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Filed
JUL - 3 2012
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CLERK, U.S. DISTRICT COURT
NORTHERN DISTRICT OF CALIFORNIA
SAN JOSE

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Attorneys for Plaintiff
NOISE FREE WIRELESS, INC.

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UNITED STATES DISTRICT COURT FOR THE NORTHERN DISTRICT OF CALIFORNIA SAN JOSE DIVISION

NOISE FREE WIRELESS, INC., A Delaware Corporation, Plaintiff vs. APPLE, INC. and AUDIENCE, INC., Defendants	Case No. CV 12-03483 DMR **PLAINTIFF NOISE FREE WIRELESS, INC.'S COMPLAINT FOR DAMAGES AND INJUNCTIVE RELIEF** **DEMAND FOR JURY TRIAL**

FAXED

Plaintiff NOISE FREE WIRELESS , INC., A Delaware Corporation ("NOISE FREE" or "Plaintiff") files this Complaint against Apple, Inc. ("Apple") and Audience, Inc. ("Audience") (collectively "Defendants"), and hereby alleges as follows:

JURISDICTION AND VENUE

1. This Court has subject matter jurisdiction under the provisions of 28 U.S.C. §§ 1331, 1332, and 1338, in that this action arises under the laws of the United States, including 35 U.S.C. § 271.

2. Personal jurisdiction over Defendants comports with the United States Constitution because Defendants regularly conduct business in California; Defendants have committed and continue to commit, or have contributed and continue to contribute to the actionable conduct alleged herein occurring within the State of California; Defendants have committed tortious acts that they knew or should have known would cause injury to Plaintiff in the State of California; or otherwise have sufficient contacts with the State of California.

3. Personal jurisdiction over Apple further comports with the United States Constitution because Apple entered into a contract with Plaintiff subjecting itself to jurisdiction within this District.

4. Venue properly lies within the Northern District of California pursuant to the provisions of 28 U.S.C. § 1391(b) and (c) and 1400 (b) in that a substantial part of the events giving rise to the claims occurred in this District, and Defendants have engaged in the acts of patent infringement, misappropriation of trade secrets, and unfair competition within the District.

5. Venue further lies within this district pursuant to contractual agreement between Noise Free and Apple, and for the reason that substantial part of the events giving rise to the claims occurred in this County and injured Noise Free within this District.

NATURE OF THE ACTION

6. This is an action for patent infringement under 35 U.S.C. § 271; breach of contract; California Uniform Trade Secrets Act violations under California Civ. Code

§ 3426.1 *et seq.*; declaratory judgment of inventorship and/or patent ownership; and unfair competition under Cal. Bus. and Prof. Code § 17200 *et seq.*

THE PARTIES

7. Noise Free is a corporation duly organized and existing under the laws of State of Delaware and duly licensed and registered to do business and doing business within the County of Santa Clara, California with its principal place of business in the County of Santa Clara, California.

8. On information and belief, Defendant Apple, Inc. ("Apple"), is a corporation organized under the laws of California, with its principal place of business in Cupertino California.

9. On information and belief, Defendant Audience, Inc., is a corporation organized under the laws of Deleware, with its principal place of business in Mountain View, California.

BACKGROUND

10. Noise Free invested significant time, money, labor, and effort in developing proprietary information relating to voice quality and background noise reduction technology. Noise Free invented, designed and deployed a novel solution for background noise reduction and/or noise cancellation to improve voice quality in digital communication devices and voice enabled appliations. Noise Free also, among other things, invented, designed and deployed a user controlled noise reduction solution directed to various noise environments.

11. With the increased mobility and virtualization of the world, personal communication devices, such as cell phones, smart phones, PDAs, tablets, and laptops, are being used in environments with varying degrees of noise levels. These noise levels include homes, offices, entertainment places, restaurants, public transportation, and busy streets. The noise is received by microphones embedded in the communication devices, and consequently degrades vocal clarity and occupies valuable bandwith and network capacity.

12. Noise Free's engineers discovered the need for a more comprehensive solution to the low signal quality and signal to noise ratio in communication devices. Noise Free's engineers and began further refining a solution to the problem in the second half of 2005.

13. After beginning preliminary research and development, Noise Free was formed in or around March 2006 to capitalize on the progress that its founding engineers made in improving signal quality and voice signal to background noise ratio in communication devices that accept or receive voice inputs.

14. Over the next year, Noise Free's team of engineers worked diligently to find a viable and economical solution to the background and environemental noise problem in communication devices.

15. By the spring of 2007, Noise Free had solved the problem. Noise Free's invention allowed for the communicaiton device to monitor the enviromental and background noise and to cancel such noise before being transmitted to the receiver. In or around the same time, Noise Free also invented a novel system and method for allowing the user to control noise cancellation and/or noise reduction in various or different noise environments.

Apple, Inc.'s & Audience, Inc.'s Misappropriation.

16. Once Noise Free solved the problem of environmental and background noise reduction for modern communication devices, Noise Free approached communications and consumer electronics companies to sell its revolutionary technology. Noise Free provided presentations to some of these companies addressing the benefits of using Noise Free's technology. These presentations disclosed detailed and proprietary information. Prior to making any presentations, however, Noise Free would enter into a Non-disclosure and/or Confidentiality Agreement with the prospective purchasers and/or expressed to the prospective purchasers that the proprietary materials were to be maintained in confidence.

17. In or around the third quarter of 2007, Noise Free approached Apple to determine whether Apple would incorporate into its iPhone, iPad and/or other

communication devices Noise Free's digital-based solution for reducing background noise and increasing voice quality in mobile phones, tablets and speaker phone devices.

18. Noise Free provided a presentation to Apple in or around September 2007 detailing in general terms the advantages of incorporating Noise Free's noise reduction technolgoy into Apple's communication devices.

19. On information and belief, at that time, Apple's products used a relatively poor and/or non-existent system for background noise reduction, echo cancellation and related voice-quality enhancement technology.

20. In or around March 2008, Noise Free followed up with Apple to determine whether Apple was still interested in incorporating Noise Free's technology into its communication devices.

21. Apple expressed interested in Noise Free's noise cancellation technology and exchanged several communicaions with Noise Free's engineers about scheduling a presentation to learn more about the technology. At that time, Apple indicated to Noise Free that the previous presentations did not provide enough detail, and that Apple wanted more specific information regarding Noise Free's noise reduction technolgoy. Noise Free promised to educate Apple on Noise Free's technology and to provide comprehensive answers to any questions that Apple had.

22. Prior to sending and/or providing Apple with confidential materials, Noise Free explained to Apple that the technology and information that Noise Free would share was/is Noise Free's proprietary and confidential information. At that time, Apple orally agreed to hold any materials that Noise Free would provide and/or provided to Apple in confidence, and that the parties would enter into a formal confidentiality agreement.

23. At Apples's request, on April 1, 2008, Noise Free sent Apple a Power Point presentation entitled "Dynamic Noise Reduction" containing confidential and proprietary information. Noise Free conspicuously marked the proprietary materials contained in the presentation as Confidential.

24. On or around April 7, 2008, Apple requested that Noise Free provide more detailed information regarding how Noise Free's new environmental and background noise reduction technology worked.

25. On or around the same day, Noise Free informed Apple that part of the solution was implemented in the software in one of the microcontrollers in the communication device.

26. After there preliminary discussions, Noise Free and Apple entered into a mutual Non-Disclosure Agreement dated September 23,2008 ("the 2008 NDA"). Noise Free did not draft the NDA.

27. The Agreement provided that each party would maintain in confidence any confidential and/or proprietary material that either party received that related to audio noise management software for a period of five years.

28. On November 11, 2008, Noise Free delivered a presentation to Apple at Apple's facilities in Cupertino, California.

29. During the presentaiton, Noise Free provided highly detailed information regading Noise Free's Smart Discriminator and the Whisper Zones.

30. Noise Free also disclosed a confidential summary of its Intellecutal Property relating to noise cancellation to Apple during the November 11, 2008 presentation.

31. On or around December 1, 2008, Noise Free personnel visited Apple's facilities in Cupertino. At Apple's request, Noise Free provided Apple with (1) a highly confidential user guide entitled "Wind & Stationary Noise Reduction Guide – UG," (2) a highly confidential fully operational circuit board that included microcontrollers containing Noise Free's highly confidential firmware and source code reflecting the algorithm used to detect and filter environmental and background noise, (3) a highly confidential fully operational phone mockup utilized by Noise Free to test its noise reduction/cancellation technology against, among other things, the environmental noises coming from the whisper zones; (4) highly confidential documentation regarding the disclosed circuit board, including the bill of

materials ("BOM"), as well as block diagrams regarding the hardware and software for the operation of the noise cancellation system.

32. Furthermore, Noise Free also provided Apple's personnel with detailed instruction on how to operate the circuit board and phone mockup in order to test against various environmental and background noises. At one point, Apples' head of mobile phones and tablets was called into the meeting to learn about Noise Free's technology.

33. Once Apple learned how to operate Noise Free's hardware and software for testing the noise reduction capabilities, it asked Noise Free to leave the hardware and documentation with Apple so that it could peform additional tests.

34. On information and belief, once Apple was in possesion of Noise Free's circuit board and microcontroller, Apple performed a series of unathorized tests on Noise Free's hardware, improperly extracted Noise Free's proprietary and confidential object code, determined Noise Free's noise reduction software and measured and duplicated the signal traces from the circuit board and microntroller. On further information and belief, Apple improperly used Noise Free's verbal and documentary confidential information along with its proprietary physical equipment to replicate Noise Free's proprietary hardware and software for noise reduction management.

35. In or around early 2009, Noise Free requested that Apple return the hardware and documentation that it provided to Apple on December 1, 2008. Apple returned just the hardware but did not return the documentation regarding the circuit board or the user guide.

36. In addition to the confidential documentation and hardware that Noise Free provided to Apple, Noise Free also verbally disclosed confidential and proprietary information related to background noise reduction and user controlled noise reduction in communication devices, including but not limited to (1) confidential and proprietary information regarding the type of specialty software for use in 2 microphone systems employed to reduce background noise reduction in cellular phones, and other related devices; (2) confidential and proprietary marketing and testing data, know-how, techniques, theories and materials relative to the standards to be employed in testing for voice quality

enhancement, including, "MOS" levels, and noise cancellation levels; (3) confidential and proprietary audio/voice technology, know-how, theories, and techniques to enhance voice quality through primarily noise cancellation and/or suppression through code and algorithms to optimize voice quality; (4) confidential and proprietary know-how, theories, and techniques regarding the mode and methods of connecting internal chips and specifications for voice quality enhancement and optimization; and (5) confidential and proprietary marketing and testing data relative to the strengths and weaknesses of the noise free system for background noise reduction and echo cancellation.

37. Pursuant to the 2008 NDA and at Apple's request, Noise Free provided Apple during 2008 with confidential information and technology that constituted protectable trade secrets within the meaning of the California Uniform Trade Secrets Act. During the course of disclosing its confidential information, Noise Free complied with all relevant portions of the 2008 NDA.

38. Without any explanation, however, Apple abruptly ceased communicating with Noise Free in 2009.

39. In early 2010, Apple reached out to Noise Free showing a new interest in its noise cancellation and whisper zone technology for cell phone and tablet implementations.

40. In or around May 2010, Noise Free met with Apple at its facilities in Cupertino, California and delivered a presentation. During the presentation, Noise Free provided highly specific confidential information regarding its unique software solution to noise cancellation, including information about the multi-microphone applications; transmit and receive cancellation; speech intelligibility; device specific EQ; echo cancellation; echo mitigation; wind noise cancellation, as well as highly detailed information regarding the Smart Discriminator and Whisper Zones for user controlled noise reduction implementation.

41. Unknown to Noise Free, on or around June 4, 2010, Apple filed U.S. Utility Patent Application No. 12/794,643, entitled "User-Specific Noise Suppression for Voice Quality Improvements" with the United States Patent and Trademark Office ("USPTO").

The listed inventors include Aram Lindahl and Baptiste Paquier. Each of the listed inventors on Apple's Utility Patent Application were involved in and/or present at Noise Free's presentations to Apple. This Patent Application was published on December 8, 2011 bearing Publication No. 2011/0300806.

42. Apples' Application No. 12/794,643 seeks patent protection for ideas and inventions directed to user controlled noise reduction in various noise zones, which were disclosed to Apple by Noise Free pursuant to the 2008 NDA. The hardware, documents and verbal instruction that Noise Free provided to Apple relate to and cover the subject matter contained within Apples' Patent App. No. 12/794,643. Moreover, the ideas and inventions that Noise Free disclosed to Apple in confidence were incorporated in Patent App. No. 12/794,643.

43. Apple never informed Noise Free that it was seeking patent protection for ideas and inventions directed to user controlled noise reduction in various noise zones. Apple also did not seek a list of Noise Free personnel to be included as inventors on Application No. 12/794,643.

44. Noise Free filed U.S. Utility Patent Applications covering the information that it disclosed to Apple related to user controlled noise reduction for various noise zones. These Patent Applications include: (a) 12/813,350 filed on June 10, 2010, entitled "Speech & Music Discriminator for Multimedia Application;" (b) 61/389,203 filed on October 2, 2010, entitled "Machine for Enabling and Disabling Noise reduction (MEDNR) based on a threshold;" and (c) 61/410,289 filed on November 4, 2010, entitled "System and Method for a Noise Reduction Controller in a Communication Device."

45. Noise Free had a subsequnet meeting with Apple on July 8, 2010 where Noise Free gave Apple an additional technical presentation. Once again, Noise Free provided highly detailed confidential information regarding its noise cancellation software and its application to the Whisper Zones or noise zones. In particular, Noise Free provided detailed information regarding how a user could either automatically or manually change

which noise zone the user was in to ensure that the proper noise cancellation protocol was employed.

46. Shortly after this meeting, Apple requested that the parties enter into a new Non-Disclosure Agreement. On or around July 19, 2010, Apple and Noise Free signed two Non-Disclosure Agreements; one agreement was for confidential information that Apple disclosed to Noise Free and the the other was for confidential information that Noise Free disclosed to Apple ("2010 NDAs"). Noise Free did not draft these agreements.

47. Over the next few weeks, Noise Free performed testing analysis on certain noise levels that Apple provided to Noise Free. On or around August 6, 2010, Noise Free sent an email to Apple detailing strategy for enhancing a user's ability to assit in managing the quality of his conversation via a user interface.

48. Shortly thereafter, however, Noise Free learned that Apple had selected an alternative supplier to provide Apple with noise reduction and/or noise cancellation systems and/or software for its mobile phones and tablets.

49. On infromation and belief, Apple selected a company named Audience, Inc. to supply Apple with chipsets that included environmental and background noise cancellation software. On further information and belief, Apple provided Audience with Noise Free's confidential trade secret information to assist Audience in delivering a noise cancellation solution that was similar and/or identical to the solution that Noise Free designed.

50. Upon learning that Apple had chosen Audience to provide it with a noise reduction/cancellation solution, Noise Free immediately severed its relationship with Apple.

51. Noise Free has used and uses a variety of means to protect the confidential aspects of the Trade Secret Information, including, but not limited to the use of appropriate confidentiality and employment agreements and company policies, and restricting access to the information on a "need to know" basis.

52. Noise Free's trade secret information derives independent economic value from not being known to the public, and gives Noise Free a competitive advantage in their ability to sell its products and services.

Patent-In-Suit.

53. On May 17, 2007, utility Patent Application No. 11/749,927 entitled "Environmental Noise Reduction and Cancellation for a Communication Device Including For A Wireless and Cellular Telephone" was filed. This application claimed priority to U.S. Provisional Application No. 60/808,169 filed on on May 23, 2006. This application duly and legally issued as U.S. Patent No. 7,742,790 ("the '790 patent") on June 22, 2010. The '790 patent was assigned to Noise Free wireless on April 7, 2012. A certificate of correction was issued in July 3, 2012. A true and correct copy of the '790 patent, as corrected, is attached hereto as Exhibit A.

Apple's Infringement of the '790 Patent

54. Noise Free is informed and believes, and thereupon alleges, that Apple has made, used, sold, imported and/or offered for sale, and/or continued to make, use, sell, import and/or offer for sale, products in the United States consisting of or including: iphone 4; iphone 4s; Ipad, Ipad 2; Ipad 3 and other such products that include noise reduction technology as claimed in the the '790 patent. The aforementioned products are hereinafter referred to collectively as the Apple Accused Products.

55. Apple's making, use, sale, offers for sale, and/or importation of the Apple Accused Products in the United States constitutes acts of direct infringement of the '790 patent.

56. On information and belief, co-Defendant Audience is one of Apple's component suppliers for noise reduction and/or cancellation in the Apple Accused Products. On further information and belief, Apple instructed co-Defendant Audience on the specific noise reduction system and process that Apple required to be included in the Apple Accused Products.

57. Audience in turn made, used, sold, offered for sale and/or imported and/or continues to make, use, sell, offer for sale and/or imports chipsets for Apple in the United States. These activities undertaken by Audience for Apple constitutes acts of direct infringement of the the '790 patent. The chipsets and corresponding software provided by

Audience to Apple are known by Apple and Audience to be especially made or especially adapted for use in infringement of the the '790 patent, and are not staple articles or commodities of commerce sutiable for substantial non-infringing use. Apple has thereby contributed to and contributes to the infringement of the the '790 patent.

58. On information and belief, Apple has induced and continues to induce acts by Audience and other third parties who manufacture Apple's noise reduction and/or cancellation chipsets that Apple knew or should have known would constitute direct infringement of the the '790 patent.

59. Noise Free is entitled to recover from Apple the actual damages it sustained as a result of Apple's wrongful acts alleged herein under 35 U.S.C. § 284 in an amount to be proven at trial, together with interests and costs.

60. On information and belief, Apple's infringement of the the '790 patent has been and is wilfull, deliberate and in disregard for Noise Free's patent rights, and Noise Free is entitled to increased damages up to three times the amount of actual damages and attorneys' fees, pursuant to 35 U.S.C. §§ 284 and 285.

61. Apple's infringement of the the '790 patent will continue to damage Noise Free, causing irreparable harm for which there is no adequate remedy at law, unless it is enjoined by this Court.

Audience's Infringement of the the '790 patent

62. On information and belief, Audience has made, used, sold, imported and/or offered for sale, and/or continued to make, use, sell, import and/or offer for sale, products in the United States consisting of or including the earSmart Voice Processor as well as other chipsets with software for noise cancellation to accompany communciation devices that utlize two microphones for noise cancellation or reduction. The aforementioned Audience products are hereinafter referred to as the "Audience Accused Products."

63. Audience's making, use, sale, offer for sale, and/or importation of the Audience Accused Products in the United States constitutes acts of direct infringement of the '790 patent.

64. Noise Free is informed and believes and thereupon alleges that Audience has sold or offered to sell its Audience Accused Products to third parties, to incorporate the Audience Accused Products into their own products. Audience advertises that its earSmart chipset is include in communication devices sold by third parties. On further information and belief, Audience also supplies the Audience Accused Products to Apple for inclusion in the Apple Accused Products.

65. These third parties in turn have made, used, sold, offered for sale, and/or imported and/or continue to make, use, sell offer for sale, and/or import their own products in the United States. These activities undertaken by third parties constitutes acts of direct infringement of the the '790 patent. The Audience Accused Produces are known by Audience to be especially made or especially adpated for use in infringement of the the '790 patent and are not staple articles or commodities of commerce suitable for non-infringing use. Audience has thereby contributed to and continues to contribute to the infringment of the the '790 patent.

66. Noise Free is informed and believes, and thereupon alleges, that, by Audience's sales and/or offers for sale of the Audience Accused Products to third parties, Audience has also induced and continues to induce acts by third parties that Audience knew or should have known constitute direct infringement of the the '790 patent. Audience actively induces infringement of the the '790 patent by designing the Audience Accused Prodcuts to be capable of infringement and by promoting and encouraging the use of its products by third parties in ways that infringe the Pa the '790 patent.

67. Noise Free is entitled to recover from Audience the actual damages it sustained as a result of Audience's wrongful acts alleged herin under 35 U.S.C. § 284 in an amount to be proven at trial, together with interests and costs.

68. Noise Free is informed and believes and thereupon alleges that Audience's infringement of the the '790 patent has been and is willful, deliberate and in disregard of Noise Free's patent rights, and Noise Free is therefore entitled to increased damages up to three times the amount of actual damages and attorneys' fees, pursuant to 35 U.S.C. §§ 284, 285.

69. Audience's infringement of the the '790 patent will continue to damage Noise Free, causing irreparable harm for which there is no adequate remedy at law, unless it is enjoined by this Court.

70. All conditions precedent to Noise Free's causes of action have been performed or occurred.

FIRST CAUSE OF ACTION

(For Patent Infringement of U.S. Patent No. 7,742,790

Under 35 U.S.C. § 271, et seq Against All Defendants)

71. Noise Free incorporates by reference and realleges as if fully stated herein paragraphs 1 through 70 above.

72. On information and belief, Apple: (1) has infringed and continues to infringe valid and enforceable claims of U.S. Patent No. 7,742,790 ("the '790 patent"), literally and/or under the doctrine of equivalents, by making, using, offering for sale, selling (directly or through intermediaries), and/or importing Apple Accused Products consisting of or including two microphones and a chipset designed to and including software that reduces and/or elminates environmental and background noise, in this district and elsewhere in the United States; and/or (2) has contributed to and continues to contribute to the literal infringement and/or infringement under the doctrine of equivalents of valid and enforceable claims of the '790 patent, and/or has actively induced and continues to actively induce such third parties as Audience, Inc. to infringe valid and enforceable claims of the '790 patent, literally and/or under the doctrine of equivalents, in this district and elswhere in the United States.

73. On information and belief, Audience: (1) has infringed and continues to infringe valid and enforceable claims of the '790 patent, literally and/or under the doctrine of equivalents, by making, using, offering for sale, selling (directly or through intermediaries), and/or importing Audience Accused Products to be included in communication devices that include two microphones and have the capability of offering environmental and background noise reduction, in this district and elsewhere in the United States; and/or (2) has contributed to and continues to contribute to the literal infringement and/or infringement under the doctrine of equivalents of valid and enforceable claims of the '790 patent, and/or has actively induced and continues to actively induce third parties to infringe valid and enforceable claims of the '790 patent, literally and/or under the doctrine of equivalents, in this district and elswhere in the United States.

SECOND CAUSE OF ACTION

(For Misappropriation of Trade Secrets

Civil Code § 3426, et seq. Against All Defendants)

74. Noise Free incorporates by reference and realleges as if fully stated herein paragraphs 1 through 73 above.

75. Defendants' conduct, as alleged herein, constitutes misappropriation of trade secrets prohibited by § 3426 of the California Civil Code.

76. Noise Free's trade secret information and confidential information has great economic value to Noise Free in that Noise Free has spent substantial time and money to obtain and develop that information and technology. Noise Free's trade secrets have independent economic value because the public or others who could derive economic value from its disclosure or use do not generally know it, and could not obtain it without expenditure of substantial time, effort and expense, if at all.

77. Noise Free has made all reasonable efforts to maintain its trade secrets in such a manner as to keep it confidential, including through the use of confidentiality agreements and keeping such information restricted and/or on a need to know basis.

78. Apple has misappropriated Noise Free's trade secrets by, inter alia, the acts described above, and incorporated herein as if fully stated.

79. Apple acquired Noise Free's trade secrets and confidential information relating to Noise Free's environmental and background noise cancellation system for communication devices, such as mobile phones and tablets, through the course of its relationship with Noise Free and under circumstances, such as the 2008 NDA and the 2010 NDAS, which gave rise to a duty to maintain the secrecy of the inforation and/or to limit its use.

80. Apple improperly used Noise Free's confidential and proprietary trade secret information relating to Noise Free's environmental and background noise cancellation systems and processes to design and contract for the manufacture and/or development of its own copycat noise cancellation system for inclusion in its mobile communication devices and tablets and to sell, offer for sale and import such communicaiton devices comprising, incorporating and/or derived from Noise Free's trade secrets.

81. Apple's communication devices such as the Apple Accused Products utilize a noise cancellation system and method that is too similar to Noise Free's to be explained by sheer coincidence alone.

82. On information and belief, Apple disclosed Noise Free's confidential trade secret information to co-Defendant Audience in disregard for the parties' 2008 NDA and 2010 NDAs. Audience captitalized on Apples' improper disclosures and has manufactured, sold, offered for sale and/or imported chipsets under, at least, the brandname earSmart Voice Processor to be included in Apple's Accused Products as well as other third parties' communications devices.

83. On information and belief, the Audience Accused Products contain and/or are manufctured using Noise Free's proprietary and confidential information. On further information and belief, Audience knew or should have known that design and technical information regarding the system and method for reducing or cancelling background and environmental noise was from Noise Free.

84. Defendants are prohibited from using these trade secrets to gain a competitive advantage over Noise Free.

85. As a direct and proximate result of Defendants acts, Noise Free has been damaged in an amount not yet ascertained, but which is in excess of the jurisdictional minimum of this Court

86. Defendants used Noise Free's trade secrets without consent of Noise Free and Defendants used Noise Free's trade secrets with knowledge and/or reason to know that Noise Free's trade secrets were being improperly used because Apple had a duty and legal obligation to limit or abstain from the use of and diclsoure of such trade secrets. The use and discloure of Noise Free's trade secrets gives Defendants a competitive advantage over Noise Free, which will unjustly benefit Defendants, has damaged Noise Free and will continue to damage Noise Free.

87. Economic damages cannot fully compensate Noise Free for the loss of and misuse of Noise Free's trade secrets. Noise Free is informed and believes that unless and until restrained and enjoined from disclosing or using Noise Free's trade secrets, Defendants will continue to improperly disclose said information to Noise Free's competitors and otherwise use Noise Free's trade secrets for their own advantage and to Noise Free's detriment.

88. Noise Free is informed and believes and based thereon alleges that these acts by Defendants were done intentionally, with malice and oppression toward Noise Free, and with the intent of injuring Noise Free in its business or in such conscious disregard of Noise Free's rights. As such, Noise Free is entitled to an award of exemplary or punitive damages against Defendants in an amount according to proof.

THIRD CAUSE OF ACTION

(For Breach of Contract

Against Defendant Apple)

89. Noise Free incorporates by reference and realleges as if fully stated herein paragraphs 1 through 88 above.

90. Noise Free has fully performed its obligations, conditions, covenants, and promises under the 2008 NDA and 2010 NDAs except those have been excused by, inter alia, Apple's failure to perform or prior breach.

91. Noise Free is informed and believes that Apple has breached his obligations under the 2008 NDA and 2010 NDAs by, among other things: disclosing to third parties and misusing Noise Free's confidential and proprietary information as described in detail above, but including, though not limited to, (1) the proprietary hardware and documentation regarding the circuit board and chipset used to perform Noise Free's novel background and environmental noise reduction method; (2) the software and/or object code reflecting the source code in Noise Free's proprietary chipset to perform environmental and background noise cancellation; (3) the technical knowhow in testing the chipset against various noise levels with Noise Free's phone mockup using two microphones; and (4) the technical knowhow in in allowing users to automaticly or manually select noise environments for maximizing noise cancellation and/or reduction in different noise zones. Apple also breached its obligations under the 2008 NDA and 2010 NDAs by using Noise Free's proprietary and confidential information as described in detail above to apply for a United States Utility Patent. Apple further breached its obligations under the 2008 NDA and the 2010 NDAs by improperly funneling Noise Free's proprietary and confidential information to Audience and/or other entities for the sole purpose of competing with and/or eliminating the need to pay Noise Free for use of its proprietary and technical information.

92. As a direct and proximate cause of these acts by Apple, Noise Free has been damaged in an amount not yet ascertained, but which is in excess of the jurisdictional minimum of this Court. Noise Free will seek leave of Court to amend this Complaint when the amount of damages has been ascertained.

93. Unless enjoined by the Court, Apple's actions threaten to and will cause great and irreparable injury to Noise Free, and Noise Free has no adequate remedy at law for such acts and threatened acts.

FOURTH CAUSE OF ACTION

(Declaration of Patent/Invention Ownership in U.S. Utility Patent Application No. 12/794,643, entitled "User-Specific Noise Suppression for Voice Quality Improvements" Against Apple, Inc.)

94. This is an action for Declaratory Judgment that Apple does not own the patent/invention claimed in U.S. Utility Patent Application No. 12/794,643.

95. Noise Free incorporates by reference and realleges as if fully stated herein paragraphs 1 through 94 above.

96. On June 4, 2010, U.S. Utility Patent Application No. 12/794,643 ("Patent App. No. 12/794,643"), entitled "User-Specific Noise Suppression for Voice Quality Improvements" was filed with the United States Patent and Trademark Office. Patent App. No. 12/794,643 was published on December 8, 2011 bearing Publication No. 2011/0300806.

97. The listed inventors on Patent App. No. 12/794,643 include Aram Lindahl and Baptiste Paquier. These listed inventors assigned their rights in Patent App. No. 12/794,643 to Apple, Inc.

98. Apples' Patent App. No. 12/794,643 seeks patent protection for ideas and inventions directed to user controlled noise reduction in various noise zones.

99. The disclosures contained in Patent App. No. 12/794,643 include and are based upon Noise Free's highly confidential information that was disclosed to Apple pursuant to the 2008 NDA.

100. Beginning in 2007 and throughout 2008, Noise Free disclosed to Apple in confidence certain significant inventions and ideas related to user controlled noise reduction for various noise zones or noise levels.

101. On or around December 1, 2008, Noise Free visited Apple's facilities in Cupertino, California and provided Apple with (1) a confidential user guide entitled "Wind & Stationary Noise Reduction Guide – UG," (2) a fully operational circuit board that included microcontrollers that included Noise Free's highly confidential firmware and

source code reflecting the algorithm used to detect and filter the environmental and background noise, (3) a fully operational phone mockup utilized by Noise Free to test its noise reduction/cancellation technology as well as all the environmental noises coming from the whisper zones; (4) highly confidential documentation regarding the disclosed circuit board, including the bill of materials ("BOM"), as well as block diagrams regarding the hardware and software for the operation of the noise cancellation system.

102. Noise Free also provided Apple with significant and detailed instruction on how to operate the circuit board and phone mockup in order to test against various environmental and background noises.

103. The hardware, documents and verbal instruction that Noise Free provided to Apple relate to and cover the subject matter contained within Apples' Patent App. No. 12/794,643. Moreover, the ideas and inventions that Noise Free disclosed to Apple were included in and/or incorporated in Patent App. No. 12/794,643.

104. Each of the listed inventors on Patent App. No. 12/794,643 were involved in and/or present at Noise Free's presentations to Apple.

105. Apple never informed Noise Free that it was seeking patent protection for the information disclosed in Patent App. No. 12/794,643. Apple also did not seek a list of Noise Free personnel to be included as inventors on Patent App. No. 12/794,643.

106. Noise Free owns all intellectual property rights in the information disclosed to Apple related to user controlled noise reduction for various noise zones or noise levels that were incorporated in Patent App. No. 12/794,643.

107. Noise Free filed U.S. Utility Patent Applications covering the information that it disclosed to Apple related to user controlled noise reduction for various noise zones. These Patent Applications include, but are not limited to: (a) 12/813,350 filed on June 10, 2010, entitled "Speech & Music Discriminator for Multimedia Application;" (b) 61/389,203 filed on October 2, 2010, entitled "Machine for Enabling and Disabling Noise reduction (MEDNR) based on a threshold;" and (c) 61/410,289 filed on November 4, 2010,

entitled "System and Method for a Noise Reduction Controller in a Communication Device."

108. Apple and the listed inventors improperly claim ownership and inventorship in the inventions and disclosures claimed and/or disclosed in Patent App. No. 12/794,643, and filed said Patent Application without Noise Free's approval or consent.

109. Accordingly, Noise Free seeks a declaratory judgment that Apple does not own the inventions dislcosed and/or claimed in Patent App. No. 12/794,643, and that Noise Free owns the rights, title and interest in any patent that matures from or vests from Patent App. No. 12/794,643.

FIFTH CAUSE OF ACTION

(California Statutory Unfair Competition)

Against All DEFENDANTS

110. Noise Free incorporates by reference and realleges as if fully stated herein paragraphs 1 through 109 above.

111. Defendants conduct as alleged herein constitutes, unfair, unlawful and fraudulent business practices prohibited by Sections 17200, et seq. and 17500 of the California Business and Professions Code.

112. On information and belief, Defendants' acts of misappropriation and patent infringement constitute unfair competition under California Business Code sections 17200 – 17209. By adopting, copying, and selling products that include and/or are improperly derived from Noise Free's proprietary and confidential trade secret infomration, Defendants have appropriated Noise Free's investment at little or no cost to Defendants. Upon information and belief, the acts of unfair competition by Defendants have resulted and are currently resulting in and/or will result in substantial unjust profits and unjust enrichment on the part of Defendants in an amount yet to be determined. In doing the acts alleged herein, Defendants are attempting to divert and/or are diverting sales and/or revenue from Noise Free to Defendants. Such acts of unfair competition are causing harm to Noise Free.

113. Noise Free has no adequate remedy at law for the injury that will be caused by Defendants' acts of unfair competition. Accordingly, Noise Free is entitled to preliminary and permanent injunctions restraining Defendants, their officers, agents, and employees and all persons acting in concert with them from further engaging in acts of unfair competition and/or fraudulent business practices.

JURY DEMAND

114. Noise Free hereby demand a trial by jury of any and all issues triable with right by a jury pursuant to Rule 38 of the Federal Rules of Civil Procedure.

PRAYER

WHEREFORE, Noise Free prays for judgment in its favor and against Defendants Apple and Audience as appropriate to the claim, and specifically for relief as follows:

(a) An adjudication that Defendants have infringed and continue to infringe the the '790 patent as alleged above;

(b) An accounting of all damages sustained by Noise Free as a result of Defendants' acts of infringement of the the '790 patent;

(c) An award to Noise Free of actual damages adequate to compensate Noise Free for Defendants' acts of infringement, but not less than a reasonable royalty, together with prejudgment and postjudgment interest;

(d) An award to Noise Free of enhanced damages, up to and including trebbeling Noise Free's damages pursuant to 35 U.S.C. § 284 for Defendants' willful infringement of the the '790 patent;

(e) An award of Noise Free's costs of suit and reasonable attorneys' fees pursuant to 35 U.S.C. § 285 due to the exceptional nature of this case, or as otherwise permitted by law;

(f) A grant of a permanent injunction pursuant to 35 U.S.C. § 283, enjoining Defendants, and each of teir agents, servants, employees, principals, officers, attorneys, successors, assignees, and all those in active concert or

participation with Defendants, including related individuals and entities, customers, representatives, OEMs, dealers, and distributors from further acts of (1) infringement; (2) contributory infringement; and (3) active inducement to infringe with respect to the Patent-In-Suit;

(g) An adjudication that Defendants have misappropriated Noise Free's trade secrets;

(h) An adjudication that Defendants have engaged in unfair, unlawful and fraudulent business practices;

(i) An adjudication that Defendant Apple, Inc. breached its contract with Noise Free;

(j) General and punitive or exemplary damages, according to proof;

(k) Attorneys' fees pursuant to Civil Code Sections 1717 and 3426.4;

(l) Orders to protect Noise Free trade secrets;

(m) An accounting from Defendants of their use of Noise Free's confidential information for their benefit and not Noise Free's;

(n) Orders to prevent Defendants from unfairly competing with Noise Free;

(o) A constructive trust for the benefit of Noise Free to be imposed upon all funds, assets, revenues and profits Defendants have or will derive from their unfair, unlawful acts and their misappropriation of Noise Free trade secrets;

(p) Costs of suit;

(q) For such other and further relief as the Court may deem just and proper

(r) Declaration that Apple does not own any rights that have vested in Patent App. No. 12/794,643 and/or that may vest if and when Patent App. No. 12/794,643 matures into an issued patent; and

(s) Declaration that Noise Free is the correct inventor of any and all inventions claimed in Patent App. No. 12/794,643;

(t) Declaration that Noise Free is the correct owner of any and all rights that have vested in Patent App. No. 12/794,643 and/or that may vest if and when Patent App. No. 12/794,643 matures into an issued patent.

Dated: July 3, 2012

Woolf Gafni & Fowler LLP

By: _____
MATEO Z. FOWLER
Attorneys for Plaintiff
NOISE FREE WIRELESS, INC.

Exhibit A

US007742790B2

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

(10) **Patent No.: US 7,742,790 B2**
(45) **Date of Patent: Jun. 22, 2010**

(54) **ENVIRONMENTAL NOISE REDUCTION AND CANCELLATION FOR A COMMUNICATION DEVICE INCLUDING FOR A WIRELESS AND CELLULAR TELEPHONE**

(75) Inventors: **Alon Konchitsky**, 20488 Stevens Creek Blvd. Apt. 1402, Cupertino, CA (US) 95014; **William Martin Ribble**, San Jose, CA (US)

(73) Assignee: **Alon Konchitsky**, Santa Clara, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 455 days.

(21) Appl. No.: **11/749,927**

(22) Filed: **May 17, 2007**

(65) **Prior Publication Data**

US 2007/0274552 A1 Nov. 29, 2007

Related U.S. Application Data

(60) Provisional application No. 60/808,169, filed on May 23, 2006.

(51) **Int. Cl.**
H04B 1/38 (2006.01)

(52) **U.S. Cl.** **455/570**; 381/92; 381/94.1; 455/550.1; 379/388.03

(58) **Field of Classification Search** 381/122, 381/338, 337, 2-4, 71.1, 71.6, 91, 92, 110, 381/94.1-94.3, 55-57, 94.7, 94.8, 123, 94.5, 381/104, 107; 704/225, 200; 379/406.01-406.06, 379/387.01, 392.01, 395; 455/73, 570, 569.1, 455/550.1

See application file for complete search history.

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2007/0263847	A1 *	11/2007	Konchitsky	379/392.01

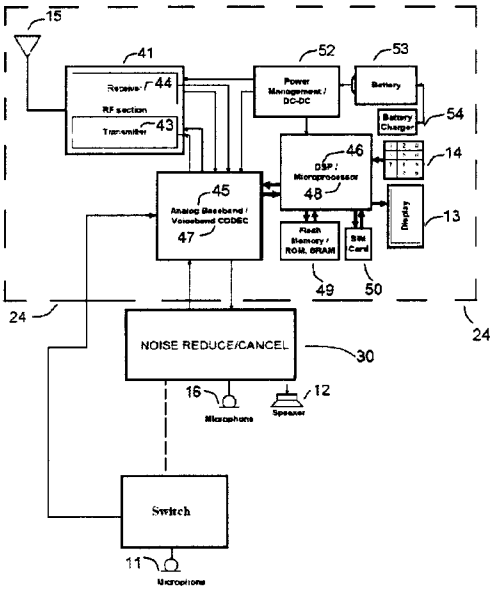
* cited by examiner

Primary Examiner—Vivian Chin
Assistant Examiner—Lun-See Lao
(74) *Attorney, Agent, or Firm*—Steven A. Nielsen; Allman & Nielsen, PC

(57) **ABSTRACT**

Various embodiments of the present invention enable a system and method for reducing or entirely canceling background or environmental noise from a voice transmission from a communications device. A communications device, such as a mobile telephone, is configured with an environmental noise compensation, correction, or counterbalanced (correction) signal generator that is connected between at least one microphone and a continuous time quadrant multiplication. Optional discrete time or digital signal processing may be applied. The original output of the at least one microphone and a compensation, correction, or counterbalanced or counter-balancing signal generated by the environmental noise compensation, correction, or counterbalanced signal generator are mixed or otherwise combined together after being received by the antenna to the receiver.

7 Claims, 5 Drawing Sheets



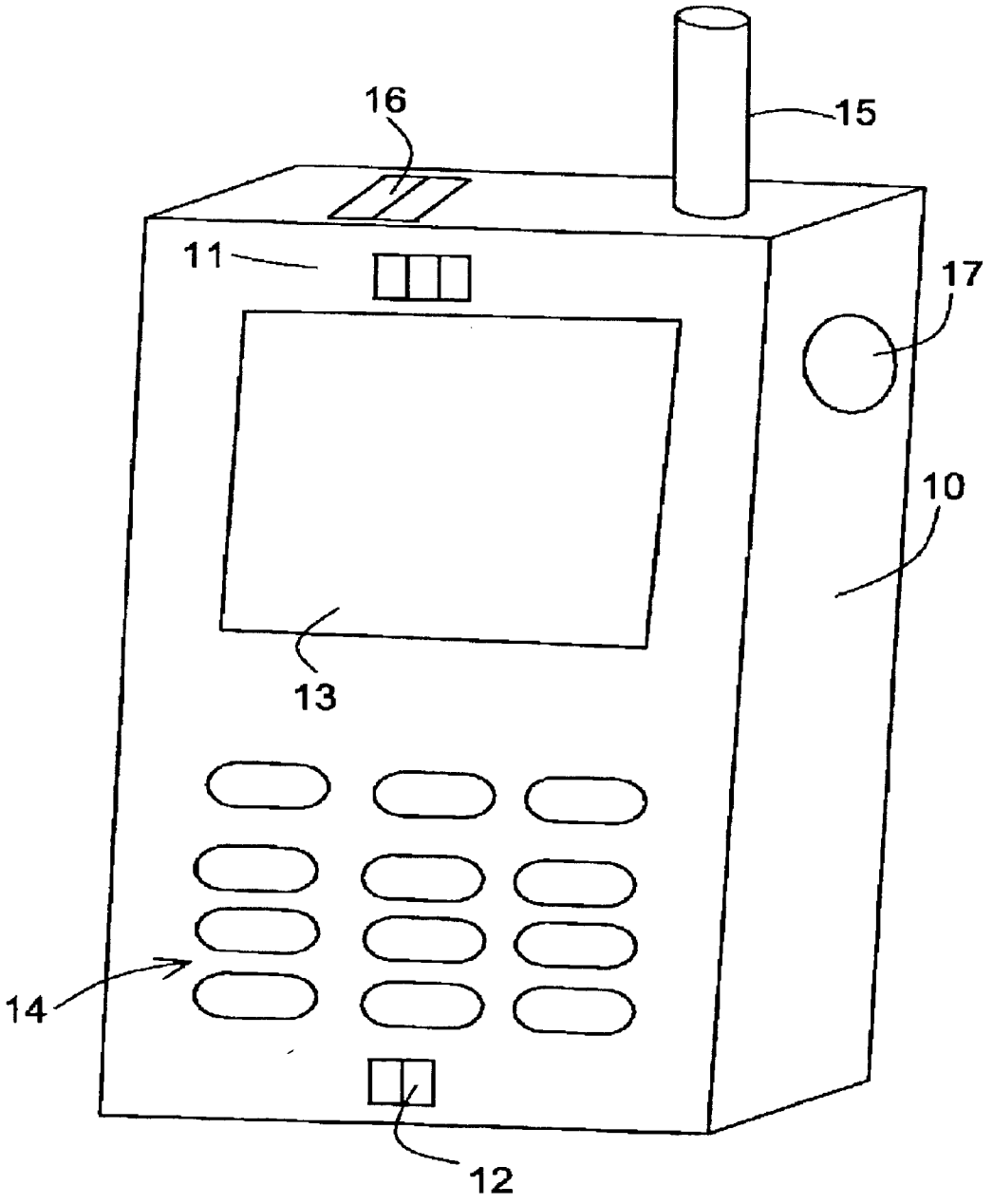


FIG. 1

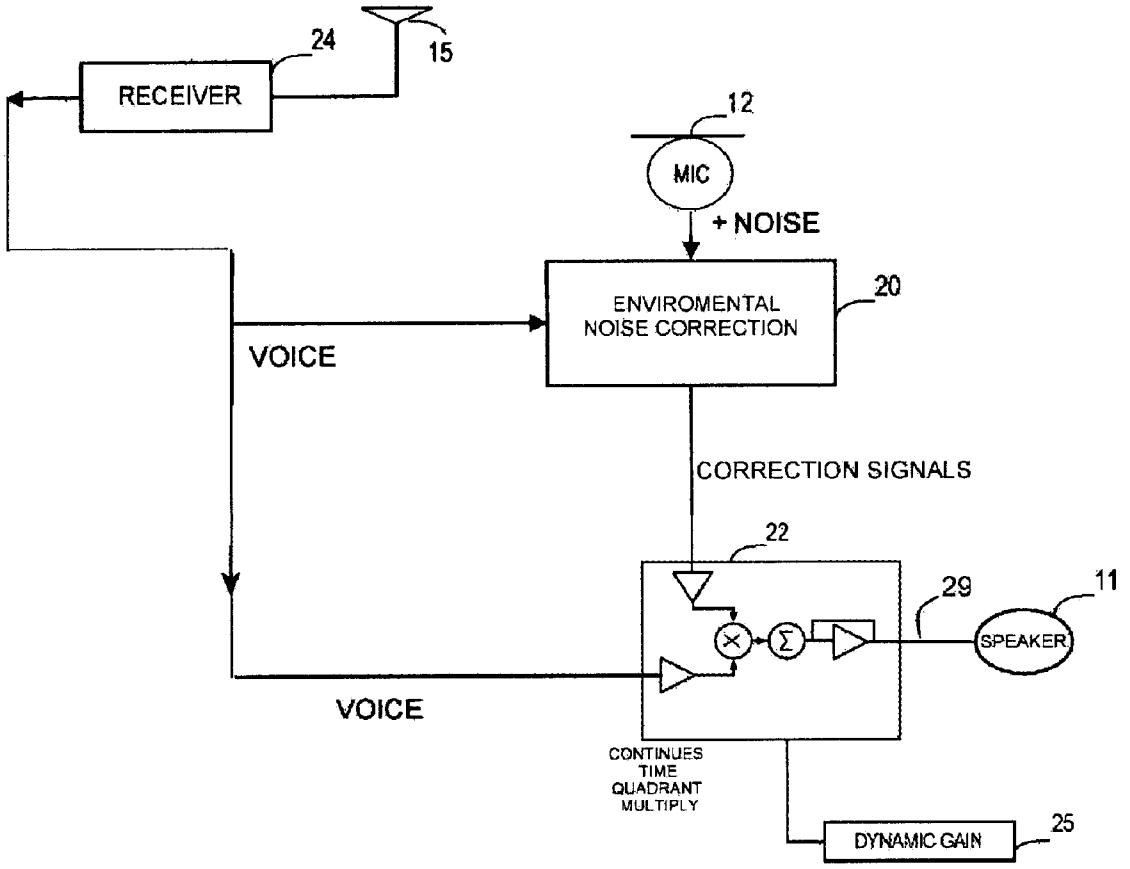

RECEIVER
24
15
12
MIC
+ NOISE
ENVIROMENTAL
NOISE CORRECTION
20
VOICE
CORRECTION SIGNALS
22
29
11
SPEAKER
VOICE
CONTINUES
TIME
QUADRANT
MULTIPLY
DYNAMIC GAIN
25

FIG. 2(a)

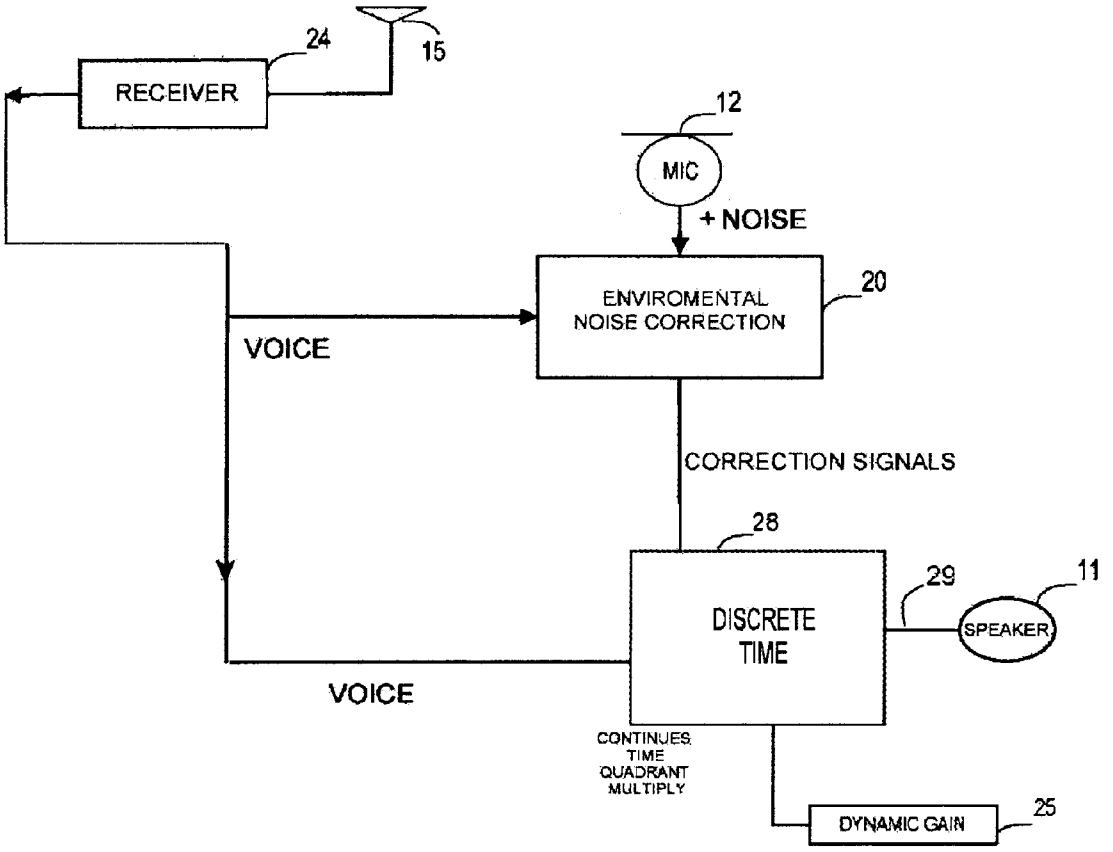
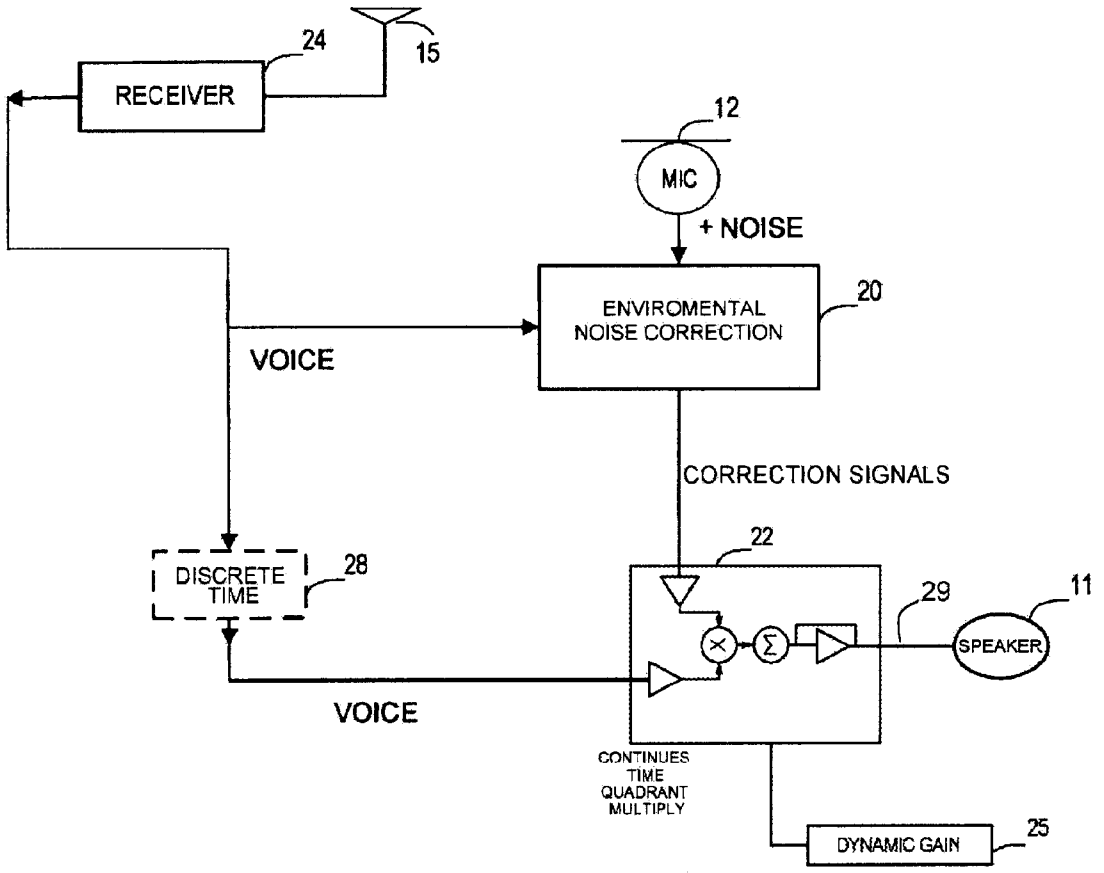

RECEIVER
24
15
12
MIC
+ NOISE
ENVIROMENTAL
NOISE CORRECTION
20
VOICE
CORRECTION SIGNALS
28
DISCRETE
TIME
29
11
SPEAKER
VOICE
CONTINUES
TIME
QUADRANT
MULTIPLY
DYNAMIC GAIN
25

FIG. 2(b)


RECEIVER
24
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+ NOISE
ENVIROMENTAL
NOISE CORRECTION
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VOICE
CORRECTION SIGNALS
22
DISCRETE
TIME
28
29
11
SPEAKER
VOICE
CONTINUES
TIME
QUADRANT
MULTIPLY
DYNAMIC GAIN
25

FIG. 2(c)

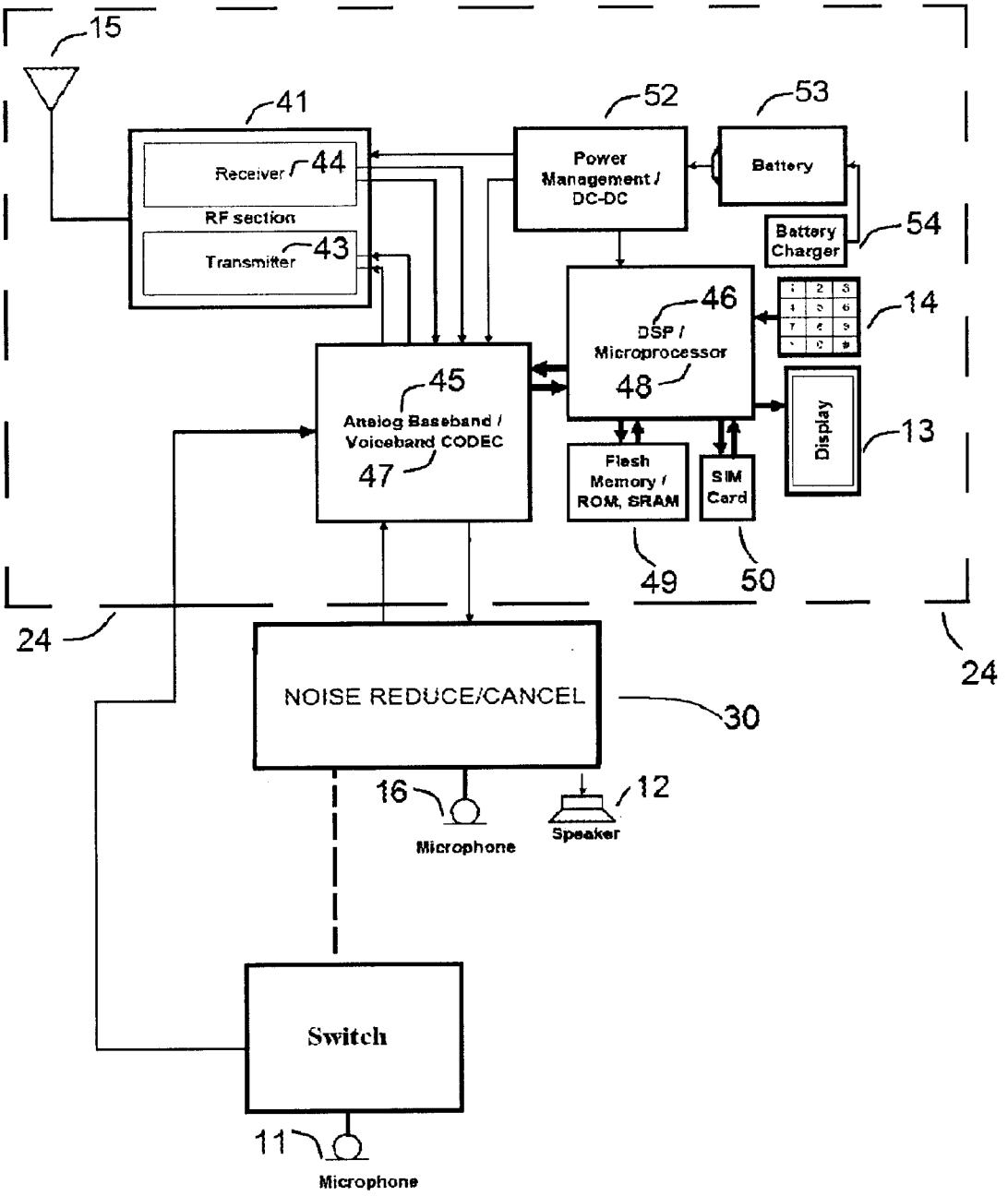
15
41
52
53
Receiver
44
RF section
Transmitter
43
Power Management / DC-DC
Battery
Battery Charger
54
46
DSP / Microprocessor
48
14
45
Analog Baseband / Voiceband CODEC
47
Flash Memory / ROM, SRAM
SIM Card
Display
13
49
50
24
24
NOISE REDUCE/CANCEL
30
16
Microphone
12
Speaker
Switch
11
Microphone

FIG. 3

ENVIRONMENTAL NOISE REDUCTION AND CANCELLATION FOR A COMMUNICATION DEVICE INCLUDING FOR A WIRELESS AND CELLULAR TELEPHONE

RELATED APPLICATIONS

This application claims priority to U.S. Provisional Patent Application No. 60/808,169, filed May 23, 2006, and entitled "ENVIRONMENTAL NOISE REDUCTION AND CANCELLATION FOR A COMMUNICATION DEVICE INCLUDING FOR A WIRELESS AND CELLULAR TELEPHONE," by Alon Konchitsky, and is hereby incorporated herein by reference.

BACKGROUND

1. Field of the Invention

The present invention relates generally to voice communication systems, devices, telephones, and methods, and more specifically, to systems, devices, and methods that automate control in order to correct for variable environmental noise levels and reduce or cancel the environmental noise after receiving the voice communication over one or a plurality of communication links.

2. Background of the Invention

Voice communication devices such as cellular telephones and wireless telephones and communications devices other than cellular telephones have become ubiquitous; they show up in almost every environment. These systems and devices and their associated communication methods are referred to by a variety of names, such as but not limited to, cellular telephones, cell phones, mobile phones, wireless telephones in the home and the office, and devices such as personal data assistants (PDAs) that include a wireless or cellular telephone communication capability. They are used in the home, at the office, in the car, on a train, at the airport, at the beach, at restaurants and bars, on the street, and almost any other imaginable venue. As might be expected, these diverse environments have relatively higher and lower levels of background, ambient, or environmental noise. For example, there is generally less noise in a quiet home than there is in a crowded bar. And, this noise is picked up by the microphone of the communications device and if at sufficient levels, degrades the intended voice communication. Although the invention described hereinafter is applicable to many different communication systems and devices, examples focus on cellular communication networks and devices for purposes of explaining the underlying problems and solutions.

A cellular network is a radio network made up of a number of radio cells (or just cells) each served by a fixed transmitter, normally known as a base station. These cells are used to cover different geographical areas in order to provide radio coverage over a wider geographical area than the area of one cell. Cellular networks are inherently asymmetric with a set of fixed main transceivers each serving a cell and a set of distributed (generally, but not always, mobile) transceivers which provide services to the network's users.

The primary requirement for a cellular network is that the each of the distributed stations need to distinguish signals from their own transmitter from the signals from other transmitters. There are two common solutions to this requirement, frequency division multiple access (FDMA) and code division multiple access (CDMA). FDMA works by using a different frequency for each neighboring cell. By tuning to the frequency of a chosen cell, the distributed stations can avoid the signal from other neighbors. The principle of CDMA is more complex, but achieves the same result; the distributed transceivers can select one cell and listen to it. Other available methods of multiplexing such as polarization division multiple access (PDMA) and time division multiple access (TDMA) cannot be used to separate signals from one cell to the next since the effects of both vary with position, making signal separation practically impossible. Orthogonal frequency division multiplex (OFDM) in principal, consists of frequencies orthogonal to each other. Time division multiple access, however, is used in combination with either FDMA or CDMA in a number of systems to give multiple channels within the coverage area of a single cell.

In the case of a typical taxi company, each radio has a selector knob or button. The knob or button acts as a channel selector and allows the radio to tune to different frequencies. As the drivers and their vehicles move around, they change from channel to channel. The drivers know which frequency covers approximately what area, when they don't get a signal from the previously selected transmitter, they may typically also try other channels until they find one which works or on which they are able to receive or monitor communications in their local area. Usually, the taxi drivers only speak one at a time, as invited by the operator or according to voice traffic on the channel, in a sense time division multiplexed system.

The wireless world comprises the following exemplary, but not limited communication schemes: time based and code based. In the cellular mobile environment these techniques are named under TDMA (time division multiple access) which comprises but not limited to the following standards GSM, GPRS, EDGE, IS-136, PDC, and the like; and CDMA (code division multiple access) which comprises but not limited to the following standards: CDMA one, IS-95A, IS-95B, CDMA 2000, CDMA 1xEvDv, CDMA 1xEvDo, WCDMA, UMTS, TD-CDMA, TD-SCDMA, OFDM, WiMax, WiFi, and others).

For the code division based standards or orthogonal frequency division, as the number of subscribers grows and average minutes per month increase, more and more mobile calls typically originate and terminate in noisy environments. The background or ambient noise degrades voice quality.

For the time based schemes, like GSM or GPRS or Edge schemes, improving the end-user voice signal-to-noise ratio (SNR), improves the listening experience for users of existing TDMA (time division multiple access) based networks, by improving the received speech quality by employing background noise reduction or cancellation at the sending or transmitting device.

Significantly, in an on-going cellular telephone call or other communication received in an environment having relatively higher environmental noise, it is sometimes difficult for the party at the receiving end of the connection in the noisy environment to hear what the transmitting party is saying. Problems associated with environmental noise on the transmitting or speaking person's side are an additional problem and addressed in the inventor's other patent applications, but not addressed here.

With further reference to the receiver or listener side, the local ambient or environmental noise in the receiving environment often "drowns out" or overwhelms the received wired, cellular, or VOIP telephone user's signal, so that the receiving party cannot hear what is being said or even if they can hear it with sufficient volume the voice or speech is not completely understandable.

Attempts to solve this problem have largely been unsuccessful. Both single microphone and two microphone approaches have been attempted. For example, U.S. Pat. No. 6,415,034 (the "Hietanen patent") describes the use of a sec-

ond background noise microphone located within an earphone unit or behind an ear capsule. Digital signal processing is used to create a noise canceling signal which enters the speech microphone. Unfortunately, the effectiveness of the method disclosed in the Hietanen patent is compromised by acoustical leakage, that is where ambient or environmental noise leaks past the ear capsule and into the speech microphone. The Hietanen patent also relies upon complex and power consuming expensive digital circuitry that may generally not be suitable for small portable battery powered devices such as pocketable cellular telephones. Another example is U.S. Pat. No. 5,969,838 (the "Paritsky patent") which discloses a noise reduction system utilizing two fiber optic microphones that are placed side-by-side next to one another. Unfortunately, the Paritsky patent discloses a system using light guides and other relatively expensive and/or fragile components not suitable for the rigors of cell phones and other mobile devices. Neither Paritsky nor Hietanen address the need to increase capacity in cellular telephone-based communication systems.

Therefore, there is a need in the art for a method of noise reduction or cancellation on the receiving end of a call that is robust, suitable for mobile use, and inexpensive to manufacture.

SUMMARY OF THE INVENTION

The present invention provides a novel system and method for monitoring the noise in the environment in which a cellular telephone is operating and canceling the environmental noise so that the receiving party of the voice communication link can more easily hear what the wired or wireless, corded or cordless, cellular, VOIP, or any other type telephone calling user is saying.

The present invention preferably employs noise reduction and or cancellation technology that is operable to attenuate or even eliminate pre-selected portions of an audio spectrum. By monitoring the ambient or environmental noise in the location in which the cellular telephone is operating and applying noise reduction and/or cancellation protocols at the appropriate time, it is possible to significantly reduce the ambient or background noise to which the receiver to a cellular telephone call might be subjected.

In one aspect of the invention, the invention provides a system and method that enhances the convenience of using a communications device, such as a wired or wireless, corded or cordless, cellular, VOIP, or any other type, even in a location having relatively loud ambient or environmental noise.

In another aspect of the invention, the invention provides a system and method for canceling ambient or environmental noise that is present in the environment of a party listening to a spoken voice or other content on a communication device after it is received.

In yet another aspect of the invention, the invention monitors ambient or environmental noise at the location of the receiver or listener via a second microphone different from the conventional transmit microphone intended to pick up primarily spoken voice for transmission to another location, where the second microphone is primarily responsible for picking up background, ambient, and/or environmental noise from the local listening environment and used to reduce, cancel, and/or compensate or correct for local noise.

In still another aspect of the invention, the invention optionally provides an enable/disable switch on a communications device such as a cellular telephone device to enable/disable the noise reduction and or cancellation features of the invention.

In yet another embodiment a single microphone is used for both collection and conversion of the local user's speech to an electrical signal when the user is talking and as the microphone transducer for collecting the environmental or background noise when the user is listening. A switch or switching logic may automatically or manually be used to change between the two microphone use modes.

In yet another embodiment first and second microphones are used, one for the collection and conversion of the local user's speech to an electrical signal when the user is talking and a second microphone for collecting the environmental or background noise when the user is listening. No switch is needed in this mode as each microphone is provided for its separate purpose.

In still another aspect, the invention provides a noise processing apparatus for use in a communications device

In still another aspect, the invention provides a method for canceling noise while listening to a spoken voice in a communications device.

These and other aspects of the present invention will become apparent upon reading the following detailed description in conjunction with the associated drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** illustrates an exemplary communications device, such as a wireless mobile telephone, that includes an optional second microphone for sampling environmental noise and an optional enable/disable button in accordance with an embodiment of the present invention.

FIG. **2**(*a*)-(*c*) illustrate exemplary embodiments of the present invention having at least a first microphone that is switched to provide both sensing of local spoken speech and during a different period of time to sense local background or environmental noise, and a second embodiment having two separate microphones for these purposes and thereby eliminate any need for the switch.

FIG. **3** illustrates yet another exemplary embodiment of the present invention showing in particular the relationship between the inventive noise reduction and/or cancellation block and conventional elements of a typical cellular telephone including the analog baseband/voiceband codec.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

The present invention provides a unique background noise or environmental noise reduction and or cancellation feature for a communications device such as a mobile or cellular telephone, corded or cordless telephone, conventional wire line or wireless telephone, or any other communications device having a microphone input and a speaker transducer output and operating in an environment of background noise. While the present invention has applicability to at least these types of communications devices, the principles of the present invention are particularly applicable to all types of communications devices. For simplicity, the following description employs the terms "mobile telephone" or "cellular telephone" or "communications device" as umbrella terms to describe the embodiments of the present invention, but those skilled in the art will appreciate that the use of such term is not to be considered limiting to the scope of the invention, which is set forth by the claims appearing at the end of this description.

FIG. **1** illustrates an exemplary mobile or stationary communications device, such as a mobile or cellular telephone **10** or any other communications device that comprises a first

microphone **12**, a speaker **11**, an optional display screen **13**, an optional keypad **14**, an optional antenna **15**, and a housing **18** having an outer surface **19**. Optionally, a second microphone **16** for either continuous time or discrete time sampling environmental noise level and an environmental noise counterbalanced (correction) enable/disable button **17** may also be provided. The enable/disable button or feature **17** may be exposed on the surface of the housing or be available through a menu driven options or telephone set up procedure, or automatic detection logic may enable the telephone **10** to automatically identify periods where the user is speaking and periods of time where the user is listening and switch between microphone configurations. This optional second microphone **16**, and optional enable/disable button or feature **17** will be described more fully below relative to particular embodiments of the invention. These latter two elements, the second optional microphone **16** and the enable/disable button and associated circuits and/or logic, will be described more fully below. Those skilled in the art will appreciate that speaker transducer **11** could be replaced by an ear piece or by two ear pieces, head-set, or other electrical signal to acoustic transducer (not shown) that is worn by the mobile, cellular, fixed or stationary, or other telephone or communications device user. Speaker **11** is used herein to mean the device by which sound (such as in the form of an acoustic pressure wave) is transferred from the mobile or fixed communications device telephone (typically in the form of a digital or electrical signal that is converted into an acoustic or pressure wave signal) to the user, and more specifically to one or both of a user's ear(s). Also, optional display screen **13** may optionally be a touch screen display or other interface and display when provided, which might optionally incorporate keypad **14** or other interface as well as optional enable/disable button **17**. Various other different interfaces may be utilized as are known in the art.

FIG. **2**(*a*)-(*c*) illustrate an exemplary embodiments of the present invention including speaker transducer **11**, environmental noise compensation, correction and/or counterbalanced or counter balancing signal circuit, or logic, or other generator **20**, a continuous time quadrant multiplication (or multiplier) **22** (FIG. **2**(*a*)), a discrete time processor **28** (FIG. **2**(*b*)), and optional receiver **24**, and optional antenna **15**.

In accordance with an embodiment of the present invention, local environmental, ambient, or background noise present at the listener's telephone is cancelled or reduced before being combined with the intended voice communication received at the optional antenna **15** and receiver **24** and delivered to the speaker **11** for reproduction as an acoustic or sound wave to the user or listener.

More specifically, in a first embodiment, antenna **15** receives a wireless communication over a radio frequency communications link which is processed by receiver **24** to a baseband signal. This baseband signal may for example correspond to the output of an analog baseband/voiceband codec **45, 47** such as illustrated in FIG. **3**. The voice output from the receiver is communicated to an environmental noise correction circuit or process **20** which also receives an electrical signal from microphone **12** and generates correction signals based on these two inputs. It will be appreciated that the voice output of the receiver **24** may generally include one or more noise components, such as noise components from the transmit or up-link users side telephone, and/or noise from the communications path or link between the sending and receiving devices, however, it is not these noise components that are addressed in the present invention. The correction signals are communicated to an input port of a continuous time quadrant multiplier circuit or logic **22**, which also receives at a second input port the original voice output signal from the receiver as shown in FIG. **2**(*a*).

The continuous time quadrant multiplier generates a noise reduced or cancelled signal **29** that is then output to the speaker transducer **11**.

An optional fixed or dynamic gain circuit or logic block **25** may optionally be employed to modify a weight, gain, or amplification of one of more of the signals in the continuous time quadrant multiplier **22**. This modification of the dynamic gain may be used to adjust the amount or gain of the noise cancellation or could be turned off or shut down if and when desired. A static or fixed gain may alternatively be utilized but is not preferred. In some instances, the gain applied may be positive (e.g., amplification), negative (e.g., attenuation), or unity gain (e.g., gain is unity or no gain, amplification, or attenuation). The gain applied to each of the possible inputs may be independently selected. Typically at least one of the gains will be a non-unity gain at least at selected times of operation.

Environmental noise reduction and or cancellation generator or other circuit **20**, in accordance with well-known techniques, generates a correction, compensation, or counterbalancing signal or signals that are operable to attenuate, reduce, or altogether cancel background noise that is not intended or desirable to be heard by the recipient party. These compensation, correction, and/or counterbalanced signals are fed into a continuous time quadrant multiplier **22**, where these signals are mixed or otherwise combined or processed with the combined signal coming directly from microphone **12**. The result is that the environmental or background noise is eliminated, or at least substantially reduced, before the combined signal (environmental noise plus voice signal) is send to the user or the speaker **12** that is reproducing or transforming the signal that is listened to and ultimately heard by the user.

Alternatively, a discreet time processor **28** such as a digital processor may be utilized in place of (or in addition to) the continuous time quadrant multiplier **22** to provide digital instead of (or in addition to) analog voice processing as shown in FIG. **2**(*b*). As is well known in the art of noise reduction and or cancellation, it is possible (for example, via filtering and digital signal processing techniques) to attenuate or even cancel-out pre-selected portions of an audio signal or pre-selected bands of a frequency spectrum, or by other means.

In one embodiment, the discrete time processor **28**, such as a discrete time or digital processing block with or without signal processing is provided to delay or slow the progress or delivery of the voice signal from the receiver, so that when the voice signal reaches continuous time quadrant multiplier **22** the arrival time of the voice signal and the correction or compensation or counterbalancing signal generated by environmental noise reduction and or cancellation generator **20**, the signals are synchronized as shown in FIG. **2**(*c*). Other delay circuits may optionally be provided in the other path to the continuous time quadrant multiplier as may be required to achieve the desired synchronization.

Various techniques for adding and subtracting or otherwise combining two signals are know in the art, such as the use of operational amplifiers, differential amplifiers, comparators, and the like circuits, and these techniques and circuits may be utilized here. The result is that the environmental noise or background noise is eliminated or cancelled, or at least substantially reduced, before the noise reduced combined signal **29** (environmental noise plus voice signal) is passed to speaker transducer **11**.

With reference to FIG. **3**, there is illustrated an embodiment of the invention which illustrated the relationship between the inventive noise reduction and cancellation block **30** of FIG. **2**, and the other conventional components of a typical cellular telephone receiver **24**. In this particular embodiment, it may be appreciated that the noise reduction and/or cancellation block **30** is interposed as an interface between the speaker transducer output of the analog baseband/voiceband codec **45**, **47** so that a corrected or compensated signal is sent to the cellular telephone device speaker rather than the signal that would have been sent by the conventional cellular telephone. Furthermore, in the single microphone embodiment, microphone **11** is used in two modes, a first mode is the conventional manner of picking up voice from a user and coupling this voice signal to the analog baseband/voiceband codec **45**, **47** in conventional manner, and is a second mode where the microphone **11** is switched to disconnect it from the analog baseband/voiceband codec block **45**, **47** and to connect it to the noise reduction and/or cancellation block of the invention.

In a alternative embodiment having two microphones, the switch is not required and first microphone **11** is used in conventional manner to provide the usual voice input and second microphone **16** is used to sense and provide an environmental noise input to the noised reduction and cancellation block **30**. When two microphones are utilized, their characteristics and placement on the telephone or other communications device may be selected to improve or optimize their performance relative to an intended function.

It may be appreciated that noise local to the speaker's environment on the transmission may or may not have been reduced or cancelled on the transmission side, and that the present invention may be combined with speaker user side noise reduction or cancellation.

In accordance with one aspect of the present invention, environmental noise or background noise is attenuated, reduced, or cancelled from the intended voice communication. It will be appreciated that a theoretical goal is to cancel all ambient or environmental voice and to attenuate none of the speech signal, however, in practice it is inevitable that some environmental noise may remain and/or that some speech signal may be attenuated. Therefore, it will be understood that references to canceling noise refer to reduction of noise with the goal of eliminating the noise.

In one embodiment, the continuous time quadrant multiplier **22**, two single ended inputs (or optionally differential inputs), and are followed by voltage-to-current or other signal conversion circuits that generate signals suitable for input to the continuous time multiplier circuit. The product of these two signals is generated by a continuous time multiplier circuit, followed by a sum circuit that could accept a gain or dynamic gain to increase (amplify) or decrease (attenuate) the output level for the signal cleaned from noise. This cleaned signal is referred to as the enhanced signal in some of the result data described hereinafter in this description. It will be appreciated that where amplification or gain are described in decibels or db, which are logarithmic units, multiplication in non-logarithmic terms becomes a summation in logarithmic terms.

The dynamic gain circuit or logic block **25** may optionally be employed to modify a weight, gain, or amplification of one of more of the signals in the continuous time quadrant multiplier **22**. This way, better noise cancellation is achieved, and a cleaner output is presented. Although not specifically illustration in the drawings to avoid obscuring the more significant features of the embodiments, it should be appreciated that the gain or dynamic gain input may be applied to the noise reduction and cancellation processor **30** in any one or combination of several ways and is therefore shown as an input to the processing block as a whole. The gain whether fixed, variable, adjustable, or dynamic may be applied to either or both of the voice+noise or noise only inputs (either before of after the voltage-to-current conversion), to the output of the continuous time multiplier only or in combination with application to one or both of the inputs. Embodiments of the invention may also provide for gains of different value to be applied to any one or combination of these signals or components processing the signals so that appropriately weighted gains may be applied to the different signals to achieve the desired processing result.

Further in accordance with the present invention there is optionally provided an enable/disable switch **17** (FIG. **1**) that is preferably operable to enable/disable environmental noise correction, compensation, and/or counterbalanced (signal generator **20**. For example, depending on the nature of the environmental noise in a particular environment, known noise reduction and or cancellation techniques might also inadvertently attenuate the voice signal that is intended to be transmitted. In such a case, it is or may be preferable that the noise reduction and or cancellation features of the present invention be disabled, at least for a limited period of time, until the environmental noise is such that it can be more effectively distinguished from the voice signal and attenuated independently. For example, a mobile or fixed location telephone user may want to call a friend from a noisy public event (e.g., a concert or sporting event) for the main purpose of letting the friend hear the background noise of the crowd. In such a case, the switch **17** is preferably manipulated to disable the noise reduction and or cancellation features of the present invention.

Having now described aspects of embodiments of the inventive noise reduction and cancellation processing block **30** relative to microphones and the other components of the communications device such as a cellular telephone, we now describe the relationship of these processing block **30** relative to a conventional cellular telephone architecture to illustrate the relationship between the inventive processing block and the analog baseband/voiceband CODEC or other stage of a communications device that normally receives the electrical signal output by the microphone.

FIG. **3** illustrates a block diagram typical of the major functional blocks of a cellular telephone of the type not having the noise reduction and cancellation processing of the invention. This architecture is described so that the manner in which the invention interoperates with and improves the performance may be better understood.

RF section **41** includes a transmit section **42** and a receive section **43** and is where the RF signal is filtered and down-converted to analog baseband signals for the receive signal. It is also where analog baseband signals are filtered and then up-converted and amplified to RF for the transmit signal. Analog Baseband **45** is where analog baseband signals from RF receiver section **44** are filtered, sampled, and digitized before being fed to the Digital Signal Processing (DSP) section **46**. It is also where coded speech digital information from the DSP section are sampled and converted to analog baseband signals which are then fed to the RF transmitter section **43**. It will be understood that no radio-frequency (RF) section or antenna would be required for a wired line implementation.

The Voiceband Codec (VoCoder) **47** is where voice speech from the microphone **11** is digitized and coded to a certain bit rate (for example, 13 kbps for GSM) using the appropriate coding scheme (balance between perceived quality of the compressed speech and the overall cellular system capacity

and cost). It is also where the received voice call binary information are decoded and converted in the speaker or speakerphone **48**.

The digital signal processor (DSP) **46** is a highly customized processor designed to perform signal-manipulation calculations at high speed. The microprocessor **48** handles all of the housekeeping chores for the keyboard and display, deals with command and control signaling with the base station and also coordinates the rest of the functions on the board.

The ROM, SRAM, and Flash memory chips **49** provide storage for the phone's operating system and customizable features, such as the phone directory. The SIM card **50** belongs to this category; it stores the subscriber's identification number and other network information.

Power Management/DC-DC converter section **52** regulates from the battery **53** all the voltages required to the different phone sections. Battery charger **54** is responsible for charging the battery and maintaining it in a charged state.

Keypad **55** and display **13** provide an interface between a user and the internal components and operational features of the telephone.

It will be apparent to those workers skilled in the art that the inventive noise reduction and cancellation block is interposed or coupled between the single microphone **11** of the telephone in its conventional configuration and the analog baseband/voiceband CODEC of the conventional telephone. In fact the output of the noise reduction processing block **30** may be seen to be a processed version of the original microphone input and may connect at the same microphone input port as in a conventional phone. Not shown in the drawing is a possible connection between the noise reduction processing block **30** and the battery **53** (or the power management block **52** (depending upon implementation) that might be needed for a cellular telephone, but may not generally be needed for a wire lined device. The noise reduction processing block **30** may optionally rely on a separate power source such as an auxiliary battery that only powers the noise reduction processing block **30**. It will also be appreciated that a wire lined device would not require a battery or battery charger and would receive electrical power (voltage and current) from other electrical supply sources within the device.

Unless the context clearly requires otherwise, throughout the description and the claims, the words "comprise," "comprising" and the like are to be construed in an inclusive sense as opposed to an exclusive or exhaustive sense; that is to say, in a sense of "including, but not limited to." Words using the singular or plural number also include the plural or singular number, respectively. Additionally, the words "herein," "above," "below," and words of similar import, when used in this application, shall refer to this application as a whole and not to any particular portions of this application.

The above detailed description of embodiments of the invention is not intended to be exhaustive or to limit the invention to the precise form disclosed above. While specific embodiments of, and examples for, the invention are described above for illustrative purposes, various equivalent modifications are possible within the scope of the invention, as those skilled in the relevant art will recognize. For example, while steps are presented in a given order, alternative embodiments may perform routines having steps in a different order. The teachings of the invention provided herein can be applied to other systems, not only the systems described herein. The various embodiments described herein can be combined to provide further embodiments. These and other changes can be made to the invention in light of the detailed description.

All the above references and U.S. patents and applications are incorporated herein by reference. Aspects of the invention can be modified, if necessary, to employ the systems, functions and concepts of the various patents and applications described above to provide yet further embodiments of the invention.

These and other changes can be made to the invention in light of the above detailed description. In general, the terms used in the following claims, should not be construed to limit the invention to the specific embodiments disclosed in the specification, unless the above detailed description explicitly defines such terms. Accordingly, the actual scope of the invention encompasses the disclosed embodiments and all equivalent ways of practicing or implementing the invention under the claims.

While certain aspects of the invention are presented below in certain claim forms, the inventors contemplate the various aspects of the invention in any number of claim forms. Accordingly, the inventors reserve the right to add additional claims after filing the application to pursue such additional claim forms for other aspects of the invention.

The foregoing disclosure of the preferred embodiments of the present invention has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise forms disclosed. Many variations and modifications of the embodiments described herein will be obvious to one of ordinary skill in the art in light of the above disclosure. The scope of the invention is to be defined only by the claims appended hereto, and by their equivalents.

Further, in describing representative embodiments of the present invention, the specification may have presented the method and/or process of the present invention as a particular sequence of steps. However, to the extent that the method or process does not rely on the particular order of steps set forth herein, the method or process should not be limited to the particular sequence of steps described. As one of ordinary skill in the art would appreciate, other sequences of steps may be possible. Therefore, the particular order of the steps set forth in the specification should not be construed as limitations on the claims. In addition, the claims directed to the method and/or process of the present invention should not be limited to the performance of their steps in the order written, and one skilled in the art can readily appreciate that the sequences may be varied and still remain within the spirit and scope of the present invention.

We claim:

1. A communications device, comprising:

a speaker containing an input of both voice and environmental noise;

a first transmit microphone having a first microphone output providing a first signal containing substantially only environmental noise;

an environmental noise counterbalanced (correction) signal generator having (i) an environmental noise counterbalanced (correction) signal generator input connected to both the speaker input and the second microphone output and (ii) an environmental noise counterbalanced (correction) signal generator output;

a continuous time quadrant multiplier or a discrete time processor having (i) a first continuous time quadrant multiplication input in communication with the first input signal to the speaker and (ii) a second continuous time quadrant multiplication input connected to the environmental noise counterbalanced (correction) signal generator output and (iii) a multiplication output;

a dynamic gain circuit for providing a dynamic gain signal to the continuous time quadrant multiplication;

a receiver having a received input connected to the multiplication output after receiving from the antenna;

a discrete time unit or processing block with or without signal processing interposed between the first microphone and the continuous time quadrant multiplication;

wherein environmental noise picked up by the recipient and by the second microphone is processed by the environmental noise counterbalanced (correction) signal generator and wherein the environmental noise is attenuated at the speaker recipient unit after being passed through the receiver.

2. The communications device of claim 1, wherein the second microphone is spatially distant from the communications device.

3. The communications device of claim 1, further comprising a second microphone, different from the first transmit microphone, having a second microphone output providing a second signal containing substantially only environmental noise.

4. A noise compensation device for a communications apparatus, comprising:

a receive input port for receiving a remote user's spoken voice electrical signal and optionally a component of environmental noise signal from the speakers location;

a microphone for receiving an acoustic air pressure input signal at a location including at least a component of local environmental noise at the speaker's location and for converting the acoustic air pressure input signal into a time varying electrical signal representing the acoustic air pressure input signal at the location;

a speaker transducer for converting an electrical signal representing a time sequence of sounds into a time varying acoustical signal within a human hearing audio frequency range;

a first microphone transducer for converting an audio frequency range signal existing in a local environment of the communications apparatus into an electrical signal representing the local audio frequency range signal from the local environment;

an environmental noise correction or compensation signal generator having: (i) an environmental noise correction or compensation signal generator input port for receiving at least a signal derived from the first microphone output, and (ii) an environmental noise correction or compensation signal output port for communicating an environmental noise correction or compensation output signal;

a continuous time quadrant multiplier or a discrete time processor having: (i) a first multiplier input in communication with the first input signal to the speaker, and (ii) a second multiplier input connected to the environmental noise counterbalanced (correction) signal generator output and (iii) a multiplication output; and

a receiver having a received input connected to the multiplication output after receiving from the antenna,

wherein environmental noise picked up by the recipient and by the second microphone is processed by the environmental noise counterbalanced (correction) signal generator and wherein the environmental noise is attenuated at the speaker recipient unit after being passed through the receiver.

5. A noise compensation device as in claim 4, further comprising:

a second microphone, different from the transmit microphone, having a microphone output providing a second signal containing substantially only environmental noise.

6. A noise compensation device, comprising:

a first microphone generating a noise signal output;

an environmental and ambient noise correction circuit having a first input for receiving the noise signal from the first microphone and a second input for a voice signal from a receiver and generating a correction signal from the first and second inputs;

a continuous time quadrant multiplier or a discrete time processor having a first input for receiving the correction signal output by the environmental noise correction circuit and a second input for receiving the voice signal from the receiver and generating an output signal that is a noise reduced version of the voice signal;

a dynamic gain circuit for modifying a gain of a component of the continuous time quadrant multiplier;

a switch for switching the first microphone between a voice sensing mode during a period of speech and a noise sensing mode during periods of listening;

the receiver generating the voice signal; and

a discrete time processor receiving the voice signal from the receiver and performing a discrete time processing operation on the voice signal before providing it to the continuous time quadrant multiplier.

7. A noise compensation device as in claim 6, further comprising a second microphone exclusively for generating a noise signal during periods of non-speech.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 7,742,790 B2
APPLICATION NO. : 11/749927
DATED : June 22, 2010
INVENTOR(S) : Alon Konchitsky and William Martin Ribble

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 10, line 58 in claim 1 replace "second microphone" with "first microphone"
Column 11, line 9 in claim 1 replace "second microphone" with "first microphone"
Column 11, line 15 in claim 2 replace "second microphone" with "first microphone"
Column 11, line 37 in claim 4 replace "a first microphone transducer" with "a microphone transducer"
Column 11, line 45 in claim 4 replace "the first microphone" with "the microphone"
Column 12, line 10 in claim 4 replace "the second microphone" with "the microphone"
Column 12, line 17-18 in claim 5 replace "the transmit microphone" with "the microphone"

Signed and Sealed this
Third Day of July, 2012

David J. Kappos

David J. Kappos
Director of the United States Patent and Trademark Office