wherein the processor is for: processing audible utterances by the user picked up by the microphone in response to activation of the microphone by the user; and transmitting a communication based on the audible utterances via the one or more ad hoc wireless communication links.
17. The headphone assembly of claim 16, wherein: the mobile, digital audio player is a first digital audio source; the headphone assembly transitions to play digital audio content received wirelessly from a second digital audio source via a second wireless communication link based on, at least, a signal strength level for the second wireless communication link, wherein the second digital audio source is different from the first digital audio source.
18. The headphone assembly of claim 15, wherein: the mobile, digital audio player is a first digital audio source; the headphone assembly transitions to play digital audio content received wirelessly from a second digital audio source via a second wireless communication link based on, at least, a signal strength level for the second wireless communication link, wherein the second digital audio source is different from the first digital audio source.
19. The headphone assembly of claim 14, wherein the processor is for: processing audible utterances by the user picked up by the microphone in response to activation of the microphone by the user; and transmitting a communication based on the audible utterances via the one or more ad hoc wireless communication links.
20. The headphone assembly of claim 19, wherein: the mobile, digital audio player is a first digital audio source; the headphone assembly transitions to play digital audio content received wirelessly from a second digital audio source via a second wireless communication link based on, at least, a signal strength level for the second wireless communication link, wherein the second digital audio source is different from the first digital audio source.
21. The headphone assembly of claim 14, wherein upon activation of the microphone by the user, data are transmitted about the headphone assembly to a remote device.
22. The headphone assembly of claim 14, wherein: the mobile, digital audio player is a first digital audio source; the headphone assembly transitions to play digital audio content received wirelessly from a second digital audio source via a second wireless communication link based on, at least, a signal strength level for the second wireless communication link, wherein the second digital audio source is different from the first digital audio source.
23. The headphone assembly of claim 10, wherein each of the first and second earphones further comprises:

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an adjustable, curved hanger bar that sits upon an upper external curvature of the user's ear, behind an upper portion of an auricula of the user's ear, when the headphone assembly is worn by the user; and

a body connected to the hanger bar, wherein the earphone extends from the body into the user's ear when the headphone assembly is worn by the user.

24. The headphone assembly of claim **23**, wherein:

in a first audio play mode, the first and second earphones play audio content stored on the mobile, digital audio player and transmitted to the headphone assembly from the mobile, digital audio player via the one or more ad hoc wireless communication links; and

in a second audio play mode, the earphones play audio content streamed from the remote, network-connected server.

25. The headphone assembly of claim **24**, wherein:

processing audible utterances by the user picked up by the microphone in response to activation of the microphone by the user; and

transmitting a communication based on the audible utterances via the one or more ad hoc wireless communication links.

26. The headphone assembly of claim **25**, wherein:

the mobile, digital audio player is a first digital audio source;

the headphone assembly transitions to play digital audio content received wirelessly from a second digital audio source via a second wireless communication link based on, at least, a signal strength level for the second wireless communication link, wherein the second digital audio source is different from the first digital audio source.

27. The headphone assembly of claim **24**, wherein:

the mobile, digital audio player is a first digital audio source;

the headphone assembly transitions to play digital audio content received wirelessly from a second digital audio source via a second wireless communication link based on, at least, a signal strength level for the second wireless communication link, wherein the second digital audio source is different from the first digital audio source.

28. The headphone assembly of claim **23**, wherein the processor is for:

processing audible utterances by the user picked up by the microphone in response to activation of the microphone by the user; and

transmitting a communication based on the audible utterances via the one or more ad hoc wireless communication links.

29. The headphone assembly of claim **28**, wherein:

the mobile, digital audio player is a first digital audio source;

the headphone assembly transitions to play digital audio content received wirelessly from a second digital audio source via a second wireless communication link based on, at least, a signal strength level for the second wireless communication link, wherein the second digital audio source is different from the first digital audio source.

30. The headphone assembly of claim **23**, wherein upon activation of the microphone by the user, data are transmitted about the headphone assembly to a remote device.

31. The headphone assembly of claim **23**, wherein:

the mobile, digital audio player is a first digital audio source;

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the headphone assembly transitions to play digital audio content received wirelessly from a second digital audio source via a second wireless communication link based on, at least, a signal strength level for the second wireless communication link, wherein the second digital audio source is different from the first digital audio source.

32. The headphone assembly of claim **1**, wherein:

the wireless circuit comprises first and second wireless circuits;

the first wireless circuit is in the first earphone; and the second wireless circuit is in the second earphone.

33. The headphone assembly of claim **32**, wherein each of the first and second earphones comprise earbuds.

34. The headphone assembly of claim **33**, wherein each of the first and second earphones comprises:

a body portion that sits at least partially in an ear of the user when the headphone assembly is worn by the user; and

an elongated portion that extends from the body portion.

35. The headphone assembly of claim **34**, wherein at least one of the first and second earphones is charged by a docking station.

36. The headphone assembly of claim **35**, wherein:

in a first audio play mode, the first and second earphones play audio content stored on a mobile, digital audio player and transmitted to the headphone assembly from the mobile, digital audio player via the one or more ad hoc wireless communication links; and

in a second audio play mode, the earphones play audio content streamed from the remote, network-connected server.

37. The headphone assembly of claim **36**, wherein the processor is for:

processing audible utterances by the user picked up by the microphone in response to activation of the microphone by the user; and

transmitting a communication based on the audible utterances via the one or more ad hoc wireless communication links.

38. The headphone assembly of claim **36**, wherein:

the mobile, digital audio player is a first digital audio source;

the headphone assembly transitions to play digital audio content received wirelessly from a second digital audio source via a second wireless communication link based on, at least, a signal strength level for the second wireless communication link, wherein the second digital audio source is different from the first digital audio source.

39. The headphone assembly of claim **35**, wherein the processor is for:

processing audible utterances by the user picked up by the microphone in response to activation of the microphone by the user; and

transmitting a communication based on the audible utterances via the one or more ad hoc wireless communication links.

40. The headphone assembly of claim **39**, wherein:

the mobile, digital audio player is a first digital audio source;

the headphone assembly transitions to play digital audio content received wirelessly from a second digital audio source via a second wireless communication link based on, at least, a signal strength level for the second

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wireless communication link, wherein the second digital audio source is different from the first digital audio source.

41. The headphone assembly of claim 34, wherein: the mobile, digital audio player is a first digital audio source;

the headphone assembly transitions to play digital audio content received wirelessly from a second digital audio source via a second wireless communication link based on, at least, a signal strength level for the second wireless communication link, wherein the second digital audio source is different from the first digital audio source.

42. The headphone assembly of claim 33, wherein each of the first and second earphones further comprises:

an adjustable, curved hanger bar that sits upon an upper external curvature of the user's ear, behind an upper portion of an auricula of the user's ear, when the headphone assembly is worn by the user; and a body connected to the hanger bar, wherein the earphone extends from the body into the user's ear when the headphone assembly is worn by the user.

43. The headphone assembly of claim 42, wherein at least one of the first and second earphones is charged by a docking station.

44. The headphone assembly of claim 42, wherein: the mobile, digital audio player is a first digital audio source;

the headphone assembly transitions to play digital audio content received wirelessly from a second digital audio source via a second wireless communication link based on, at least, a signal strength level for the second wireless communication link, wherein the second digital audio source is different from the first digital audio source.

45. The headphone assembly of claim 42, wherein upon activation of the microphone by the user, data are transmitted about the headphone assembly to a remote device.

46. The headphone assembly of claim 42, wherein the headphone assembly is for receiving firmware upgrades transmitted from the remote, network-connected server.

47. The headphone assembly of claim 1, wherein the headphone assembly further comprises first and second integrated circuits, wherein the first integrated circuit comprises the wireless communication circuit and the second integrated circuit, which is separate from the first integrated circuit, comprises the processor.

48. The headphone assembly of claim 1, wherein each of the first and second earphones further comprises:

an adjustable, curved hanger bar that sits upon an upper external curvature of the user's ear, behind an upper portion of an auricula of the user's ear, when the headphone assembly is worn by the user; and a body connected to the hanger bar, wherein the earphone extends from the body into the user's ear when the headphone assembly is worn by the user.

49. The headphone assembly of claim 1, wherein each of the first and second earphones comprise earbuds.

50. The headphone assembly of claim 1, wherein each of the first and second earphones comprise on-ear speaker elements.

51. The headphone assembly of claim 1, wherein each of the first and second earphones comprise over-ear speaker elements.

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52. The headphone assembly of claim 1, wherein the processor comprises a digital signal processor that provides a sound quality enhancement for the audio content played by the acoustic transducers.

53. The headphone assembly of claim 52, further comprising a baseband processor circuit that is in communication with the wireless communication circuit.

54. The headphone assembly of claim 1, wherein each of the first and second earphones comprise:

an antenna for receiving wireless signals from the mobile, digital audio player via the one or more ad hoc wireless communication links;

a wireless communication circuit connected to the antenna, wherein the wireless communication circuit is for receiving and transmitting wireless signals to and from the headphone assembly;

a processor;

a memory for storing firmware that is executed by the processor; and

a rechargeable battery for powering the headphone assembly.

55. The headphone assembly of claim 54, wherein each of the first and second earphones comprise an earbud.

56. The headphone assembly of claim 55, wherein the processor of each of the first and second earphones comprises a digital signal processor that provides a sound quality enhancement for the audio content played by the acoustic transducer of the earphone.

57. The headphone assembly of claim 56, wherein the processor of each of the first and second earphones comprises a baseband processor circuit that is in communication with the wireless communication circuit of the earphone.

58. A headphone assembly comprising:

first and second earphones, wherein each of the first and second earphones comprises an acoustic transducer; and

an antenna for receiving wireless signals from a mobile, digital audio player via one or more ad hoc wireless communication link, wherein the mobile, digital audio player is a first digital audio source;

a wireless communication circuit connected to the antenna, wherein the wireless communication circuit is for receiving and transmitting wireless signals to and from the headphone assembly;

a processor;

a rechargeable battery for powering the headphone assembly; and

a microphone for picking up utterances by a user of the headphone assembly; and

wherein the headphone assembly is configured to play, by the first and second earphones, digital audio content transmitted by the mobile, digital audio player via the one or more ad hoc wireless communication links;

wherein the processor is configured to, upon activation of a user-control of the headphone assembly, initiate transmission of a request to a remote, network-connected server that is in wireless communication with the mobile, digital audio player; and

wherein the headphone assembly transitions to play digital audio content received wirelessly from a second digital audio source via a second wireless communication link based on, at least, a signal strength level for the second wireless communication link, wherein the second digital audio source is different from the first digital audio source.

59. The headphone assembly of claim **58**, wherein:
in a first audio play mode, the first and second earphones
play audio content stored on the mobile, digital audio
player and transmitted to the headphone assembly from
the mobile, digital audio player via the one or more ad
hoc wireless communication links; and
in a second audio play mode, the earphones play audio
content streamed from the remote, network-connected
server.

60. The headphone assembly of claim **59**, wherein the
processor is for:
processing audible utterances by the user picked up by the
microphone in response to activation of the microphone
by the user; and
transmitting a communication based on the audible utter-
ances via the one or more ad hoc wireless communi-
cation links.


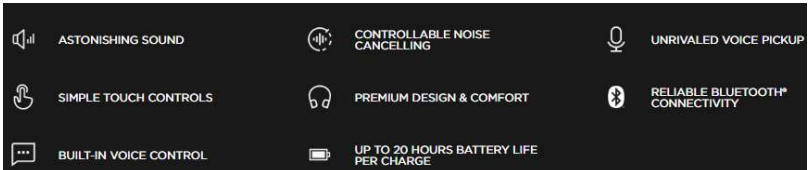
61. The headphone assembly of claim **58**, wherein upon
activation of the microphone by the user, data are transmit-
ted about the headphone assembly to a remote device.

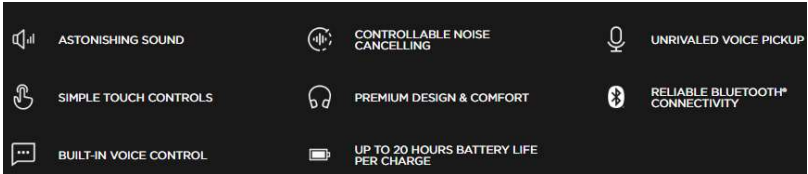

62. The headphone assembly of claim **58**, wherein the
headphone assembly is for receiving firmware upgrades
transmitted from the remote, network-connected server.

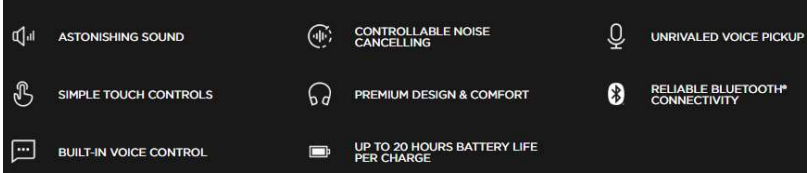
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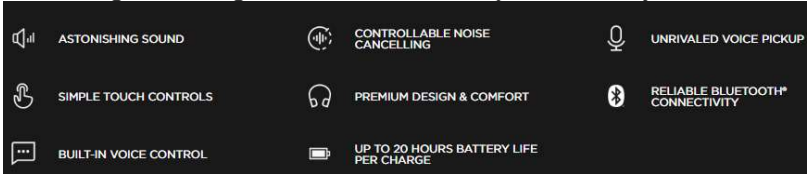
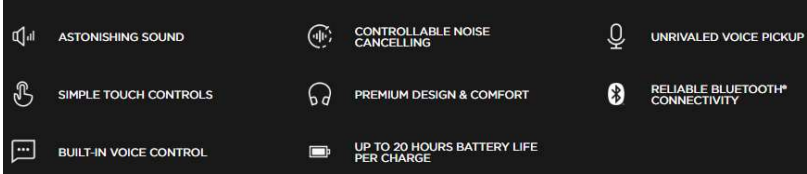
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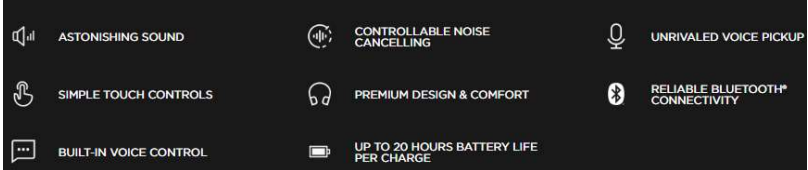
Bose Infringement Chart

Infringement of Claim 1 of U.S. Patent No. 10,206,025 by Bose 700 Headphones	
A system comprising: a mobile, digital audio player that stores digital audio content;	Bose 700 Series headphones are configured to connect (e.g., via Bluetooth) to a mobile, digital audio player (e.g., a smartphone) that stores digital audio content.   https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise_cancelling_headphones-700.html#v=noise_cancelling_headphones_700_soapstone

Infringement of Claim 1 of U.S. Patent No. 10,206,025 by Bose 700 Headphones	
<p>and a headphone assembly, separate from and in wireless communication with the mobile digital audio player,</p>	<p>Bose 700 Series headphones include a headphone assembly separate from and in wireless communication with the mobile digital audio player.</p> <div style="text-align: center;">  </div> <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p>
<p>wherein the headphone assembly comprises: first and second earphones, wherein each of the first and second earphones comprises an acoustic transducer;</p>	<p>Bose 700 Series headphones include a first and second earphone, where each includes an acoustic transducer.</p> <div style="text-align: center;">  </div> <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p>

Infringement of Claim 1 of U.S. Patent No. 10,206,025 by Bose 700 Headphones	
an antenna for receiving wireless signals from the mobile, digital audio player via one or more ad hoc wireless communication links;	<p>Bose 700 Series headphones include an antenna for receiving wireless signals from a mobile digital audio player via one or more ad hoc wireless communications links.</p>  <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p> <h3>Bluetooth</h3> <p>Bluetooth range: Up to 33 ft (10 m) Bluetooth version: 5.0 (including all headphone profiles) Codec: SBC and AAC</p> <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p>

Infringement of Claim 1 of U.S. Patent No. 10,206,025 by Bose 700 Headphones	
<p>a wireless communication circuit connected to the at least one antenna, wherein the at least one wireless communication circuit is for receiving and transmitting wireless signals to and from the headphone assembly;</p>	<p>Bose 700 Series headphones include a wireless communication circuit connected to the at least one antenna, wherein the at least one wireless communication circuit is for receiving and transmitting wireless signals to and from the headphone assembly.</p>  <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p> <h3>Bluetooth</h3> <hr/> <p>Bluetooth range: Up to 33 ft (10 m) Bluetooth version: 5.0 (including all headphone profiles) Codec: SBC and AAC</p> <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p>
<p>a processor;</p>	<p>Bose 700 Series headphones include a processor.</p>  <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p>


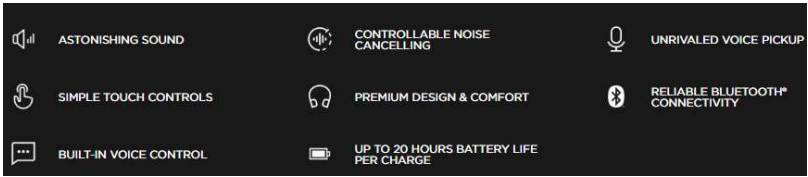
Infringement of Claim 1 of U.S. Patent No. 10,206,025 by Bose 700 Headphones	
<p>a rechargeable battery for powering the headphone assembly; and</p>	<p>Bose 700 Series headphones include a rechargeable battery for powering the headphone assembly.</p> <p>Battery</p> <hr/> <p>Battery life: Up to 20 hours Battery charging time: Up to 2.5 hours Quick 15-minute charge: For up to 3.5 hours Battery charge method: USB-C</p> <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p>
<p>a microphone for picking up utterances by a user of the headphone assembly; and</p>	<p>Bose 700 Series headphones include a microphone for picking up utterances by a user of the headphone assembly.</p>  <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p> <p>Microphones</p> <hr/> <p>8 total microphones 6 microphones for Active Noise Cancelling (ANC) 4 microphones for Voice Pickup (2 are shared with ANC)</p> <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p>

Infringement of Claim 1 of U.S. Patent No. 10,206,025 by Bose 700 Headphones	
<p>a remote, network-connected server that is in wireless communication with the mobile, digital audio player;</p>	<p>Bose 700 Series headphones are configured to communicate with a remote, network-connected server that is in wireless communication with the mobile, digital audio player.</p> <p style="text-align: center;">ASTONISHING SOUND</p> <h2 style="text-align: center;">Nothing comes between you and your music</h2> <p>The patented active noise cancelling technology in Headphones 700 uses microphones both inside and outside the earcups to monitor the sounds around you and instantly produce an opposite signal to cancel them out, creating an empty stage for your music to play on. At the same time, our proprietary TriPort acoustic headphone structure uses external ports to vent the earcups and maximize the acoustic space inside, giving your music depth and detail.</p> <p style="text-align: center;">https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p>
<p>wherein the mobile, digital audio player is for transmitting digital audio content to the headphone assembly via the one or more ad hoc wireless communication links, such that the digital audio content received by the headphone assembly from the mobile, digital audio player is playable by the first and second earphones;</p>	<p>Bose 700 Series headphones are configured to communicate with the mobile, digital audio player is for transmitting digital audio content to the headphone assembly via the one or more ad hoc wireless communication links, such that the digital audio content received by the headphone assembly from the mobile, digital audio player is playable by the first and second earphones.</p> <p style="text-align: center;">ASTONISHING SOUND</p> <h2 style="text-align: center;">Nothing comes between you and your music</h2> <p>The patented active noise cancelling technology in Headphones 700 uses microphones both inside and outside the earcups to monitor the sounds around you and instantly produce an opposite signal to cancel them out, creating an empty stage for your music to play on. At the same time, our proprietary TriPort acoustic headphone structure uses external ports to vent the earcups and maximize the acoustic space inside, giving your music depth and detail.</p> <p style="text-align: center;">https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p>

Infringement of Claim 1 of U.S. Patent No. 10,206,025 by Bose 700 Headphones	
and wherein the processor is for, upon activation of a user-control of the headphone assembly, initiating transmission of a request to the remote, network-connected server.	<p>Bose 700 Series headphones include a processor for, upon activation of a user-control of the headphone assembly, initiating transmission of a request to the remote, network-connected server.</p> <h3>Microphones</h3> <hr/> <ul style="list-style-type: none">8 total microphones6 microphones for Active Noise Cancelling (ANC)4 microphones for Voice Pickup (2 are shared with ANC) <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p> <h3>Controls</h3> <hr/> <ul style="list-style-type: none">Touch: Volume, skip track, phone calls, customizable shortcutButtons: VPA (Google Assistant, Amazon Alexa), Bluetooth, Controllable Noise CancellingVoice-enabled VPA: Amazon AlexaBose Music appSiri <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p>

EXHIBIT E

Bose Infringement Chart









Infringement of Claim 1 of U.S. Patent No. 10,368,155 by Bose 700 Headphones	
A wireless headphone assembly comprising:	<p>Bose 700 Series headphones are a wireless headphone assembly.</p>   <ul style="list-style-type: none">ASTONISHING SOUNDCONTROLLABLE NOISE CANCELLINGUNRIVALED VOICE PICKUPSIMPLE TOUCH CONTROLSPREMIUM DESIGN & COMFORTRELIABLE BLUETOOTH® CONNECTIVITYBUILT-IN VOICE CONTROLUP TO 20 HOURS BATTERY LIFE PER CHARGE <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p>

Infringement of Claim 1 of U.S. Patent No. 10,368,155 by Bose 700 Headphones

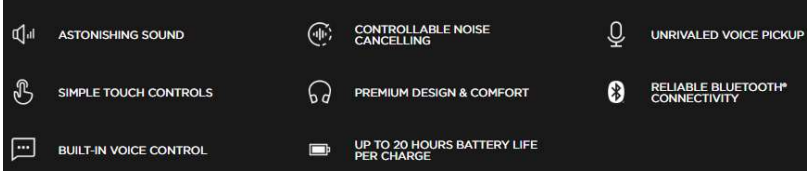
first and second earphones, wherein each of the first and second earphones comprises an acoustic transducer;

Bose 700 Series headphones include first and second earphones, wherein each of the first and second earphones comprises an acoustic transducer.



 ASTONISHING SOUND	 CONTROLLABLE NOISE CANCELLING	 UNRIVALED VOICE PICKUP
 SIMPLE TOUCH CONTROLS	 PREMIUM DESIGN & COMFORT	 RELIABLE BLUETOOTH* CONNECTIVITY
 BUILT-IN VOICE CONTROL	 UP TO 20 HOURS BATTERY LIFE PER CHARGE	

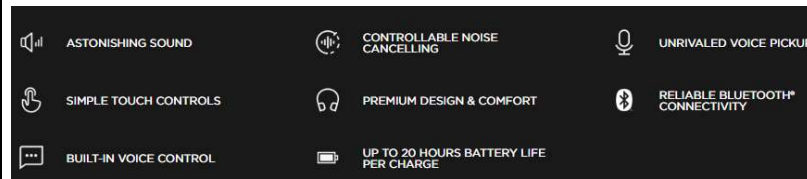
[https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones 700 soapstone](https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone)

Infringement of Claim 1 of U.S. Patent No. 10,368,155 by Bose 700 Headphones	
an antenna for receiving wireless signals;	<p>Bose 700 Series headphones include an antenna for receiving wireless signals.</p>  <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p> <h3>Bluetooth</h3> <p>Bluetooth range: Up to 33 ft (10 m) Bluetooth version: 5.0 (including all headphone profiles) Codec: SBC and AAC</p> <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p>

Infringement of Claim 1 of U.S. Patent No. 10,368,155 by Bose 700 Headphones

a wireless communication circuit connected to the antenna, wherein the wireless communication circuit is for receiving and transmitting wireless signals to and from the wireless headphone assembly;

Bose 700 Series headphones include a wireless communication circuit connected to the antenna, wherein the wireless communication circuit is for receiving and transmitting wireless signals to and from the wireless headphone assembly.



https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone

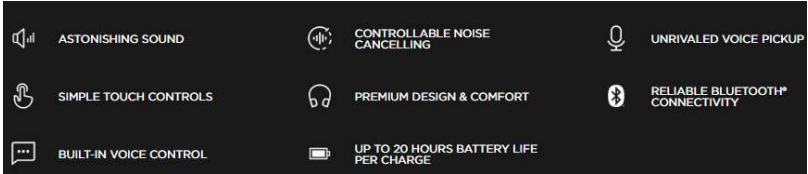
Bluetooth

Bluetooth range: Up to 33 ft (10 m)

Bluetooth version: 5.0 (including all headphone profiles)

Codec SBC and AAC


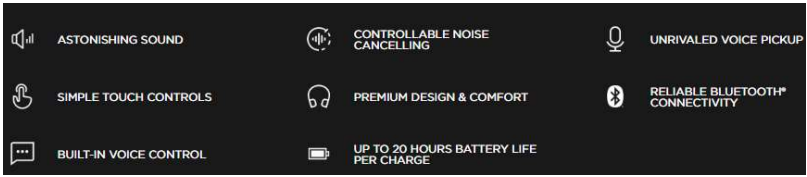
https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone


Infringement of Claim 1 of U.S. Patent No. 10,368,155 by Bose 700 Headphones	
<p>a processor in communication with the wireless communication circuit; and</p>	<p>Bose 700 Series headphones include a processor in communication with the wireless communication circuit.</p>  <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p>
<p>a rechargeable battery for powering the wireless headphone assembly,</p>	<p>Bose 700 Series headphones include a rechargeable battery for powering the wireless headphone assembly.</p> <p>Battery</p> <hr/> <p>Battery life: Up to 20 hours Battery charging time: Up to 2.5 hours Quick 15-minute charge: For up to 3.5 hours Battery charge method: USB-C</p> <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p>

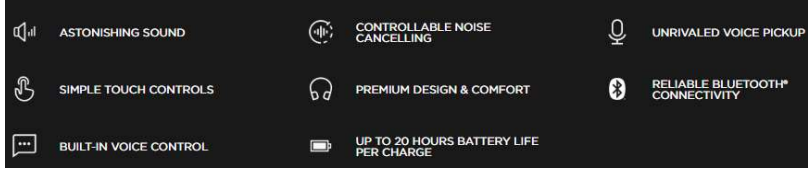
Infringement of Claim 1 of U.S. Patent No. 10,368,155 by Bose 700 Headphones	
wherein the headphone assembly is configured, with the processor, to transition automatically from playing digital audio content received wirelessly by the headphone assembly via a first wireless network to playing digital audio content received wirelessly by the headphone assembly via a second wireless network.	<p>Bose 700 Series headphones are configured, with the processor, to transition automatically from playing digital audio content received wirelessly by the headphone assembly via a first wireless network to playing digital audio content received wirelessly by the headphone assembly via a second wireless network.</p> <p>Can Bose Noise Cancelling Headphones 700 be connected to two mobile devices simultaneously?</p> <p>Yes. Multi-point technology allows Bose Headphones 700 to maintain a wireless Bluetooth connection to two devices at the same time — for example, an iPad and a smartphone. So while you're watching video on the connected iPad, the headphones will automatically pause the video to answer a call from the connected smartphone. When the call is finished, the headphones switch back to the video on the iPad.</p> <p>https://www.bose.com/content/consumer_electronics/b2c/north_america/websites/en_us/product/noise_cancelling_headphones_700.html#ProductTabs_tab4</p>

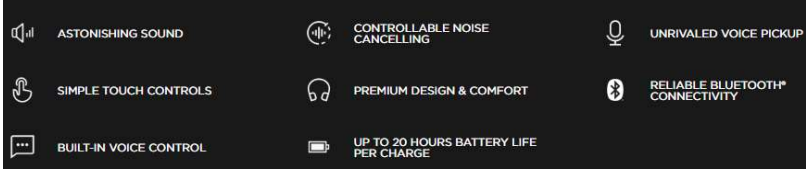
EXHIBIT F

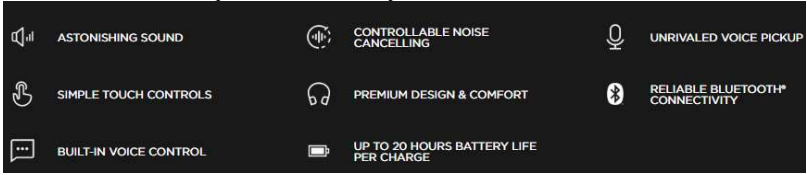
Bose Infringement Chart

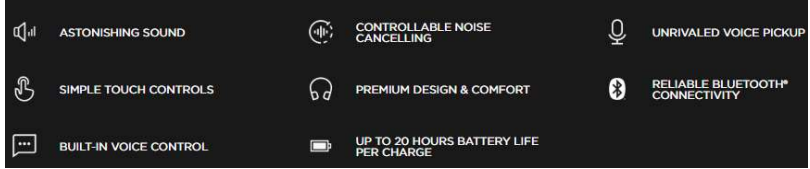
Infringement of Claim 1 of U.S. Patent No. 10,469,934 by Bose 700 Headphones	
A headphone assembly comprising: first and second earphones,	Bose 700 Series headphones are a headphone assembly comprising a first and second earphone.   https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone

Infringement of Claim 1 of U.S. Patent No. 10,469,934 by Bose 700 Headphones	
wherein each of the first and second earphones comprises an acoustic transducer; and	<p>Bose 700 Series headphones include a first and second earphone, where each includes an acoustic transducer</p>  <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p>

Infringement of Claim 1 of U.S. Patent No. 10,469,934 by Bose 700 Headphones	
an antenna for receiving wireless signals from a mobile, digital audio player via one or more ad hoc wireless communication links;	<p>Bose 700 Series headphones include an antenna for receiving wireless signals from a mobile digital audio player via one or more ad hoc wireless communications links.</p>  <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p> <h3>Bluetooth</h3> <p>Bluetooth range: Up to 33 ft (10 m) Bluetooth version: 5.0 (including all headphone profiles) Codec SBC and AAC</p> <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p>

Infringement of Claim 1 of U.S. Patent No. 10,469,934 by Bose 700 Headphones	
<p>a wireless communication circuit connected to the antenna, wherein the wireless communication circuit is for receiving and transmitting wireless signals to and from the headphone assembly;</p>	<p>Bose 700 Series headphones include a wireless communication circuit connected to the at least one antenna, wherein the at least one wireless communication circuit is for receiving and transmitting wireless signals to and from the headphone assembly.</p>
	
	<p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p>
	<h3>Bluetooth</h3>
	<p>Bluetooth range: Up to 33 ft (10 m) Bluetooth version: 5.0 (including all headphone profiles) Codec SBC and AAC</p>
	<p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p>

Infringement of Claim 1 of U.S. Patent No. 10,469,934 by Bose 700 Headphones	
<p>a processor;</p>	<p>Bose 700 Series headphones include a processor.</p>  <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p>
<p>a memory for storing firmware that is executed by the processor;</p>	<p>Bose 700 Series headphones include memory for storing firmware to be executed by the processor.</p> <h3 style="text-align: center;">Updating your headphones</h3> <p style="text-align: center;"><small>Applies to: Bose Noise Cancelling Headphones 700</small></p> <p style="text-align: center;"><small>Periodic updates will be available for your headphones. The Bose Music app will notify you when an update is available for your headphones.</small></p> <p>https://www.bose.com/en_us/support/article/updating-the-headphones.html</p>
<p>a rechargeable battery for powering the headphone assembly; and</p>	<p>Bose 700 Series headphones include a rechargeable battery for powering the headphone assembly</p> <h3 style="text-align: center;">Battery</h3> <hr style="width: 20%; margin: auto;"/> <p style="text-align: center;"> Battery life: Up to 20 hours Battery charging time: Up to 2.5 hours Quick 15-minute charge: For up to 3.5 hours Battery charge method: USB-C </p> <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p>

Infringement of Claim 1 of U.S. Patent No. 10,469,934 by Bose 700 Headphones	
<p>a microphone for picking up utterances by a user of the headphone assembly; and</p>	<p>Bose 700 Series headphones include a microphone for picking up utterances by a user of the headphone assembly.</p>  <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p> <h3>Microphones</h3> <p>8 total microphones 6 microphones for Active Noise Cancelling (ANC) 4 microphones for Voice Pickup (2 are shared with ANC)</p> <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p>

Infringement of Claim 1 of U.S. Patent No. 10,469,934 by Bose 700 Headphones	
wherein the headphone assembly is configured to play, by the first and second earphones, digital audio content transmitted by the mobile, digital audio player via the one or more ad hoc wireless communication links;	<p>Bose 700 Series headphones are configured to play, by the first and second earphones, digital audio content transmitted by the mobile, digital audio player via the one or more ad hoc wireless communication links.</p> <p>ASTONISHING SOUND</p> <h2>Nothing comes between you and your music</h2> <p>The patented active noise cancelling technology in Headphones 700 uses microphones both inside and outside the earcups to monitor the sounds around you and instantly produce an opposite signal to cancel them out, creating an empty stage for your music to play on. At the same time, our proprietary TriPort acoustic headphone structure uses external ports to vent the earcups and maximize the acoustic space inside, giving your music depth and detail.</p> <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise_cancelling_headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p>

Infringement of Claim 1 of U.S. Patent No. 10,469,934 by Bose 700 Headphones	
wherein the processor is configured to, upon activation of a user-control of the headphone assembly, initiate transmission of a request to a remote, network-connected server that is in wireless communication with the mobile, digital audio player; and	<p>Bose 700 Series headphones are configured to, upon activation of a user-control of the headphone assembly, initiate transmission of a request to a remote, network-connected server that is in wireless communication with the mobile, digital audio player.</p> <h3>Microphones</h3> <hr/> <ul style="list-style-type: none">8 total microphones6 microphones for Active Noise Cancelling (ANC)4 microphones for Voice Pickup (2 are shared with ANC) <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p> <h3>Controls</h3> <hr/> <ul style="list-style-type: none">Touch: Volume, skip track, phone calls, customizable shortcutButtons: VPA (Google Assistant, Amazon Alexa), Bluetooth, Controllable Noise CancellingVoice-enabled VPA: Amazon AlexaBose Music appSiri <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p>

Infringement of Claim 1 of U.S. Patent No. 10,469,934 by Bose 700 Headphones	
wherein the headphone assembly is for receiving firmware upgrades transmitted from the remote, network-connected server.	<p>Bose 700 Series headphones are configured to receive firmware upgrades transmitted from the remote, network-connected server</p> <h2>Updating your headphones</h2> <p><small>Applies to: Bose Noise Cancelling Headphones 700</small></p> <p>Periodic updates will be available for your headphones. The Bose Music app will notify you when an update is available for your headphones.</p> <p>https://www.bose.com/en_us/support/article/updating-the-headphones.html</p>

EXHIBIT G

K&L GATES

July 9, 2020

Benjamin E. Weed
benjamin.weed@klgates.com

Via FedEx and Electronic Mail

T +1 312 781 7166
F +1 312 827 8000

Bose Corporation
c/o CT Corporation Systems Inc. (Registered Agent)
155 Federal Street, Suite 700
Boston, MA 02110

David Schuler
david_schuler@bose.com
Chief Intellectual Property Counsel
Bose Corporation
The Mountain Rd.,
Framingham, MA 01701

Re: Notice of Infringement of Koss Corporation Patents

Mr. Schuler:

Koss Corporation (“Koss”), located in Milwaukee Wisconsin, is one of the world’s foremost innovators in personal audio technology. Since 1958, founder and inventor John C. Koss and his company have been inventing, designing, manufacturing, and selling personal audio products, including high-fidelity headphones and audio accessories, that have made Koss a leader in the field. Koss is also an Original Equipment Manufacturer and technology licensing company that owns a growing number of patents directed to circuits and systems for receiving streaming audio from data sources such as digital audio players over wireless networks.

This letter is to address Bose’s infringement of several of Koss’ patents.

Koss is committed to protecting its innovations and its substantial investment in wireless audio technology, including enforcing its patents as needed. Such patents include U.S. Patent Nos. 10,206,025 (“the ’025 Patent”), 10,368,155 (“the ’155 Patent”), and 10,469,934 (“the ’934 Patent”).

Bose’s wireless audio products have been made, offered for sale, and sold for some time, and continue to be made, offered for sale, and sold today; these products include wireless earbud and headphone products that utilize circuits and systems for receiving streaming audio from data sources such as digital audio players over wireless networks (e.g., Bose 700 products).

The conduct of making, offering to sell, and selling such products in the United States constitutes infringement of Koss’ patents, namely one or more claim of at least the ’025, ’155, and ’934

Patents. Attached to this letter are charts showing, in preliminary terms, the manner in which the aforementioned products infringe these patents.

Please respond to the undersigned by July 17, 2020 and confirm that: (1) Bose will ensure that all the offering and selling of the aforementioned products and other wireless earbud and headphone products that utilize circuits and systems for receiving streaming audio from data sources such as digital audio players over wireless networks, will stop immediately; and (2) personnel within Bose with relevant authority will promptly meet with Koss to discuss patent license terms in good faith, including sharing, under appropriate confidentiality agreements, the 2018, 2019, and 2020 United States-based unit sales of the aforementioned products and other wireless audio products.

Koss hopes that Bose will respond to Koss and engage in meaningful discussion.


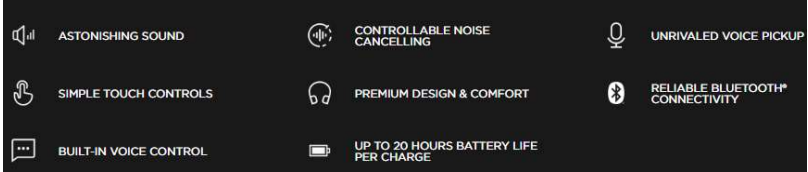
Very truly yours,

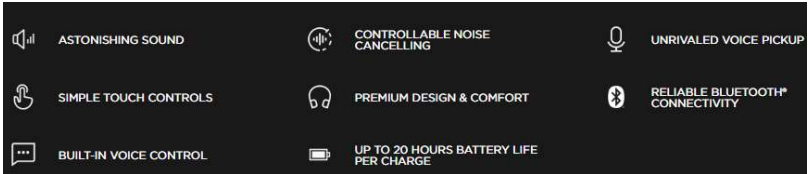

A handwritten signature in blue ink, appearing to read "B. Weed", is positioned above the typed name.

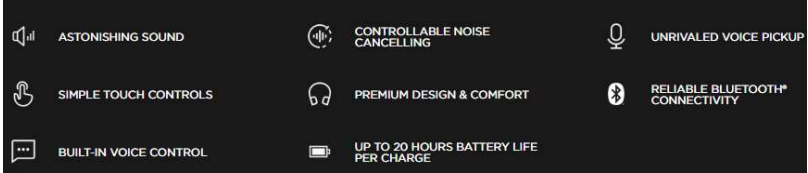
Benjamin E. Weed, Esq.

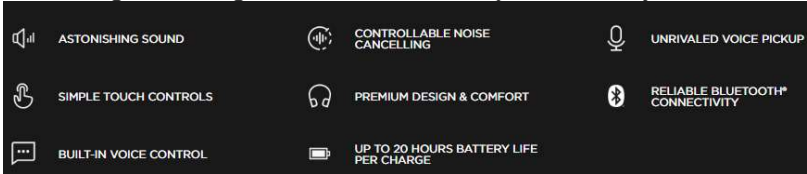
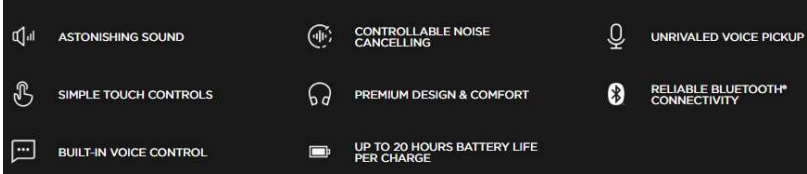
ATTACHMENT


Bose Infringement Chart

Infringement of Claim 1 of U.S. Patent No. 10,206,025 by Bose 700 Headphones	
A system comprising: a mobile, digital audio player that stores digital audio content;	<p>Bose 700 Series headphones are configured to connect (e.g., via Bluetooth) to a mobile, digital audio player (e.g., a smartphone) that stores digital audio content.</p>   <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p>

Infringement of Claim 1 of U.S. Patent No. 10,206,025 by Bose 700 Headphones	
<p>and a headphone assembly, separate from and in wireless communication with the mobile digital audio player,</p>	<p>Bose 700 Series headphones include a headphone assembly separate from and in wireless communication with the mobile digital audio player.</p> <div style="text-align: center;">  </div> <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p>
<p>wherein the headphone assembly comprises: first and second earphones, wherein each of the first and second earphones comprises an acoustic transducer;</p>	<p>Bose 700 Series headphones include a first and second earphone, where each includes an acoustic transducer.</p> <div style="text-align: center;">  </div> <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p>

Infringement of Claim 1 of U.S. Patent No. 10,206,025 by Bose 700 Headphones	
an antenna for receiving wireless signals from the mobile, digital audio player via one or more ad hoc wireless communication links;	<p>Bose 700 Series headphones include an antenna for receiving wireless signals from a mobile digital audio player via one or more ad hoc wireless communications links.</p>  <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p> <h3>Bluetooth</h3> <p>Bluetooth range: Up to 33 ft (10 m) Bluetooth version: 5.0 (including all headphone profiles) Codec: SBC and AAC</p> <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p>



Infringement of Claim 1 of U.S. Patent No. 10,206,025 by Bose 700 Headphones	
<p>a wireless communication circuit connected to the at least one antenna, wherein the at least one wireless communication circuit is for receiving and transmitting wireless signals to and from the headphone assembly;</p>	<p>Bose 700 Series headphones include a wireless communication circuit connected to the at least one antenna, wherein the at least one wireless communication circuit is for receiving and transmitting wireless signals to and from the headphone assembly.</p>  <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p> <h3>Bluetooth</h3> <hr/> <p>Bluetooth range: Up to 33 ft (10 m) Bluetooth version: 5.0 (including all headphone profiles) Codec: SBC and AAC</p> <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p>
<p>a processor;</p>	<p>Bose 700 Series headphones include a processor.</p>  <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p>

Infringement of Claim 1 of U.S. Patent No. 10,206,025 by Bose 700 Headphones	
<p>a rechargeable battery for powering the headphone assembly; and</p>	<p>Bose 700 Series headphones include a rechargeable battery for powering the headphone assembly.</p> <p>Battery</p> <hr/> <p>Battery life: Up to 20 hours Battery charging time: Up to 2.5 hours Quick 15-minute charge: For up to 3.5 hours Battery charge method: USB-C</p> <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p>
<p>a microphone for picking up utterances by a user of the headphone assembly; and</p>	<p>Bose 700 Series headphones include a microphone for picking up utterances by a user of the headphone assembly.</p>  <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p> <p>Microphones</p> <hr/> <p>8 total microphones 6 microphones for Active Noise Cancelling (ANC) 4 microphones for Voice Pickup (2 are shared with ANC)</p> <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p>

Infringement of Claim 1 of U.S. Patent No. 10,206,025 by Bose 700 Headphones	
<p>a remote, network-connected server that is in wireless communication with the mobile, digital audio player;</p>	<p>Bose 700 Series headphones are configured to communicate with a remote, network-connected server that is in wireless communication with the mobile, digital audio player.</p> <p style="text-align: center;">ASTONISHING SOUND</p> <h2 style="text-align: center;">Nothing comes between you and your music</h2> <p>The patented active noise cancelling technology in Headphones 700 uses microphones both inside and outside the earcups to monitor the sounds around you and instantly produce an opposite signal to cancel them out, creating an empty stage for your music to play on. At the same time, our proprietary TriPort acoustic headphone structure uses external ports to vent the earcups and maximize the acoustic space inside, giving your music depth and detail.</p> <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p>
<p>wherein the mobile, digital audio player is for transmitting digital audio content to the headphone assembly via the one or more ad hoc wireless communication links, such that the digital audio content received by the headphone assembly from the mobile, digital audio player is playable by the first and second earphones;</p>	<p>Bose 700 Series headphones are configured to communicate with the mobile, digital audio player is for transmitting digital audio content to the headphone assembly via the one or more ad hoc wireless communication links, such that the digital audio content received by the headphone assembly from the mobile, digital audio player is playable by the first and second earphones.</p> <p style="text-align: center;">ASTONISHING SOUND</p> <h2 style="text-align: center;">Nothing comes between you and your music</h2> <p>The patented active noise cancelling technology in Headphones 700 uses microphones both inside and outside the earcups to monitor the sounds around you and instantly produce an opposite signal to cancel them out, creating an empty stage for your music to play on. At the same time, our proprietary TriPort acoustic headphone structure uses external ports to vent the earcups and maximize the acoustic space inside, giving your music depth and detail.</p> <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p>

Infringement of Claim 1 of U.S. Patent No. 10,206,025 by Bose 700 Headphones	
and wherein the processor is for, upon activation of a user-control of the headphone assembly, initiating transmission of a request to the remote, network-connected server.	<p>Bose 700 Series headphones include a processor for, upon activation of a user-control of the headphone assembly, initiating transmission of a request to the remote, network-connected server.</p> <h3>Microphones</h3> <hr/> <ul style="list-style-type: none">8 total microphones6 microphones for Active Noise Cancelling (ANC)4 microphones for Voice Pickup (2 are shared with ANC) <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p> <h3>Controls</h3> <hr/> <ul style="list-style-type: none">Touch: Volume, skip track, phone calls, customizable shortcutButtons: VPA (Google Assistant, Amazon Alexa), Bluetooth, Controllable Noise CancellingVoice-enabled VPA: Amazon AlexaBose Music appSiri <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p>

Bose Infringement Chart









Infringement of Claim 1 of U.S. Patent No. 10,368,155 by Bose 700 Headphones	
A wireless headphone assembly comprising:	<p>Bose 700 Series headphones are a wireless headphone assembly.</p>   <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p>

Infringement of Claim 1 of U.S. Patent No. 10,368,155 by Bose 700 Headphones

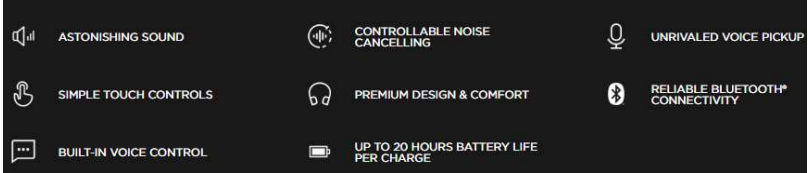
first and second earphones, wherein each of the first and second earphones comprises an acoustic transducer;

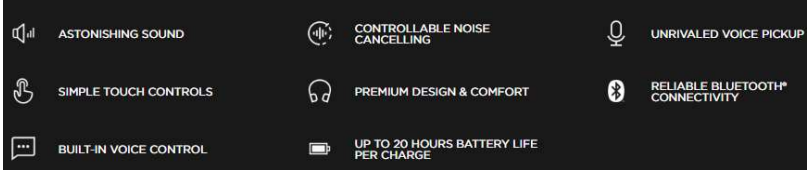
Bose 700 Series headphones include first and second earphones, wherein each of the first and second earphones comprises an acoustic transducer.

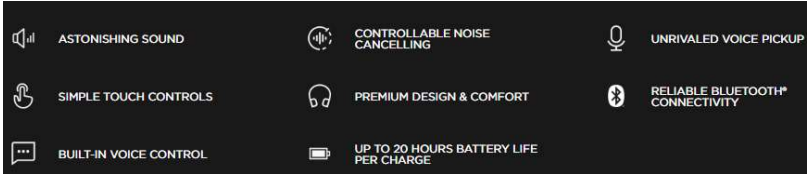


 ASTONISHING SOUND	 CONTROLLABLE NOISE CANCELLING	 UNRIVALED VOICE PICKUP
 SIMPLE TOUCH CONTROLS	 PREMIUM DESIGN & COMFORT	 RELIABLE BLUETOOTH* CONNECTIVITY
 BUILT-IN VOICE CONTROL	 UP TO 20 HOURS BATTERY LIFE PER CHARGE	

[https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones 700 soapstone](https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone)


Infringement of Claim 1 of U.S. Patent No. 10,368,155 by Bose 700 Headphones	
an antenna for receiving wireless signals;	<p>Bose 700 Series headphones include an antenna for receiving wireless signals.</p>  <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p> <h3>Bluetooth</h3> <p>Bluetooth range: Up to 33 ft (10 m) Bluetooth version: 5.0 (including all headphone profiles) Codec: SBC and AAC</p> <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p>


Infringement of Claim 1 of U.S. Patent No. 10,368,155 by Bose 700 Headphones	
<p>a wireless communication circuit connected to the antenna, wherein the wireless communication circuit is for receiving and transmitting wireless signals to and from the wireless headphone assembly;</p>	<p>Bose 700 Series headphones include a wireless communication circuit connected to the antenna, wherein the wireless communication circuit is for receiving and transmitting wireless signals to and from the wireless headphone assembly.</p>
	
	<p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p>
	<h2>Bluetooth</h2>
	<p>Bluetooth range: Up to 33 ft (10 m) Bluetooth version: 5.0 (including all headphone profiles) Codec SBC and AAC</p>
	<p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p>

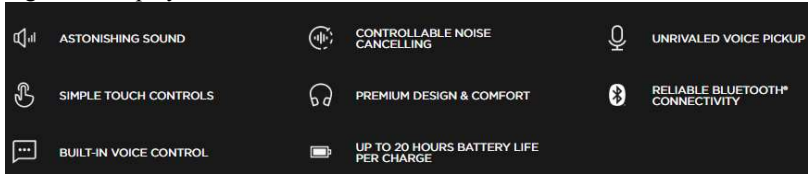
Infringement of Claim 1 of U.S. Patent No. 10,368,155 by Bose 700 Headphones	
<p>a processor in communication with the wireless communication circuit; and</p>	<p>Bose 700 Series headphones include a processor in communication with the wireless communication circuit.</p>  <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p>
<p>a rechargeable battery for powering the wireless headphone assembly,</p>	<p>Bose 700 Series headphones include a rechargeable battery for powering the wireless headphone assembly.</p> <p>Battery</p> <hr/> <p>Battery life: Up to 20 hours Battery charging time: Up to 2.5 hours Quick 15-minute charge: For up to 3.5 hours Battery charge method: USB-C</p> <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p>

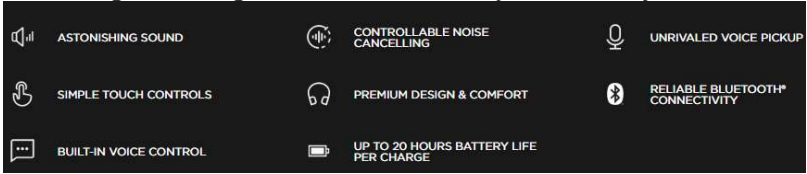
Infringement of Claim 1 of U.S. Patent No. 10,368,155 by Bose 700 Headphones	
wherein the headphone assembly is configured, with the processor, to transition automatically from playing digital audio content received wirelessly by the headphone assembly via a first wireless network to playing digital audio content received wirelessly by the headphone assembly via a second wireless network.	<p>Bose 700 Series headphones are configured, with the processor, to transition automatically from playing digital audio content received wirelessly by the headphone assembly via a first wireless network to playing digital audio content received wirelessly by the headphone assembly via a second wireless network.</p> <p>Can Bose Noise Cancelling Headphones 700 be connected to two mobile devices simultaneously?</p> <p>Yes. Multi-point technology allows Bose Headphones 700 to maintain a wireless Bluetooth connection to two devices at the same time — for example, an iPad and a smartphone. So while you're watching video on the connected iPad, the headphones will automatically pause the video to answer a call from the connected smartphone. When the call is finished, the headphones switch back to the video on the iPad.</p> <p>https://www.bose.com/content/consumer_electronics/b2c/north_america/websites/en_us/product/noise_cancelling_headphones_700.html#ProductTabs_tab4</p>

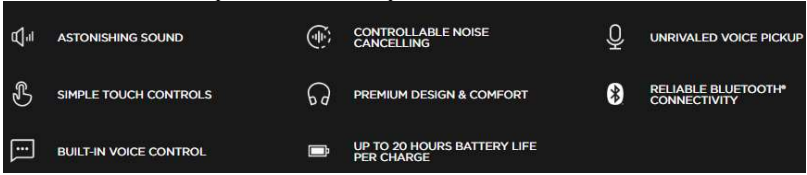
Bose Infringement Chart

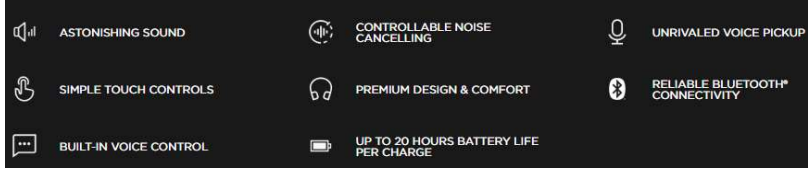
Infringement of Claim 1 of U.S. Patent No. 10,469,934 by Bose 700 Headphones	
A headphone assembly comprising: first and second earphones,	<p>Bose 700 Series headphones are a headphone assembly comprising a first and second earphone.</p>  <ul style="list-style-type: none">ASTONISHING SOUNDCONTROLLABLE NOISE CANCELLINGUNRIVALED VOICE PICKUPSIMPLE TOUCH CONTROLSPREMIUM DESIGN & COMFORTRELIABLE BLUETOOTH® CONNECTIVITYBUILT-IN VOICE CONTROLUP TO 20 HOURS BATTERY LIFE PER CHARGE <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p>

Infringement of Claim 1 of U.S. Patent No. 10,469,934 by Bose 700 Headphones	
wherein each of the first and second earphones comprises an acoustic transducer; and	<p>Bose 700 Series headphones include a first and second earphone, where each includes an acoustic transducer</p>  <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p>

Infringement of Claim 1 of U.S. Patent No. 10,469,934 by Bose 700 Headphones	
an antenna for receiving wireless signals from a mobile, digital audio player via one or more ad hoc wireless communication links;	<p>Bose 700 Series headphones include an antenna for receiving wireless signals from a mobile digital audio player via one or more ad hoc wireless communications links.</p>  <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p> <h3>Bluetooth</h3> <p>Bluetooth range: Up to 33 ft (10 m) Bluetooth version: 5.0 (including all headphone profiles) Codec SBC and AAC</p> <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p>

Infringement of Claim 1 of U.S. Patent No. 10,469,934 by Bose 700 Headphones	
<p>a wireless communication circuit connected to the antenna, wherein the wireless communication circuit is for receiving and transmitting wireless signals to and from the headphone assembly;</p>	<p>Bose 700 Series headphones include a wireless communication circuit connected to the at least one antenna, wherein the at least one wireless communication circuit is for receiving and transmitting wireless signals to and from the headphone assembly.</p>  <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p> <h3>Bluetooth</h3> <p>Bluetooth range: Up to 33 ft (10 m) Bluetooth version: 5.0 (including all headphone profiles) Codec SBC and AAC</p> <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p>

Infringement of Claim 1 of U.S. Patent No. 10,469,934 by Bose 700 Headphones	
<p>a processor;</p>	<p>Bose 700 Series headphones include a processor.</p>  <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p>
<p>a memory for storing firmware that is executed by the processor;</p>	<p>Bose 700 Series headphones include memory for storing firmware to be executed by the processor.</p> <h3 style="text-align: center;">Updating your headphones</h3> <p style="font-size: small; text-align: center;">Applies to: Bose Noise Cancelling Headphones 700</p> <p style="font-size: x-small; text-align: center;">Periodic updates will be available for your headphones. The Bose Music app will notify you when an update is available for your headphones.</p> <p>https://www.bose.com/en_us/support/article/updating-the-headphones.html</p>
<p>a rechargeable battery for powering the headphone assembly; and</p>	<p>Bose 700 Series headphones include a rechargeable battery for powering the headphone assembly</p> <h3 style="text-align: center;">Battery</h3> <hr style="width: 20%; margin: auto;"/> <p style="text-align: center; font-size: small;"> Battery life: Up to 20 hours Battery charging time: Up to 2.5 hours Quick 15-minute charge: For up to 3.5 hours Battery charge method: USB-C </p> <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p>

Infringement of Claim 1 of U.S. Patent No. 10,469,934 by Bose 700 Headphones	
<p>a microphone for picking up utterances by a user of the headphone assembly; and</p>	<p>Bose 700 Series headphones include a microphone for picking up utterances by a user of the headphone assembly.</p>  <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p> <h3>Microphones</h3> <p>8 total microphones 6 microphones for Active Noise Cancelling (ANC) 4 microphones for Voice Pickup (2 are shared with ANC)</p> <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p>

Infringement of Claim 1 of U.S. Patent No. 10,469,934 by Bose 700 Headphones	
wherein the headphone assembly is configured to play, by the first and second earphones, digital audio content transmitted by the mobile, digital audio player via the one or more ad hoc wireless communication links;	<p>Bose 700 Series headphones are configured to play, by the first and second earphones, digital audio content transmitted by the mobile, digital audio player via the one or more ad hoc wireless communication links.</p> <p>ASTONISHING SOUND</p> <h2>Nothing comes between you and your music</h2> <p>The patented active noise cancelling technology in Headphones 700 uses microphones both inside and outside the earcups to monitor the sounds around you and instantly produce an opposite signal to cancel them out, creating an empty stage for your music to play on. At the same time, our proprietary TriPort acoustic headphone structure uses external ports to vent the earcups and maximize the acoustic space inside, giving your music depth and detail.</p> <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise_cancelling_headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p>

Infringement of Claim 1 of U.S. Patent No. 10,469,934 by Bose 700 Headphones	
wherein the processor is configured to, upon activation of a user-control of the headphone assembly, initiate transmission of a request to a remote, network-connected server that is in wireless communication with the mobile, digital audio player; and	<p>Bose 700 Series headphones are configured to, upon activation of a user-control of the headphone assembly, initiate transmission of a request to a remote, network-connected server that is in wireless communication with the mobile, digital audio player.</p> <h3>Microphones</h3> <hr/> <ul style="list-style-type: none">8 total microphones6 microphones for Active Noise Cancelling (ANC)4 microphones for Voice Pickup (2 are shared with ANC) <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p> <h3>Controls</h3> <hr/> <ul style="list-style-type: none">Touch: Volume, skip track, phone calls, customizable shortcutButtons: VPA (Google Assistant, Amazon Alexa), Bluetooth, Controllable Noise CancellingVoice-enabled VPA: Amazon AlexaBose Music appSiri <p>https://www.bose.com/en_us/products/headphones/noise_cancelling_headphones/noise-cancelling-headphones-700.html#v=noise_cancelling_headphones_700_soapstone</p>

Infringement of Claim 1 of U.S. Patent No. 10,469,934 by Bose 700 Headphones	
wherein the headphone assembly is for receiving firmware upgrades transmitted from the remote, network-connected server.	<p>Bose 700 Series headphones are configured to receive firmware upgrades transmitted from the remote, network-connected server</p> <h2>Updating your headphones</h2> <p><small>Applies to: Bose Noise Cancelling Headphones 700</small></p> <p>Periodic updates will be available for your headphones. The Bose Music app will notify you when an update is available for your headphones.</p> <p>https://www.bose.com/en_us/support/article/updating-the-headphones.html</p>



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9:05am.



Delivered to 155 FEDERAL ST FL 7, BOSTON, MA 02110
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PSShip eMail Notification

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FROM	Four Embarcadero Center Suite 1200 San Francisco, CA, US, 94111
TO	Bose Corporation 155 FEDERAL ST STE 700 BOSTON, MA, US, 02110

REFERENCE	1284037.00958
SHIPPER REFERENCE	1284037.00958
SHIP DATE	Thu 7/09/2020 04:37 PM
DELIVERED TO	Receptionist/Front Desk
ORIGIN	San Francisco, CA, US, 94111
DESTINATION	BOSTON, MA, US, 02110
SPECIAL HANDLING	No Signature Required
NUMBER OF PIECES	1
TOTAL SHIPMENT WEIGHT	0.50 LB
SERVICE TYPE	FedEx Priority Overnight



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Delivered to 100 MOUNTAIN RD, FRAMINGHAM,, MA 01701
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Personal Message

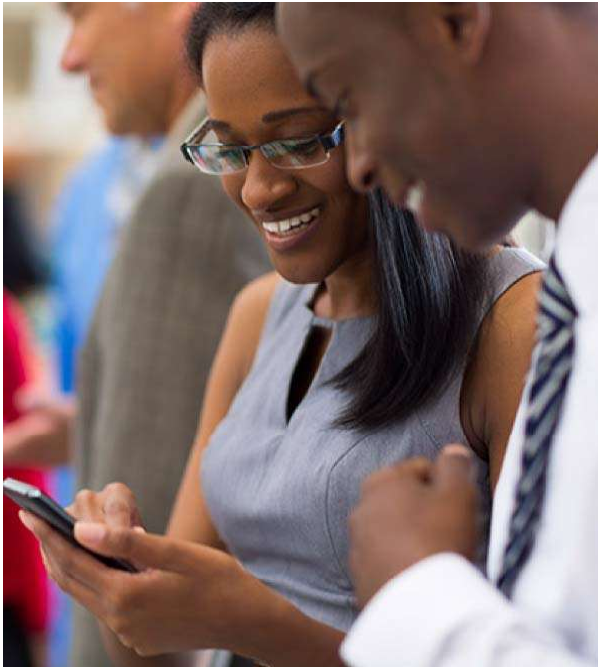
PSShip eMail Notification

TRACKING NUMBER [394681437364](#)

FROM Four Embarcadero Center
Suite 1200
San Francisco, CA, US, 94111

TO David Schuler
THE MOUNTAIN RD
FRAMINGHAM,, MA, US, 01701

REFERENCE	1284037.00958
SHIPPER REFERENCE	1284037.00958
SHIP DATE	Thu 7/09/2020 04:37 PM
DELIVERED TO	Shipping/Receiving
ORIGIN	San Francisco, CA, US, 94111
DESTINATION	FRAMINGHAM,, MA, US, 01701
SPECIAL HANDLING	No Signature Required
NUMBER OF PIECES	1
TOTAL SHIPMENT WEIGHT	0.50 LB
SERVICE TYPE	FedEx Priority Overnight



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