

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

GOOGLE LLC,

Petitioner,

v.

JAWBONE INNOVATIONS, LLC,

Patent Owner.

Case IPR2022-01027

Patent No. 8,467,543

DECLARATION OF DAVID V. ANDERSON

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I. INTRODUCTION

1. I have been retained by Google LLC (“Google” or “Petitioner”) as an independent expert consultant in this proceeding before the United States Patent and Trademark Office.

2. I am over 21 years of age, and, if I am called upon to do so, I would be competent to testify as to the matters set forth herein.

3. My compensation is in no way contingent on the nature of my findings, the presentation of my findings in testimony, or the outcome of any proceeding.

4. I understand that this proceeding involves U.S. Patent No. 8,467,543 (“the ’543 patent,” Ex. 1001). The application for the ’543 patent was filed on March 27, 2003, as U.S. Patent Application No. 10/400,282 (“the ’282 application”). The ’282 application issued as the ’543 patent on June 18, 2013.

5. The ’543 patent claims priority to U.S. Provisional Application No. 60/368,209, filed March 27, 2002.

6. I have been asked by Petitioner to provide my opinion on whether the claims of the ’543 patent would have been obvious to a person of ordinary skill in the art at the time of the earliest claimed priority date of the ’543 patent. In performing my analysis, I have been asked to assume that the priority date is March 27, 2002. My opinions are set forth below.

7. Throughout this declaration, I refer to specific pages, figures, and/or line numbers of various exhibits. These citations are illustrative and are not intended to suggest that they are the only support for the propositions for which they are cited.

II. QUALIFICATIONS

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

9. Prior to my time at Georgia Tech, I worked in the field of speech and audio signal processing. From 1993 to 1994, I designed and implemented signal processing methods for hearing aids at Sonic Innovations. From 1994 to 1999, I performed research in audio signal processing, specializing in speech enhancement. During that time, I also worked as a consultant to multiple companies developing algorithms for general speech enhancement in wireless telephone systems, speech quality assessment, and speech detection. This work led to the filing and issuance of several patents, including one on speech detection in noise and one on speech enhancement (noise removal from speech).

10. In my employment prior to Georgia Tech, as well as in my subsequent studies and research, I have worked extensively in areas related to research, design, and implementation of audio and speech processing algorithms and in speech enhancement. I have designed and taught a graduate course on adaptive signal processing, which includes the topics of estimating transfer functions, correlation, using cross-correlation to estimate signal similarity and to compute transfer functions, and extracting signals of interest from noisy signals. I have also taught graduate and undergraduate level courses at Georgia Tech on the implementation of signal processing theory, algorithms, implementation, and software. For example, I have taught courses on multimedia processing and systems, machine learning for speech, pattern recognition, software design, and signal processing applications (covering topics in audio processing, speech detection, speech processing, and speech recognition). These courses and my research have covered many topics relevant to the subject matter of the '543 patent and the cited prior art. In particular, concepts such as voice detection, denoising, and subband processing are all topics with which I am intimately familiar.

11. I also have extensive experience with the practical implementation of signal processing algorithms, information theory, signal detection, and related topics through my research and consulting.

12. A copy of my CV, including a list of recent litigations I have testified in, is attached as Exhibit 1004. My compensation is not contingent upon the outcome of this *inter partes* review or any other proceeding.

III. MATERIALS CONSIDERED

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

Exhibit	Description
Ex. 1001	U.S. Patent No. 8,467,543 (“the ’543 patent”)
Ex. 1002	Prosecution History of the ’543 Patent
Ex. 1005	U.S. Patent No. 5,732,143 to Andrea et al. (“Andrea”)
Ex. 1006	Amir Hussain et al., <i>A New Metric for Selecting Sub-Band Processing in Adaptive Speech Enhancement Systems</i> , Proc. 5th European Conference on Speech Communication and Technology (Eurospeech ’97), 2611-14 (“Hussain”)
Ex. 1007	U.S. Patent No. 6,006,175 to Holzrichter (“Holzrichter”)
Ex. 1008	K.N. Stevens et al., <i>A Miniature Accelerometer For Detecting Glottal Waveforms and Nasalization</i> , Journal of Speech and Hearing Research, September 1975, Vol. 18 (No. 3) 594-99 (“Stevens”)
Ex. 1009	U.S. Patent No. 3,746,789 to Alcivar (“Alcivar”)

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

15. All of the opinions contained in this declaration are based on the documents I reviewed and my knowledge and professional judgment. My opinions have also been guided by my understanding of how a person of ordinary skill in the art would have understood the claims of the '543 patent at the time of the alleged invention. For purposes of this declaration, I have been asked to assume that the date of the alleged invention is the earliest claimed priority date (in this case, the filing date of the provisional patent application to which the '543 patent claims priority): March 27, 2002.

16. I reserve the right to supplement and amend any of my opinions in this declaration based on documents, testimony, and other information that becomes available to me after the date of this declaration.

IV. LEGAL STANDARDS

17. For purposes of this declaration, I have been asked to opine only on issues regarding obviousness under 35 U.S.C. § 103. I have been informed of the following legal standards, which I have applied in forming my opinions.

18. I have been asked to provide my opinions as to whether the cited prior art teaches or renders obvious claims 1-26 of the '543 patent from the perspective of a person of ordinary skill in the art at the '543 patent's priority date in 2002, as described in more detail below.

19. For purposes of this declaration, I have been informed and understand certain aspects of the law as it relates to my opinions.

20. I have been advised and understand that there are two ways in which prior art may render a patent claim unpatentable. First, I have been advised that the prior art can “anticipate” a claim. Second, I have been advised that the prior art can make a claim “obvious” to a person of ordinary skill in the art. I understand that for an invention claimed in a patent to be patentable, it must not be anticipated and must not be obvious based on what was known before the invention was made.

21. I have been advised and understand the information used to evaluate whether an invention was new and not obvious when made is generally referred to as “prior art.” I understand that prior art includes patents and printed publications that existed before the earliest filing date of the patent (which I have been informed is also called the “effective filing date”). I have been informed and understand that a patent or published patent application is prior art if it was filed before the earliest filing date of the claimed invention and that a printed publication is prior art if it was publicly available before the earliest filing date.

22. I have been advised and understand that a dependent claim is a patent claim that refers back to another patent claim. I have been informed and understand that a dependent claim includes all of the limitations of the claim to which it refers.

23. I have been advised and understand that a patent claim may be invalid as obvious under 35 U.S.C. § 103 if the differences between the subject matter claimed and the prior art are such that the claimed subject matter as a whole would have been obvious to a person of ordinary skill in the art at the time the invention was made. I have also been advised that several factual inquiries underlie a determination of obviousness. These inquiries include (1) the scope and content of the prior art, (2) the level of ordinary skill in the field of the invention, (3) the differences between the claimed invention and the prior art, and (4) any objective evidence of non-obviousness (which I have been informed may also be called “secondary considerations”).

24. I have also been advised and understand that, when obviousness is based on a combination of references, that party must identify a reason why a person skilled in the art would have been motivated to combine or modify the asserted references in the manner recited in the claims and to explain why one skilled in the art would have had a reasonable expectation of success in making such combinations or modifications.

25. I have been advised and understand that the law permits the application of “common sense” in examining whether a claimed invention would have been obvious to a person skilled in the art. For example, I have been advised that combining familiar elements according to known methods and in a predictable

way may suggest obviousness when such a combination would yield nothing more than predictable results. I understand, however, that a claim is not obvious merely because every claim element is disclosed in the prior art and that a party asserting obviousness must still provide a specific motivation to combine or modify the references as recited in the claims and explain why one skilled in the art would have reasonably expected to succeed in doing so.

26. I have been advised and understand that two references are considered to be in the same field of art when the references are either (1) in the same field of endeavor, regardless of the problems they address, or (2) reasonably pertinent to the particular problem being solved by the inventor in his or her patent.

27. I am not aware of any evidence of secondary considerations that would support a determination of non-obviousness of the claimed subject matter in the '543 patent.

28. I have been informed that in *inter partes* review proceedings, such as this one, the party challenging the patent bears the burden of proving unpatentability by a preponderance of the evidence. I understand that a preponderance of the evidence means "more likely than not."

V. LEVEL OF ORDINARY SKILL IN THE ART

29. In rendering the opinions set forth in this declaration, I have been asked to consider the '543 patent's claims and the prior art through the eyes of a

person of ordinary skill in the art (which I may also refer to as “one skilled in the art,” “skilled artisan,” “POSITA,” or similar variation). I have considered factors such as the educational level and years of experience of those working in the pertinent art, the types of problems encountered in the art, the teachings of the prior art, patents and publications of other persons or companies, and the sophistication of the technology.

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

31. Taking these factors into consideration, it is my opinion that a person of ordinary skill in the art of the '543 patent as of its filing date, would have at least a bachelor's degree in computer engineering, computer science, electrical engineering, mechanical engineering, or a similar field, and approximately three years of industry or academic experience in a field related to acoustics, speech recognition, speech detection, or signal processing. Work experience can substitute for formal education and additional formal education can substitute for work experience.

32. By March 27, 2002, I was at least a person of ordinary skill in the art, as shown by my qualifications and work experience above.

33. In this declaration, and for all of my opinions herein, I have applied the knowledge of a person of ordinary skill in the art as of March 27, 2002.

VI. CLAIM CONSTRUCTION

34. I have been instructed that the words of a claim are typically given their ordinary and customary meaning, as they would have been understood by a person of ordinary skill in the art at the time of the invention, in view of the intrinsic record (discussed below). In this case, I have been instructed to assume that the “time of the invention” for purposes of claim construction is March 27, 2002, which is the earliest claimed priority filing date for the ’543 patent. The opinions herein pertain to that time frame, except where expressly stated otherwise.

35. I have been instructed that the “intrinsic record” includes the patent itself, including the claims, description, and figures (Ex. 1001), and the patent’s prosecution history—i.e., the record of proceedings at the U.S. Patent and Trademark Office (“Patent Office”) concerning the patent (Ex. 1002). I understand that, like the claims and written description, the prosecution history provides evidence to a person of ordinary skill in the art of how the inventor intended his or her patent to be understood, and how the Patent Office understood the patent. I understand that the inventor is permitted to apply a special definition to the terms or to limit the scope of claim terms in his or her patent claims, which may differ from the term’s plain and ordinary meaning. That special definition or limitation

on scope may be provided in the patent's written description, the patent's prosecution history, or both.

36. I understand that claim interpretation may also be informed by “extrinsic evidence” (that is, evidence outside of the patent record itself). I have been informed that extrinsic evidence may include dictionaries, technical treatises, and other materials evidencing the meaning of a claim term and the understanding held by a POSITA in the relevant time period.

37. I have been asked for purposes of this declaration to apply the plain and ordinary meaning of the claim terms as they would have been understood by a person of ordinary skill in the art at the earliest claimed priority date of the '543 patent (March 27, 2002).

38. I understand that no claim term's construction is in dispute at this time. Based on my review of these materials and my personal knowledge and experience, I have considered each term of the '543 patent as it would have been understood by one skilled in the art as of March 27, 2002.

VII. BACKGROUND OF THE '543 PATENT

A. Specification

39. The '543 patent describes “detecting and processing a desired acoustic signal in the presence of acoustic noise.” Ex. 1001, 1:28-30. The '543 patent states that most prior noise suppression systems were “based on a single-microphone

spectral subtraction technique” and used “a single-microphone Voice Activity Detector (VAD) to determine the background noise characteristics.” *Id.*, 1:35-37, 1:44-47. The ’543 patent explains that these systems were “limited in capability” because they used a single microphone to receive acoustic information and that performance was especially limited “when processing signals having a low signal-to-noise ratio (SNR), and in settings where the background noise varies quickly.” *Id.*, 1:60-67.

40. The ’543 patent describes a signal processing system 100 shown in Figure 1 below. *Id.*, 5:18-20, 14:40-50, Fig. 1. Signal processing system 100 includes a noise removal or suppression system 105 and a VAD system 106. *Id.* The signal processing system 100 also includes an array of two microphones, MIC 1 103 and MIC 2 104, that receive signals from a speech source 101 and a noise source 102. *Id.*, 5:20-24, 14:43-46. $H_1(z)$ represents the path from the noise source 102 to MIC 1, and $H_2(z)$ represents the path from the speech signal source 101 to MIC 2. *Id.*, 5:26-28, 14:48-50.

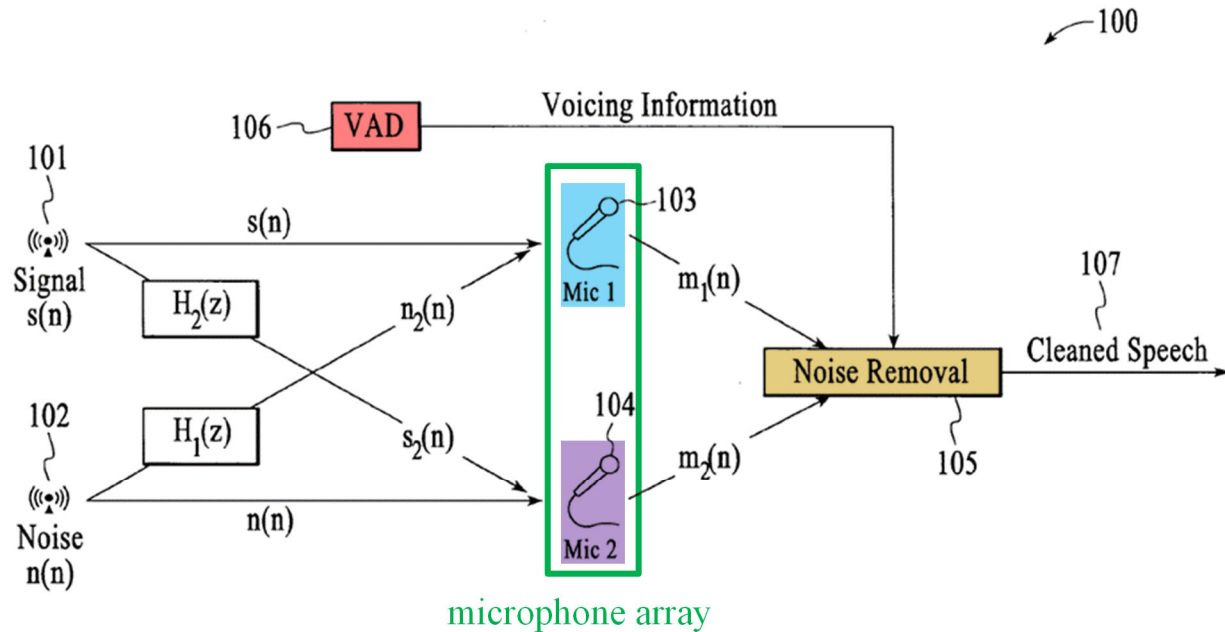


FIG.1

Id., Fig. 1 (annotated). The VAD indicates whether speech (voice activity) is occurring. *See id.*, 4:52-57.

41. The system uses the VAD signal 106 “to control the method of noise removal.” *Id.* 14:51-52. For example, “where the VAD indicates voicing is not occurring,” the system assumes that the speech signal is zero and approximates $H_1(z)$ as:

$$H_1(z) = \frac{M_{1n}(z)}{M_{2n}(z)}$$

where $M_1(z)$ and $M_2(z)$ denote the digital frequency (“z”) domain acoustic information coming into MIC 1 and MIC 2, respectively, and where the n subscript indicates that only noise is being received. *Id.*, 14:51-56, 14:67-15:14. In contrast,

“[w]hen the VAD indicates voicing,” the system assumes that the noise signal is zero and approximates $H_2(z)$ as:

$$H_2(z) = \frac{M_{2s}(z)}{M_{1s}(z)}$$

Id., 15:20-35.

42. The calculations of $H_1(z)$ and $H_2(z)$ are “used to remove the noise from the [speech] signal” to produce a cleaned or denoised speech signal $S(z)$ as follows:

$$S(z) = \frac{M_1(z) - M_2(z)H_1(z)}{1 - H_2(z)H_1(z)}$$

Id., 15:46-63.

43. The '543 patent describes subband processing of the acoustic signals. *Id.*, 16:9-11. The signals from the first and second microphones are filtered into multiple subbands, sending data from each subband to its own adaptive filter, and then adding the noise-suppressed results from each subband “to form the final denoised signal at the end.” *Id.*, 16:31-40.

44. The '543 patent also describes a number of microphone types (omnidirectional and unidirectional) and configurations in handsets and headsets. *See, e.g., id.*, 2:34-3:35.

B. Prosecution History

45. The '543 patent was filed as U.S. Patent Application No. 10/400,282 ("the '282 application") and claims priority to U.S. Provisional Application No. 60/368,209, filed March 27, 2002. The '282 application received eight rejections during prosecution. Ex. 1002, 213-221, 289-307, 330-342, 381-394, 431-444, 481-492, 541-553, 613-621.

46. In response to the first rejection, Applicant amended independent claims 1 and 18 to recite a voice detection subsystem comprising two unidirectional microphones separated by a distance in a range of 0-15 centimeters and an angle in a range of 0-180° and a VAD algorithm. *Id.*, 232, 235. Applicant also amended independent claim 34 to recite a headset, *id.*, 238, and added four new independent claims, *id.*, 239-241. Applicant argued that the amended claims were patentable because they incorporated subject matter the Examiner identified as allowable. *Id.*, 242-243.

47. In the next rejection, the Examiner indicated that the subject matter Applicant had added to independent claims 1 and 18 was "mistakenly included in the list" of allowable subject matter in the previous rejection. *See id.*, 291. The Examiner rejected all pending claims. *Id.*, 289-307.

48. In response to the second rejection, Applicant amended independent claims 1 and 41 to remove the language it added by its previous amendment,

remove additional language, and add limitations related to “a microphone array” of two microphones and their relative orientation. *Id.*, 313, 316-317. Applicant argued that none of the prior art references disclosed two microphones with vectors normal to the front surfaces and an angle between the two vectors. *Id.* 321. Applicant also added 12 new dependent claims related to the types of microphones (unidirectional and omnidirectional) and their relative spacing and orientation. *Id.*, 317-318.

49. The Examiner found Applicant’s amendments and arguments unpersuasive and “assert[ed] that the newly recited claim language is implicit.” *Id.*, 332.

50. In response to the third and fourth rejections, Applicant did not amend the claims, *id.*, 364-369, 408-413, and instead argued that the prior art did not disclose “the relative positioning of the two microphones” as claimed. *Id.*, 373, 415; *see also id.*, 374-378, 416-422.

51. In response to the fifth rejection, Applicant amended independent claims 1 and 41 to remove reference to “vector[s]” normal to the front of the microphones and instead recite the orientation of the microphones based on a first and second position relative to the mouth of a user and each other. *Id.*, 459, 462. Applicant continued to argue that the prior art did not teach “the relative positioning of the two microphones” as claimed. *Id.*, 465-472.

52. In response to the sixth rejection, Applicant amended independent claims 1 and 41 to recite “wherein the angle [between the front of the first and second microphones] is greater than zero degrees” and argued that the prior art did not teach this limitation. *Id.*, 520, 523, 526-535.

53. In the next rejection, the Examiner found Applicant’s arguments about the microphone orientation, specifically “a first position oriented towards the mouth and the other position away from the mouth” persuasive, withdrew the prior rejection, but issued an additional ground of rejection. *Id.*, 543.

54. In response to the seventh rejection, Applicant amended independent claims 1 and 41 to recite “wherein the voice detection subsystem is configured to receive the voice activity signals using a sensor independent from the microphone array and to output the control signals generated from the voice activity signals to the denoising system, the denoising system configured to use the control signals to denoise the acoustic signals from the microphone array.” *Id.* 585-586, 589.

55. After issuing two notices of noncompliant amendments, *id.*, 592-593, 608-609, the Examiner issued an office action withdrawing the prior rejection and issuing a double patenting rejection over copending U.S. Application Nos. 10/301,237, 12/163,647, and 12/123,364, *id.*, 615-620. In response to the eighth rejection, Applicant filed a terminal disclaimer to address the double patenting rejection. *Id.*, 637-638.

56. The Examiner issued a notice of allowance and provided the following reasons for allowance:

The above claims are allowed after further search since although, the prior arts disclose of the voice detecting subsystem and denoising subsystem but, none of the prior art disclose of such specific as wherein the *voice detection subsystem is configured to receive the voice activity signals using a sensor independent from the microphone array and to output the control signals generated from the voice activity signals to the denoising system, the denoising system configured to use the control signals to denoise the acoustic signals from the microphone array.*

Id., 654 (emphasis added).

57. During prosecution, the Examiner did not have the benefit of the prior art asserted in this Petition (with the exception of Holzrichter, which was submitted in an IDS but not applied by the Examiner), which disclose the features the Examiner determined were not present in the prior art.

VIII. GROUNDS OF UNPATENTABILITY

58. Based on my review of the materials set forth above, including my application of the knowledge of a person of ordinary skill in the art, it is my opinion that claims 1-26 of the '543 patent would have been obvious to a person of ordinary skill in the art.

59. In particular, it is my opinion that claims 1-26 of the '543 patent would have been obvious to a person of ordinary skill in the art based on the combinations shown below:

Ground 1	Andrea, Hussain, and Holzrichter render obvious claims 1-2 and 5-26 under pre-AIA § 103.
Ground 2	Andrea, Hussain, Holzrichter, and Stevens render obvious claim 3 under pre-AIA § 103.
Ground 3	Andrea, Hussain, Holzrichter, and Alcivar render obvious claim 4 under pre-AIA § 103.

IX. CLAIMS 1-26 WOULD HAVE BEEN OBVIOUS TO A PERSON OF ORDINARY SKILL IN THE ART BASED ON THE PRIOR ART IN GROUNDS 1-3

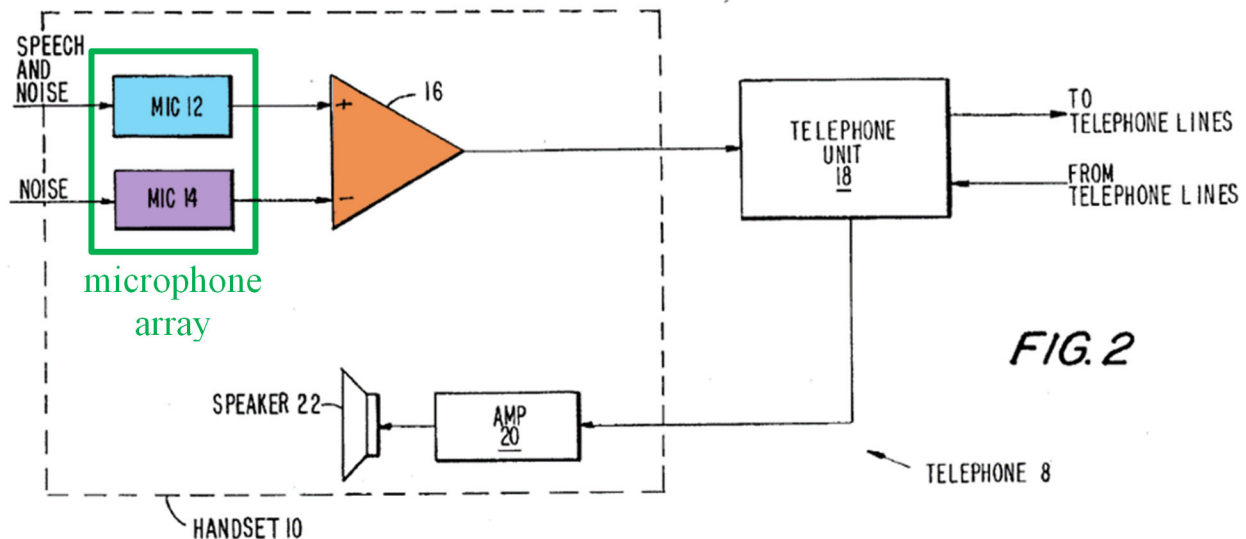
A. Ground 1: Claims 1-2 and 5-26 Are Obvious over Andrea, Hussain, and Holzrichter

60. In my opinion, claims 1-2 and 5-26 would have been obvious to a POSITA based on Andrea, Hussain, and Holzrichter.

1. Overview of Andrea

61. Andrea, like the '543 patent, discloses a “noise cancellation apparatus” used in telecommunication and other communication systems. Ex. 1005, 11:19-20, 9:13-21, 6:58-61, 7:9-13. Andrea’s Figure 2, shown below, discloses a nearly identical structure to Figure 1 of the '543 patent. *Compare* Ex. 1005, Fig. 2, *with* Ex. 1001, Fig. 1. Andrea discloses a first microphone 12 and a second microphone 14 (making up a microphone array) and a subtracting device

16, such as an operation amplifier (op-amp). Ex. 1005, 12:46-54. Andrea describes a “VOX circuit” to sense speech in a “headset having a ‘talk-thru’ capability.” See Ex. 1005, 33:44-35:7.

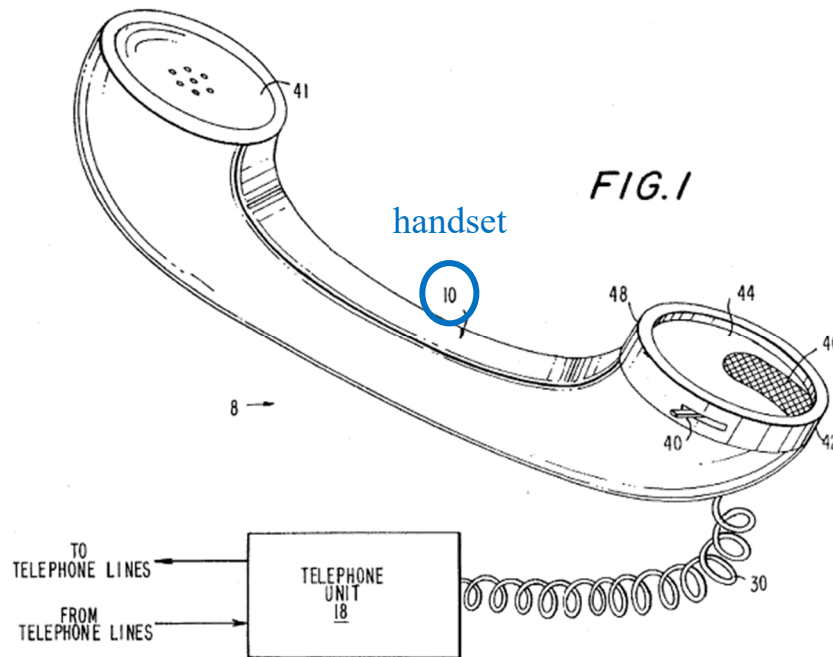


Id., Fig. 2 (annotated).

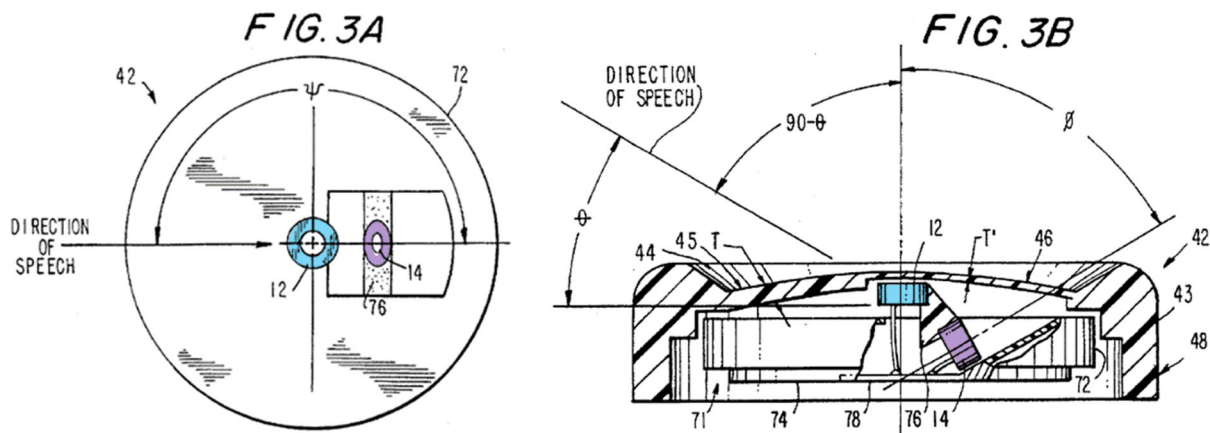
62. Andrea discloses that “[t]he op-amp 16 is adapted to subtract the noise signal from the second microphone 14 from the speech and noise signal from the first microphone 12” and to supply “an electrical signal representing substantially the speech to the telephone unit 18.” *Id.*, 12:55-66.

63. Andrea contains various disclosures implementing its system in handsets or headsets. Figure 1 of Andrea, below, shows an exemplary handset. *Id.*, 12:33-45, Fig. 1. Andrea describes, and Figures 3A and 3B below show, the relative position and orientation of the first microphone 12 and second microphone

14 below portion 46 of handset 10. *Id.*, 13:65-14:6, 14:7-29, 14:30-34, 14:49-53,
Figs. 3A, 3B.



Id., Fig. 1 (annotated).



Id., Figs. 3A, 3B (annotated).

64. Figure 9C of Andrea, below, shows a headset. *Id.*, 19:65-20:14, Fig. 9C. Andrea describes, and Figure 9A below shows, the relative position and

orientation of the first microphone 300 and second microphone 302 in a microphone boom 320/440 of headset assembly 400. *Id.*, 19:11-43, 19:65-20:14, Fig. 9A.

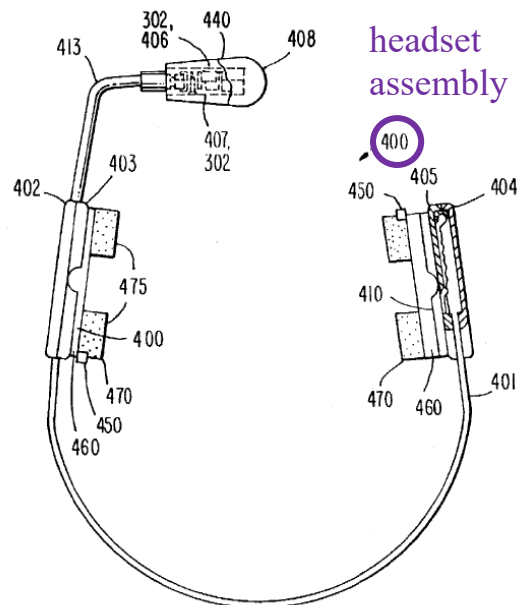


FIG. 9C

Id., Fig. 9C (annotated).

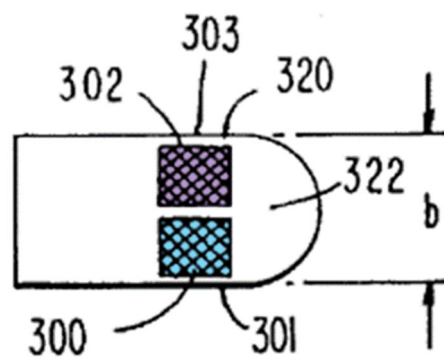


FIG. 9A

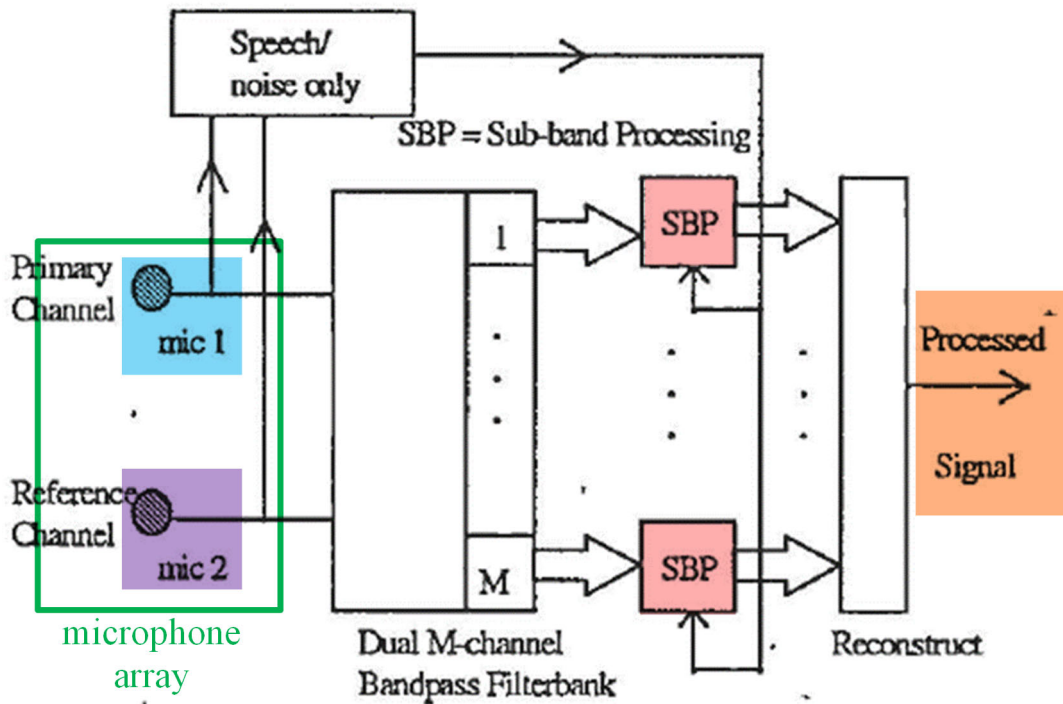
Id., Fig. 9A (annotated).

2. Overview of Hussain

65. Hussain is a paper published at *EuroSpeech '97*, of the 5th European Conference on Speech Communication and Technology, held in Rhodes, Greece, September 22-25, 1997. Ex. 1006. *EuroSpeech* is coordinated by the European Speech Communication Association (ESCA), which was a well-known organization to those skilled in the art. Hussain was published as part of the “Proceedings, Volume 5,” meaning that it was distributed to attendees of the conference without limitation on subsequent distribution. Attendees of *EuroSpeech '97* would have included POSITAs who would have regularly attended such academic proceedings to understand and learn about developments in speech processing, speech detection, voice detection, and other speech communication related areas that are relevant to POSITAs. In 1997, “Proceedings” were typically bound volumes that were either mailed to attendees just prior to or shortly after the conference or distributed in-person to attendees to review during presentations. Copies of papers may also be available for attendees to pick up at various presentations so that the attendees do not have to carry the complete published volumes around the conference. Hussain, therefore, would have been made available to POSITAs on or about September 22-25, 1997, the date of the conference, and may have been further disseminated by libraries that regularly receive and catalog such proceedings.

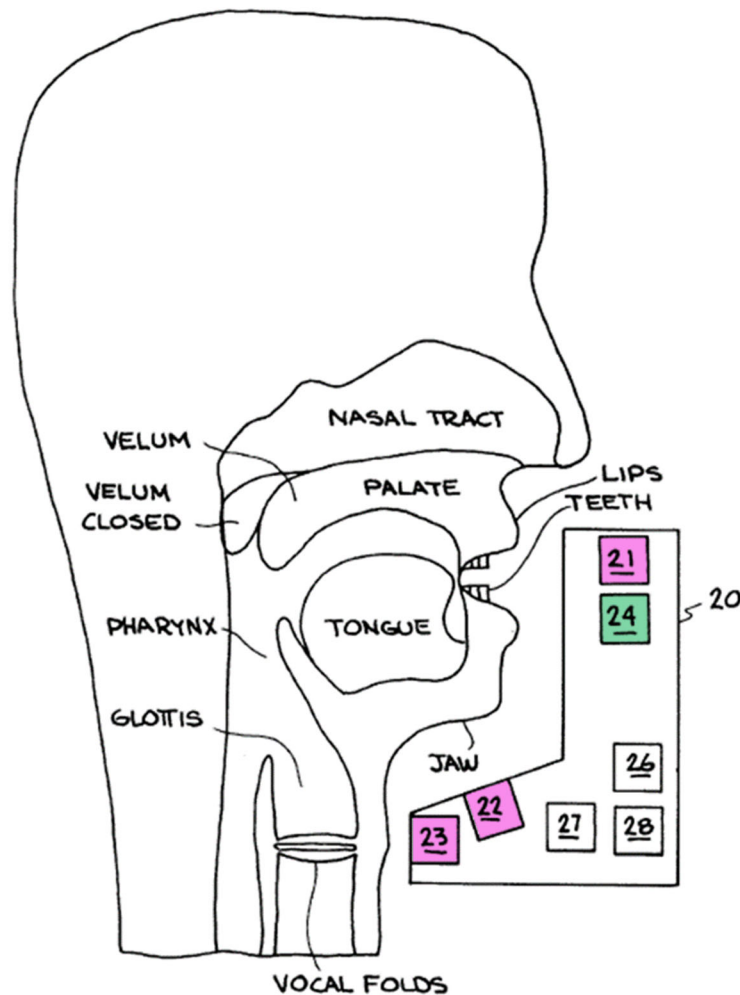
66. Hussain discloses an “adaptive noise cancellation scheme” that improves performance in reverberant environments by separating the acoustic signals into sub-bands, generating a transfer function for each sub-band, removing noise in that sub-band, and reconstructing the signal to produce a denoised processed signal. Ex. 1006, 10-11, 13.

67. Like Andrea, Hussain uses a **microphone array** of “[t]wo or more relatively closely spaced microphones”—“**mic 1** and **mic 2**.” *Id.*, 10-11. A filter bank separates signals received by the microphones into sub-bands. *Id.*, 10-11. Hussain assumes “an effective **voice activity detector (VAD)**” is available to determine a “noise alone period” and a “speech plus noise period.” *Id.*, 11. “[D]uring the noise alone period” (when voicing activity is not detected), Hussain uses “an adaptive filter” to determine a “differential acoustic-path transfer function” for each sub-band. *Id.*, 11. Then, “during the speech plus noise period” (when voicing activity is detected), Hussain uses the transfer function “to process the noisy speech signal” and output a denoised speech signal. *Id.*, 11. **Sub-band processing (“SBP”)** is applied to each sub-band, the processed signals are reconstructed, and the **denoised processed signal** is output, as shown below in Figure 1.

*Id.*, Fig. 1 (annotated).

3. Overview of Holzrichter

68. Holzrichter discloses a speech recognition system that uses “nonacoustic information in combination with acoustic information.” Ex. 1007, 1:12-15. As shown in Figure 4 below, Holzrichter uses EM sensor modules 21, 22, 23 to measure speech organs and “determine if voiced speech is occurring” and a separate acoustic microphone 24 “to obtain simultaneous acoustic information” *Id.*, 10:35-37, 12:3-6, 16:42-49, 17:53-58, 18:42-48.

**FIG. 4**

Id., Fig. 4 (annotated).

69. Referring to Figure 3, below, Holzrichter describes the “signals from an **acoustic microphone 1**” and explains that the signals from **EM sensors 2, 3, 4**¹ “can also be used to **generate individual feature vectors 7, 8, 9**” and “provide

¹ EM sensors 2, 3, 4 of Figure 3 correspond to EM sensors 23, 22, 21 of Figure 4, respectively. Ex. 1007, 17:24-29, 17:61-65, Figs. 3-4.

valuable information ... to determine if voiced speech is occurring.” *Id.*, 12:3-6, 17:24-29.

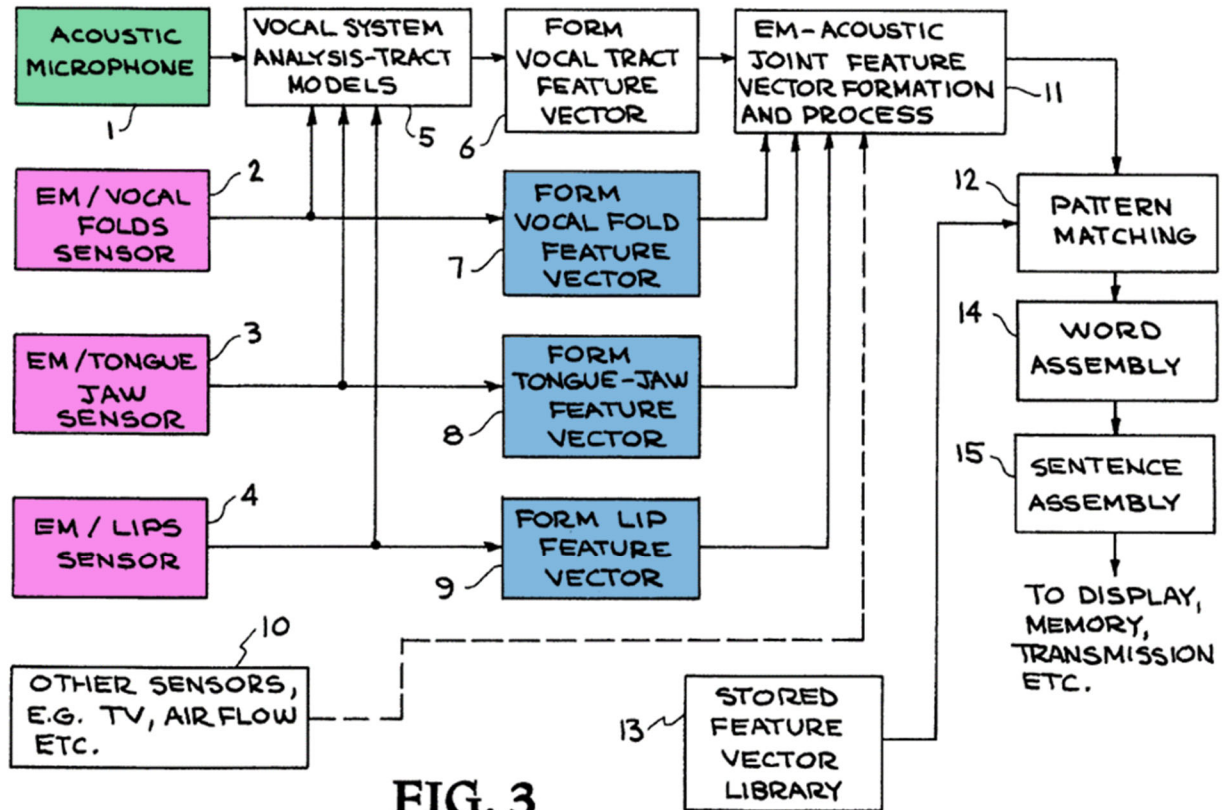


FIG. 3

Id., Fig. 3 (annotated).

4. Independent Claim 1

70. In my opinion, Andrea, Hussain, and Holzrichter render obvious claim

1.

a. [1P] “A communications system, comprising:”

71. If the preamble is limiting, it is my opinion that Andrea discloses or suggests [1P].

72. Andrea discloses an “active noise reduction apparatus as well as [a] noise cancellation apparatus” that “can be used in any *telecommunication systems* ... or in other settings such as *telephones*.” Ex. 1005, 9:13-21 (emphases added). Andrea further describes the objectives of the invention as including providing a relatively low-cost noise reduction and cancellation apparatus for use with “telecommunication systems,” “audio communication systems,” and “communication systems.” Ex. 1005, 6:58-61, 7:9-19. A POSITA would have, therefore, understood Andrea to disclose a communications system.

b. [1A] “a voice detection subsystem configured to receive voice activity signals that includes information associated with human voicing activity,

73. It is my opinion that Andrea discloses or suggests [1A]. If Patent Owner argues that Andrea does not disclose this limitation, it is my opinion that Hussain renders obvious [1A].

74. Andrea’s “noise cancellation apparatus” includes a **voice detection subsystem** (“**VOX circuit 1950**”) that senses speech to disable active noise cancellation so the wearer can hear nearby speech or other sounds while still wearing the headset. *See* Ex. 1005, 33:44-35:7. **VOX circuit 1950** is “connected to the microphone output of the microphone amplifier” and can “determine[] that the signal at the output of the microphone is useable audio.” Ex. 1005, 34:14-16, 34:22-29. It is my opinion that a POSITA would have understood that determining

whether the microphone signal is useable audio corresponds to **receiving voice activity signals that include information associated with human voicing activity.**

75. Alternatively, it is my opinion that Hussain renders obvious Andrea's **voice detection subsystem** being configured to **receive voice activity signals associated with human voicing activity.** Hussain's sub-band processing adaptive noise-cancellation system includes a **voice detection subsystem.** Ex. 1006, 10-11. In fact, Hussain "assume[s] ... that an **effective voice activity detector (VAD)** is available." Ex. 1006, 11. Hussain describes using a **VAD** to determine a "noise alone period" or a "speech plus noise period," which allows the system to "perform adaptive intermittent noise cancellation." Ex. 1006, 11. A POSITA would have understood that detecting a "speech plus noise period" corresponds to **receiving voice activity signals that include information associated with human voicing activity.**

76. In my opinion, a POSITA would have found it obvious to use Hussain's sub-band processing and voice detection subsystem, which receives voice activity signals associated with human voicing activity, in Andrea's noise-cancellation apparatus. Andrea's noise-cancellation system is known as "full-band," meaning that it performs the same processing on all frequency sub-bands. As discussed in Section IX.A.4.b.i below, Andrea's system does well at cancelling low-frequency background noise, but the noise-cancellation performance decreases

with increasing frequency. Hussain discloses an “adaptive noise cancellation scheme” that uses “sub-band processing” to “automatically select the best form of processing within each sub-band.” Ex. 1006, 10-12, Fig. 1. A POSITA would have looked to Hussain to improve noise cancellation with sub-band processing and would have found it obvious to use Hussain’s sub-band processing and VAD in Andrea’s noise-cancellation apparatus to “apply the most appropriate processing to each sub-band” and “to improve performance in reverberant environments.” Ex. 1006, 10-11. In my opinion, it would have been obvious to a POSITA to use Hussain’s VAD to receive voice activity signals associated with human voicing activity to detect whether speech is occurring and determine when to adaptively determine the transfer functions (when no speech is detected, “noise alone” period) and when to apply the transfer function for denoising (when speech is detected, “speech plus noise period”). *Infra* § IX.A.4.b.i.

i. Motivation and Expectation of Success

77. In my opinion, a POSITA would have been motivated to combine Hussain’s sub-band processing and VAD configured to receive voice activity signals including information associated with human voicing activity with Andrea’s noise-cancellation system. Andrea and Hussain are in the same field of endeavor as the ’543 patent and are thus analogous art. Like the ’543 patent,

Andrea and Hussain both describe noise-cancellation systems. *See, e.g.*, Ex. 1005, Title, Abstract; Ex. 1006, 10-11.

78. Andrea's system performs noise cancellation using an op-amp "to subtract the noise signal from the second microphone 14 from the speech and noise signal from the first microphone 12" and to provide "an electrical signal representing substantially the speech." Ex. 1005, 12:55-66. Andrea's noise-cancellation system is known as "full-band," meaning that it performs the same processing on all frequency sub-bands. Andrea provides "active noise cancellation curves" and data from tests of its exemplary noise-cancellation apparatus. *See* Ex. 1005, Figs. 13A and 13B, 11:53-54, 26:49-27:61. These data and "active noise cancellation curves" show that Andrea's system does well at cancelling low-frequency background noise but that the noise-cancellation performance decreases with increasing frequency. *See* Ex. 1005, Figs. 13A and 13B, 11:53-54, 26:49-27:61. In fact, around 3kHz, Andrea's system offers little to no advantage.

79. Because Andrea's noise cancellation is performed on all frequencies and can deteriorate at higher frequencies, it would have been obvious to combine Hussain's multi-microphone "sub-band processing" noise cancellation to "automatically select the best form of processing within each sub-band." Ex. 1006, 10-12, Fig. 1. Hussain explains that it is advantageous to use "diverse processing in frequency bands" rather than to apply the same processing to every frequency band

because “processing appropriate in one sub-band, may not be so in another.” Ex. 1006, 10.

80. In my opinion, a POSITA would have understood that in many environments, acoustic sound reverberates off surfaces, like walls or windows. Hussain recognizes that the performance of full-band multi-microphone noise-cancellation methods (like Andrea) “deteriorate[] in reverberant environments.” Ex. 1006, 10. Hussain explains that “[m]ulti-band processing has been found to be important in combatting reverberation effects.” Ex. 1006, 10. Hussain explains that “[e]ven non-optimised” multi-microphone sub-band adaptive systems can “yield more than 6dB SNR improvements over conventional full-band methods in real reverberant environments.” Ex. 1006, 10. Hussain “assume[s] ... that an effective voice activity detector (VAD) is available” to identify the “noise alone” and “speech plus noise” periods that allows the system to “perform adaptive intermittent noise cancellation.” Ex. 1006, 11.

81. In my opinion, a POSITA would have been motivated to implement Hussain’s sub-band processing and VAD in Andrea’s noise-cancellation apparatus to improve noise cancellation across frequencies and improve performance in reverberant environments. Ex. 1006, 10-11. Hussain provides this motivation and explains sub-band processing “is capable of outperforming conventional noise

cancellation schemes,” like Andrea’s full-band processing system. Ex. 1006, 10, 12.

82. In my opinion, a POSITA would have been motivated to use Hussain’s VAD to receive voice activity signals to determine “noise alone” and “speech plus noise” periods so the system can use Hussain’s “adaptive filter” to determine a “differential acoustic-path transfer function” for each sub-band to optimize noise-cancellation processing and then use the transfer function “to process the noisy speech signal” to output a denoised speech signal, respectively. Ex. 1006, 11.

83. In my opinion, a POSITA would have had a reasonable expectation to succeed incorporating Hussain’s sub-band processing and VAD receiving voice activity signals into Andrea’s noise-cancellation apparatus. A POSITA would have recognized that incorporating Hussain’s sub-band processing and VAD into Andrea’s noise-cancellation apparatus would apply the same principles to improve noise cancellation by using a VAD receiving voice activity signals to determine the “noise alone” and “speech plus noise” periods, together with sub-band processing that improves noise-cancellation performance. Ex. 1006, 10-11. Using Hussain’s sub-band processing and VAD therefore represents the combination of known prior art elements implemented according to their known functions to yield predictable results.

c. **[1B] the voice detection subsystem configured to automatically generate control signals using the voice activity signals; and”**

84. It is my opinion that Andrea discloses or suggests [1B]. If Patent Owner argues that Andrea does not disclose this limitation, it is my opinion that Hussain and Holzrichter render obvious [1B].

85. As discussed above in [1A], Andrea discloses, or Andrea and Hussain render obvious, a **voice detection subsystem** configured to **receive voice activity signals that include information associated with human voicing activity**. *Supra* § IX.A.4.b.

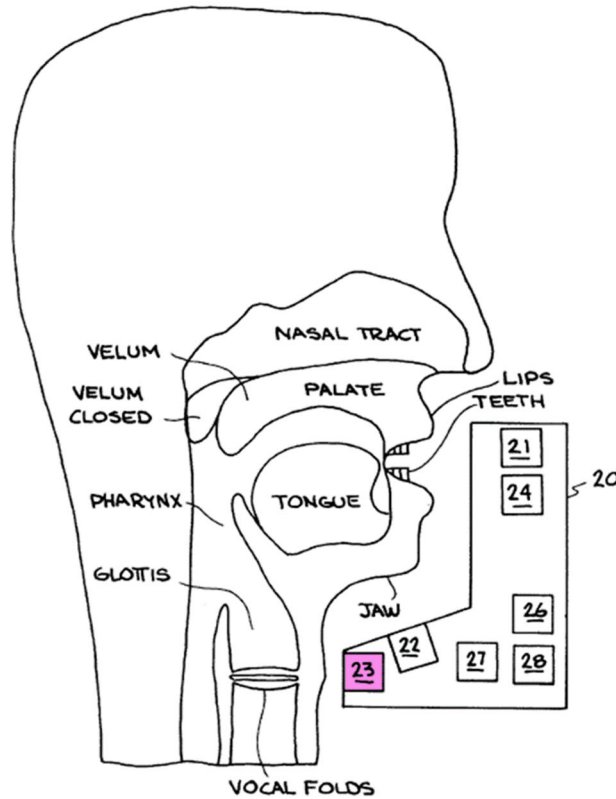
86. Andrea’s **voice detection subsystem (VOX 1950)** is configured to **automatically generate control** signals using the voice activity signals. For example, “[w]hen the **VOX 1950** has determined that the signal at the output of the microphone is useable audio, it **will activate the ‘speech signal’** at point C 1955.” Ex. 1005, 34:22-24. A POSITA would have understood “activat[ing] the ‘speech signal’” corresponds to **automatically generating control signals** using the voice activity signals.

87. Alternatively, Hussain strongly suggests, and Holzrichter renders obvious [1B].

88. Hussain “assume[s] ... that an **effective voice activity detector (VAD)** is available.” *See* Ex. 1006, 11. In my opinion, A POSITA would have looked to

Holzrichter for details of the VAD to implement in the Andrea-Hussain system.

Holzrichter discloses a **voice detection subsystem** including an **EM sensor (EM sensor module 23)** that receives voice activity signals that include information associated with human voicing activity. Ex. 1007, 17:54-56, Figs. 3, 4. For example, EM sensor module 23 “is directed at the vocal folds and glottis” and “measure[s] the presence or absence of vocal fold motions.” Ex. 1007, 17:62-63, 12:3-6, Fig. 4. Holzrichter’s EM sensors are electromagnetic sensors that “measure[s] the presence or absence of vocal fold motions” to “provide information required for accurate speech recognition.” Ex. 1007, 24:5-7, 17:62-63, 12:3-6.

**FIG. 4**

Ex. 1007, Fig. 4 (annotated).

89. Holzrichter further discloses signals from “three EM sensors 2, 3, 4 for vocal folds, tongue-jaw, and lips” respectively. Ex. 1007, 17:24-26. As shown in Figure 3 of Holzrichter, signals received by EM sensors 2, 3, 4 and EM sensors 23, 22, and 21, respectively, “can also be used to generate individual feature vectors 7, 8, 9.” Ex. 1007, 17:24-29, 17:61-65, Figs. 3-4. The vocal folds EM sensor module 2/23 of Holzrichter [automatically generates control signals using the voice activity signals](#) because it “[generate\[s\] \[an\] individual feature vector](#)” corresponding to the vocal folds signals. *See* Ex. 1007, 17:24-29, 16:44-47

(“feature vectors describing these signals”), 58:45-46 (“automatically forming the feature vector”), 9:42-47 (describing “[t]he use of vocal organ information for adaptively determining the speech time frame ... to automatically associate the speech output with a constant excitation function and time independent vocal tract condition”). Holzrichter further explains that this vocal fold information signal “provide[s] valuable information to a speech recognition system to determine if voiced speech is occurring” (voice activity signals). Ex. 1007, 12:3-6, Fig. 3. A POSITA would have understood that automatically generating or forming the feature vector corresponding to the vocal folds signals is automatically generating control signals using the voice activity signals.

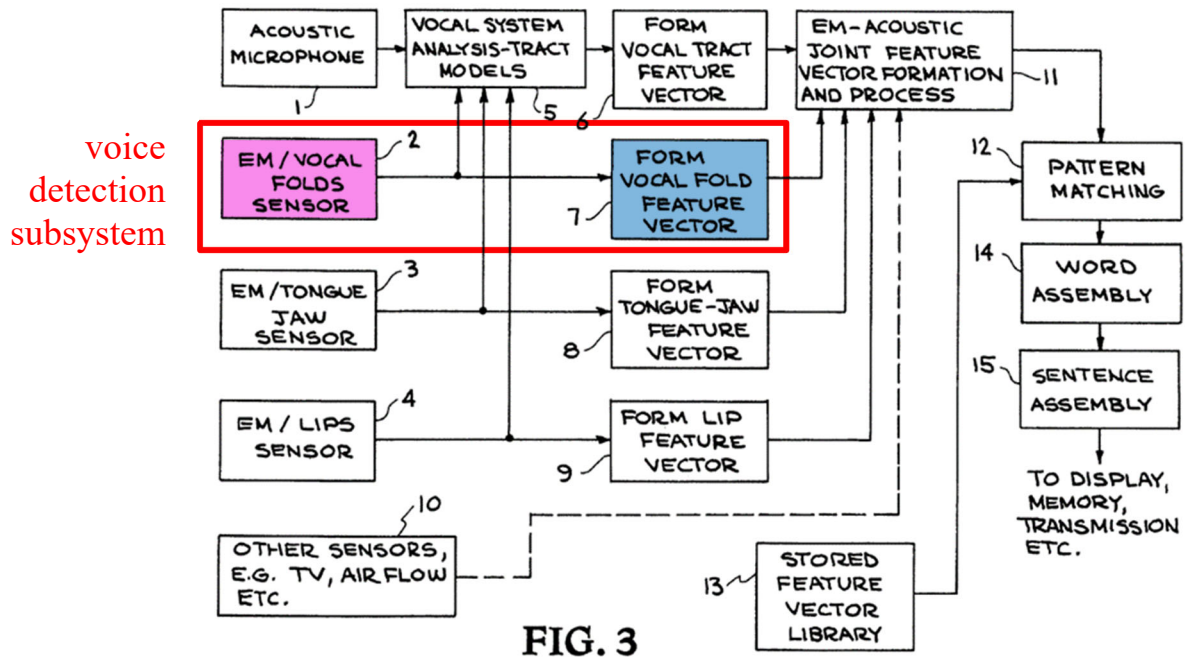


FIG. 3

Ex. 1007, Fig. 3 (annotated).

90. In my opinion, A POSITA would have found it obvious to use Holzrichter's EM sensor(a) as Hussain's VAD and to automatically generate control signals using the voice activity signals. Ex. 1006, 11. Holzrichter explains that its "EM sensor measurements of organ location and motion provide the information required for accurate speech recognition" and "provide explicit evidence of specific articulator activities which are very difficult to reliably extract from the acoustic signal," which, in turn, "provide[s] a significantly better and more accurate representation of the feature vector coefficients." Ex. 1007, 24:5-7, 10:35-37; 17:4-23. A POSITA would, therefore, have looked to Holzrichter's EM sensor, which automatically generates control signals using the voice activity signals, to ensure effective voice activity detection.

i. Motivation and Expectation of Success

91. In my opinion, a POSITA would have been motivated to combine Andrea and Hussain with Holzrichter's VAD to automatically generate control signals using voice activity signals. Hussain assumes a VAD is present in the system, which provides an express motivation. Ex. 1006, 11. A POSITA would have been motivated to use Holzrichter's EM sensor as the VAD to generate control signals to improve overall noise-cancellation performance by improving the accuracy of the voice activity detection.

92. For example, it is my opinion that a POSITA would have recognized that Holzrichter's EM sensor is highly accurate and efficient at detecting speech. Holzrichter explains that its "EM sensor measurements of organ location and motion provide the information required for accurate speech recognition." Ex. 1007, 24:5-7. Holzrichter further explains that its EM sensor signals "provide a significantly better and more accurate representation of the feature vector coefficients" because they "provide explicit evidence of specific articulator activities which are very difficult to reliably extract from the acoustic signal." Ex. 1007, 10:35-37; 17:4-23. Therefore, in my opinion, a POSITA would have been motivated to incorporate Holzrichter's EM sensor as the VAD in Andrea and Hussain's noise-cancellation system to accurately detect when the user is speaking to generate control signals using voice activity signals to avoid speech-detection errors and identify processing periods in Hussain to differentiate between noise-only and speech-and-noise periods.

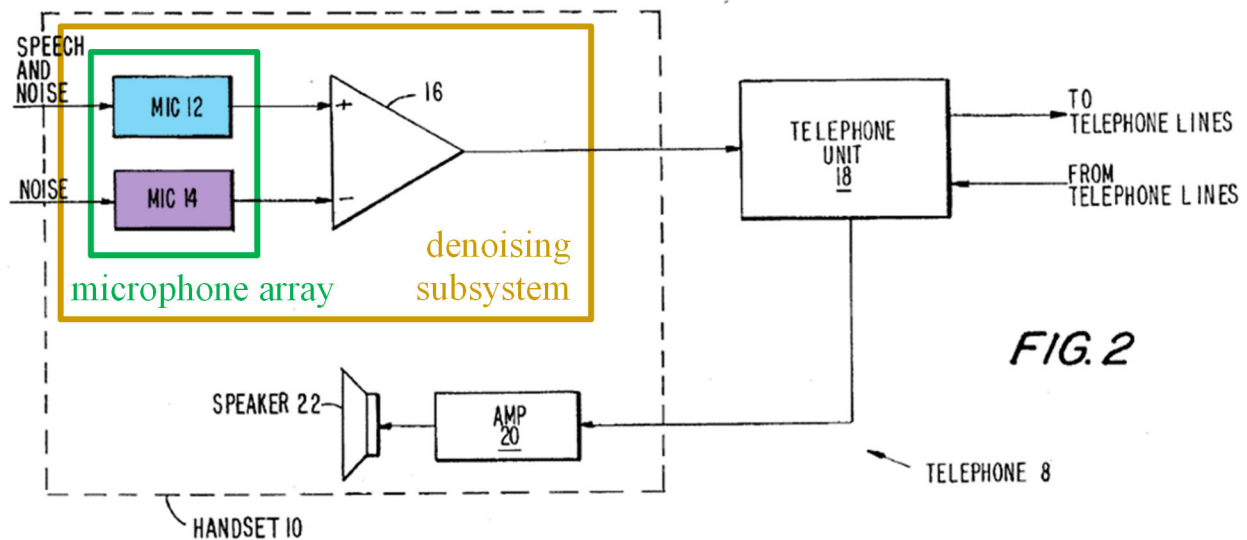
93. In my opinion, a POSITA would have also recognized that Holzrichter's EM sensor would be advantageous because it "can transmit pulses at rates of a million times per second," which is more than adequate to capture the "relatively slow" velocities of speech organs, which "requir[e] only 100 to 1000 samples per second to keep track of their interfaces." Ex. 1007, 22:56-63.

94. In my opinion, a POSITA would have reasonably expected to succeed using Holzrichter's EM sensor as Hussain's effective VAD and to generate control signals using voice activity signals. Holzrichter uses EM sensor measurements of organ location and motion to provide accurate information required for speech recognition. Ex. 1007, 24:5-7, 10:35-37; 17:4-23. Incorporating Holzrichter's EM sensors to more accurately detect "noise alone" and "speech plus noise" periods and to generate control signals using the voice activity signals would have been understood to improve Hussain's sub-band processing by applying the same techniques as Holzrichter. Ex. 1006, 10-11. Incorporating Holzrichter's EM sensor into the Andrea-Hussain system therefore represents the combination of known prior art elements implemented according to their known functions to yield predictable results.

d. [1C] "a denoising subsystem coupled to the voice detection subsystem, the denoising subsystem comprising a microphone array including a plurality of microphones,"

95. It is my opinion that Andrea and Hussain render obvious [1C].

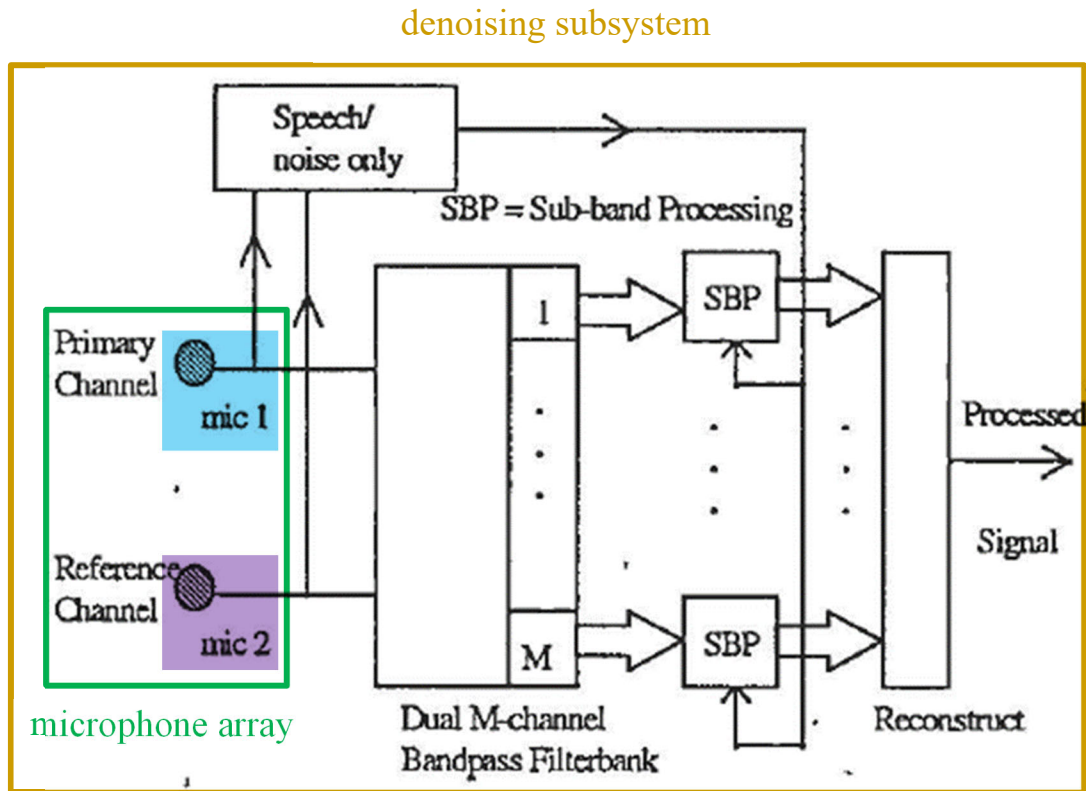
96. As shown below in Figure 2, Andrea discloses a **denoising subsystem** ("noise cancellation apparatus") comprising a **microphone array** including a plurality of physical microphones ("first and second microphones 12 and 14"). Ex. 1005, 11:19-20, 12:46-54, Fig. 2.



Ex. 1005, Fig. 2 (annotated).

97. In my opinion, Hussain and Andrea render obvious a **denoising subsystem** coupled to the **voice detection subsystem**. *Supra* § IX.A.4.b.

98. Like Andrea, and as shown below, Hussain discloses a **denoising subsystem** (“**adaptive noise cancellation scheme**”) comprising a **microphone array** including “two or more closely spaced microphones,” “**mic 1** and **mic 2**.” Ex. 1006, 10-11, Fig. 1.



Ex. 1006, Fig. 1 (annotated).

99. As discussed in [1A], Hussain includes an “effective” **VAD (voice detection subsystem)**. *Supra* § IX.A.4.b. It is my opinion that a POSITA would have understood that the **VAD (voice detection subsystem)** of Hussain is coupled to the “**adaptive noise cancellation scheme**” (**denoising subsystem**) because Hussain uses the VAD to determine noise-alone and speech-plus-noise periods to “perform adaptive intermittent noise cancellation” by using adaptive filters to apply to process the speech-plus-noise signal. Ex. 1006, 11. For example, Hussain explains:

If the noise power is significant and the noise between the two channels is significantly correlated in a sub-band, then

perform adaptive intermittent noise cancellation, wherein an adaptive filter may be determined which models the differential acoustic-path transfer function between the microphones *during the noise alone period*. This can then be used in a noise cancellation format *during the speech plus noise period* to process the noisy speech signal.

Ex. 1006, 11 (emphasis added). Accordingly, a POSITA would have found it obvious and would have been motivated to combine the teachings of Andrea and Hussain to couple the denoising subsystem to the voice detection subsystem, as taught by Hussain.

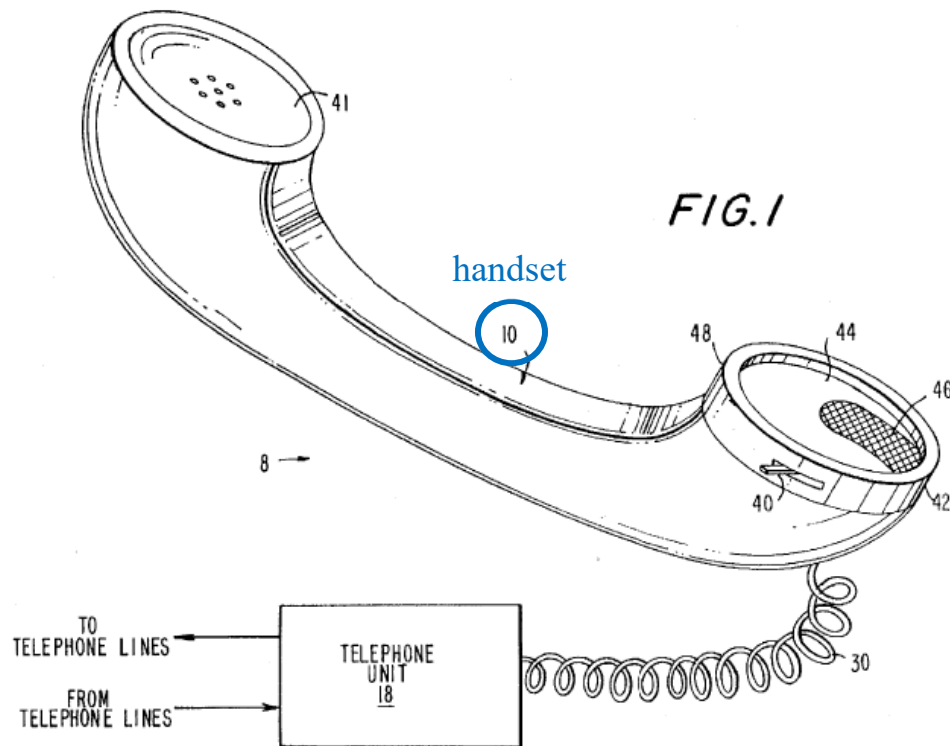
100. In my opinion, a POSITA would have been motivated to implement Hussain's sub-band processing adaptive noise-cancellation system and VAD in Andrea's noise-cancellation apparatus as discussed in [1A]. *Supra* § IX.A.4.b.i. And a POSITA would have been motivated to couple the denoising subsystem to provide the denoising system with information on whether voiced speech is occurring to perform adaptive intermittent noise cancellation. A POSITA would have reasonably expected to succeed coupling the voice detection subsystem in Hussain to the denoising subsystem in Andrea, as explained in [1A]. *Supra* § IX.A.4.b.i.

- e. **[1D] “wherein a first microphone of the array is fixed at a first position relative to a mouth, wherein the first position orients a front of the first microphone towards the mouth,”**

101. It is my opinion that Andrea discloses or suggests [1D] based on multiple exemplary disclosures. Although these are described as handsets and headsets, a person of ordinary skill in the art would have recognized that the teachings of one disclosure would have been applicable to the other disclosure.

Handset disclosure

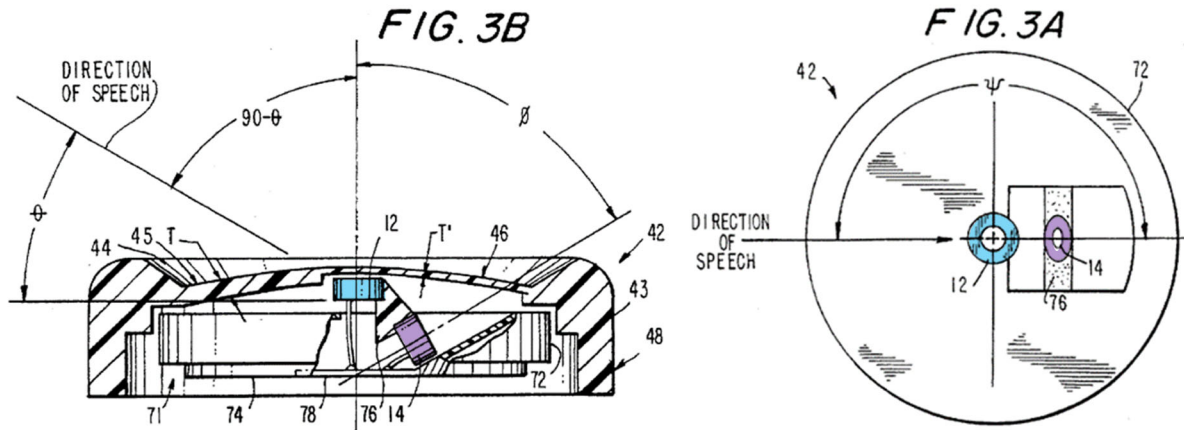
102. Andrea discloses an exemplary handset, shown in Figures 1, 3A, and 3B below, which has a **first microphone** of the array (**first microphone 12**) fixed at a first position relative to a mouth, wherein the first position **orients a front (receiving or sensitive surface) of the first microphone towards the mouth**. Ex. 1005, 13:65-14:6, 14:7-29, Figs. 1, 3A, 3B.



Ex. 1005, Fig. 1 (annotated).

103. The **first microphone 12** is “positioned relatively close to the underside of the portion 46” of the receiver so that “the speech travels a relatively short distance from an operator, who is speaking into the receiver portion 42 from a distance of preferably less than 1 inch, through the portion 46 to the first microphone.” Ex. 1005, 13:65-14:6. The **first microphone 12** has “a receiving or ‘sensitive’ surface” that is oriented towards the direction of speech (the user’s mouth) such that it “receives both the speech from the operator and the background acoustic noise which is present in the vicinity.” Ex. 1005, 14:7-29. In my opinion, a POSITA would have understood that receiving the user’s speech means that **first**

microphone 12 is fixed at a position relative to the operator's mouth. Ex. 1005, 13:65-14:6, 14:7-29, Figs. 3A, 3B.



Ex. 1005, Figs. 3A, 3B (annotated).

Headset disclosure

104. Andrea discloses an exemplary headset, shown in Figures 9A and 9C below, which has a first microphone of the array (first microphone 300) fixed at a first position relative to a mouth, wherein the first position orients a front of the first microphone (pressure sensitive surface 301) towards the mouth. Ex. 1005, 19:11-43, 19:65-20:14, 26:19-35, Figs. 9A, 9C.

105. The first microphone 300 is located in microphone boom 320/440 and is oriented towards the user's mouth. Ex. 1005, 26:19-35, 19:65-20:14, 19:11-28. The first microphone 300 has "pressure sensitive surface 301" that is oriented towards the mouth of the user such that it can "receive acoustical sound such as speech from a user ... [and] also receive background noise which may exist." See

Ex. 1005, 19:11-43, Fig. 9A. Andrea also explains that the “voice-side of the microphone ... should be adjusted to directly face the mouth.” Ex. 1005, 26:30-31.

Andrea further explains that, “[p]referably the distance from the mouth to the microphone should be in the range of about 1/4 to about 3/4, preferably about 1/2 inch or less.”

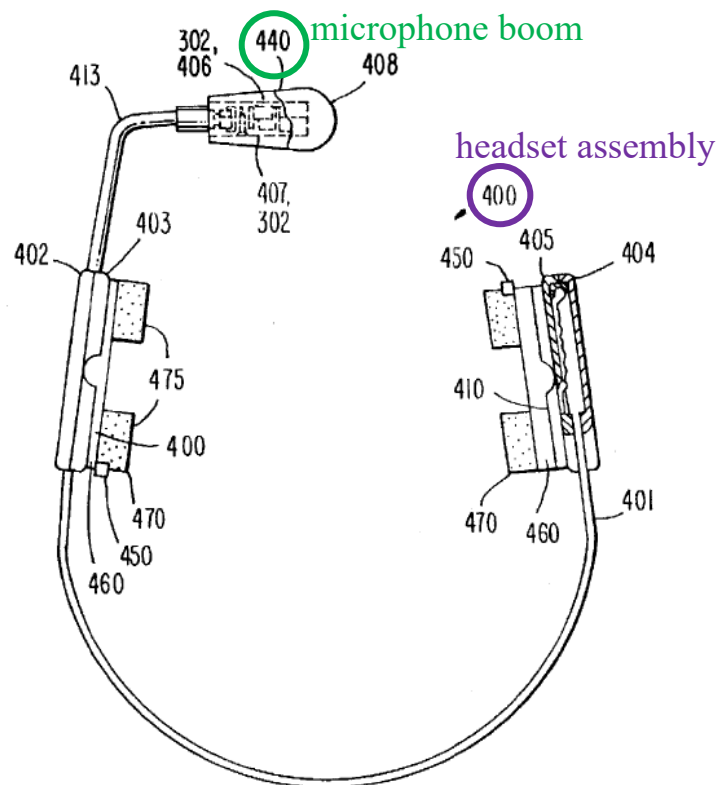
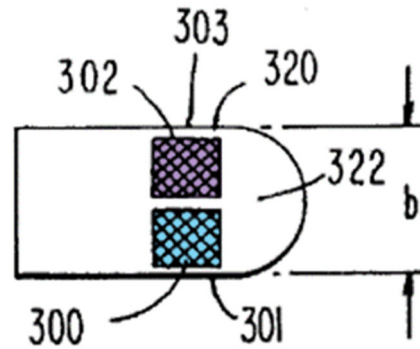


FIG. 9C

**FIG. 9A**

Ex. 1005, Fig. 9C, 9A (annotated).

106. In my opinion, a POSITA would have understood that in the exemplary headset of Andrea, the **first microphone 300** is fixed at a first position relative to a mouth, wherein the first position **orients the pressure sensitive surface 301 of the first microphone towards the mouth**. Ex. 1005, 19:11-43, 19:65-20:14, 26:19-35, Figs. 9A, 9C.

- f. **[1E] “wherein a second microphone of the array is fixed at a second position relative to the mouth, wherein the second position orients a front of the second microphone away from the mouth such that the second position forms an angle relative to the first position, wherein the angle is greater than zero degrees,”**

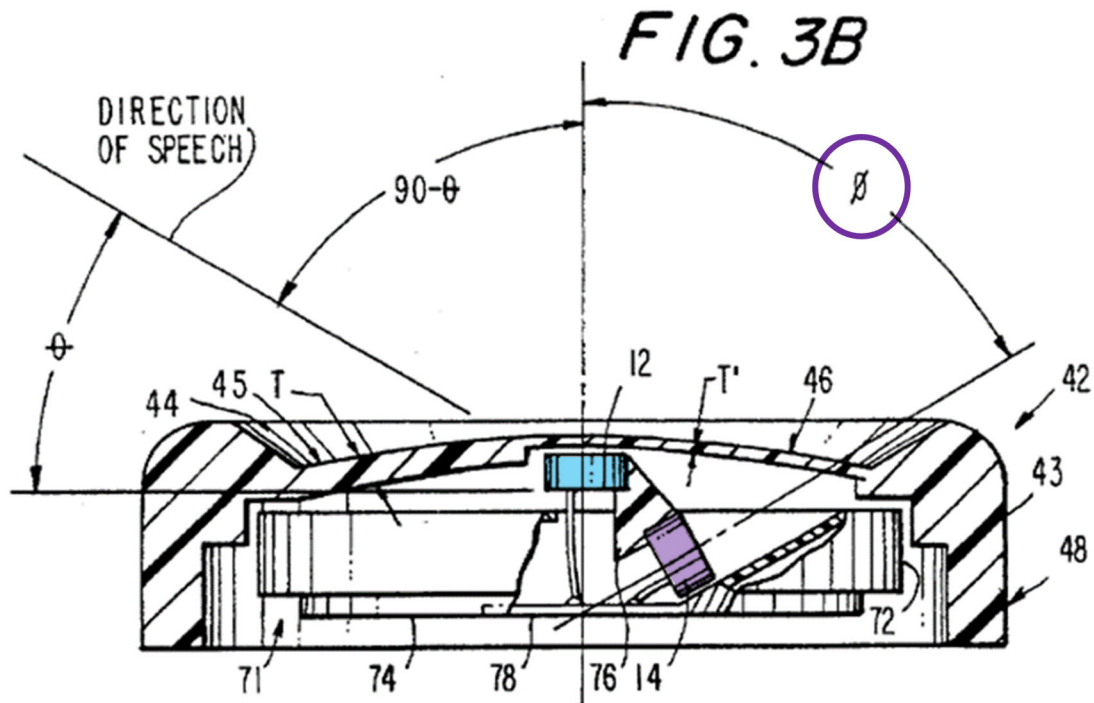
107. It is my opinion that Andrea discloses or suggests [1E] based on multiple exemplary disclosures. Although these are described as handsets and headsets, a person of ordinary skill in the art would have recognized that the teachings of one disclosure would have been applicable to the other disclosure.

Handset disclosure

108. Andrea discloses an exemplary handset having a **second microphone** of the array (**second microphone 14**) fixed at a second position relative to the mouth, wherein the second position **orients the front (sensitive surface)** of the **second microphone away from the mouth** such that the second position forms an **angle (ϕ)** relative to the first position, wherein the angle is **greater than zero degrees (e.g., 30-60 degrees)**. Ex. 1005, 13:65-14:1, 14:7-29, 14:30-34, Fig. 3B.

109. Andrea's handset disclosure also includes a **second microphone 14** "arranged below the portion 46" of the receiver. Ex. 1005, 13:65-14:1. A POSITA would have understood that this describes the **second microphone 14** is fixed at a second position relative to the operator's mouth.

110. Andrea further explains that the **second microphone 14** has a "sensitive surface." Ex. 1005, 14:17. And, as shown below in Figure 3B, the "sensitive surface" of microphone 14 is oriented away from the direction of speech so that it "essentially receives only the same background acoustic noise which is received by the first microphone." Ex. 1005, 14:7-29.



Ex. 1005, Fig. 3B (annotated).

111. Andrea describes angle ϕ , circled in Figure 3B above, as the angle between the first and second microphones. Ex. 1005, 14:9-12. As shown above, angle ϕ represents the angle between the sensitive surface of the first microphone and the sensitive surface of the second microphone, which corresponds to the claimed first and second position. Andrea discloses that angle ϕ “preferably has a value in a range between 30° and 60° .” Ex. 1005, 14:9-12.² Andrea therefore discloses the claimed angle between the first and second position of “greater than zero degrees.”

² Andrea also notes that the microphones may be “arranged so as to have an angle ϕ which lies outside” the preferred range of 30° to 60° . Ex. 1005, 14:30-34.

112. Andrea further explains the relative angular orientation of the first and second microphones as follows:

The first and second microphones are further respectively arranged so as to have an angle θ and $[(90-\theta)+\varphi]$ between a plane parallel to the receiving or “sensitive” surface of the first microphone 12 and the direction of speech from an operator, and an axis normal to the sensitive surface of the second microphone 14 and the direction of speech, as shown in FIG. 3B

Ex. 1005, 14:7-18 (brackets in original). In other words, angle θ is the angle between a plane parallel to the “sensitive” surface of the first microphone 12 and the direction of speech; and angle $[(90-\theta)+\varphi]$ is the angle between an axis normal to the sensitive surface of the second microphone 14 and the direction of speech.

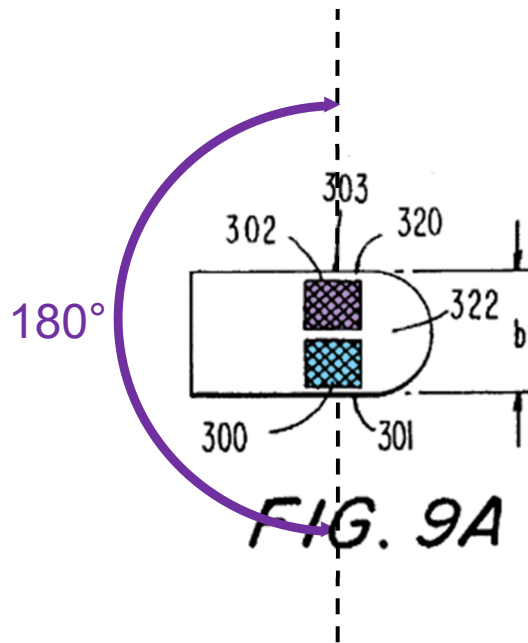
Ex. 1005, 14:7-18. Andrea discloses that angle θ is preferably less than approximately 35° . Ex. 1005, 14:20-22. And as discussed above, Andrea discloses that angle φ is preferably 30° - 60° . Ex. 1005, 14:9-12. As an example, substituting $\theta = 35^\circ$ and $\varphi = 30^\circ$ into the equation $(90-\theta)+\varphi$ amounts to 85° as the angle between an axis normal to the sensitive surface of the second microphone 14 and the direction of speech. As another example, substituting $\theta = 35^\circ$ and $\varphi = 60^\circ$ into the equation $(90-\theta)+\varphi$ amounts to 115° as the angle between an axis normal to the sensitive surface of the second microphone 14 and the direction of speech. In both examples, the sensitive surface” of microphone 14 is oriented away from the direction of speech.

Headset disclosure

113. Andrea discloses an exemplary headset, shown in Figures 9A and 9C below, having a **second microphone** of the array (**second microphone 302**) fixed at a second position relative to the mouth, wherein the second position **orients a front of the second microphone (second pressure sensitive surface 303)** away from the **mouth** such that the second position forms an **angle** relative to the first position, wherein the angle is **greater than zero degrees (e.g., 180 degrees)**. Ex. 1005, 19:11-28, 19:29-43, 19:65-20:14. Figs. 9A, 9C.

114. The **second microphone 302** is located in microphone boom 320/440 and is “located within a distance or dimension b” of first microphone 300. Ex. 1005, 19:11-28 (referring to microphone boom 320), 19:29-43 (referring to microphone boom 320), 19:65-20:14 (referring to microphone boom 440). A POSITA would have understood that this describes the **second microphone 302** being fixed at a second position relative to the operator’s mouth.

115. Andrea further explains that the second microphone 302 has a “second pressure sensitive surface 303.” Ex. 1005, 19:13-28. And, as shown below in Figure 9A, the “pressure sensitive surface 303” of second microphone 302 is oriented away from the direction of speech “so as to receive primarily only the background noise.” Ex. 1005, 19:37-39, Fig. 9A.



Ex. 1005, Fig. 9A (annotated).

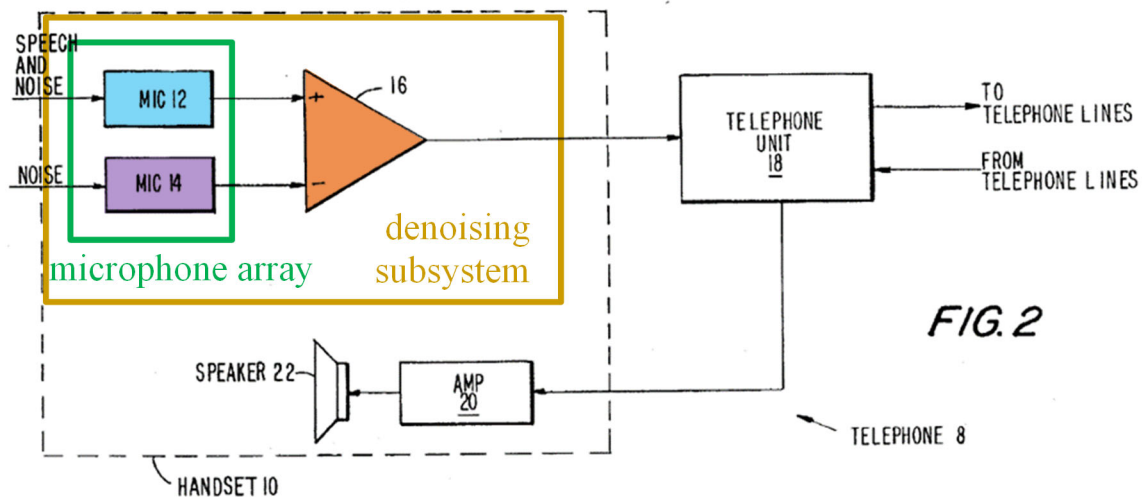
116. Andrea discloses that “the respective pressure sensitive surfaces 301 and 303 are substantially 180° apart from each other,” which is greater than zero degrees. Ex. 1005, 19:14-17; *see also id.*, 19:39-43 (“[T]he pressure sensitive surface 303 of the second microphone 302 is preferably arranged at an angle of substantially 180° from the pressure sensitive surface 301 of the first microphone 300.”). The sensitive surface of the first microphone and the sensitive surface of the second microphone correspond to the claimed first and second position.

- g. [1F] “the microphone array providing acoustic signals of an environment to components of the denoising subsystem,”**

117. It is my opinion that Andrea discloses or suggests [1F].

118. Andrea discloses the microphone array (first and second microphones 12 and 14) providing acoustic signals of an environment (an electrical signal corresponding to the acoustic signal of speech and noise and an electrical signal corresponding to the acoustic signal of noise) to components of the denoising subsystem (op-amp 16). Ex. 1005, 12:46-54, 12:55-66, Fig. 2.

119. As discussed above in [1C] and as shown below in Figure 2, Andrea discloses a denoising subsystem (“noise cancellation apparatus”) comprising a microphone array (“first and second microphones 12 and 14”). *Supra* § IX.A.4.d. Andrea further describes a subtracting device 16 (e.g., op-amp 16). Ex. 1005, 12:46-54, 12:62-66. A POSITA would have understood that the subtracting device 16/op-amp 16 of Andrea is a component of the denoising subsystem.



Ex. 1005, Fig. 2 (annotated).

120. Andrea's first and second microphones 12 and 14 provide electrical signals corresponding to acoustic signals of the environment to the op-amp 16. For example:

Acoustic signals composed of speech or the like and background noise are supplied to the first microphone 12 and converted therein into a corresponding electrical signal which is thereafter supplied to the plus terminal of the op-amp 16. The background noise is supplied to the second microphone 14 and converted therein into a corresponding electrical signal which is thereafter supplied to the minus terminal of the op-amp 16.

Ex. 1005, 12:55-62; *see also id.* 35:33-42 (describing the microphones converting “acoustic sound” into signals). A POSITA would have understood that providing acoustic signals of noise or speech and noise corresponds to providing signals of an environment to the op-amp 16 (denoising subsystem).

- h. [1G] “components of the denoising subsystem automatically selecting at least one denoising method appropriate to data of at least one frequency subband of the acoustic signals using the control signals and processing the acoustic signals using the selected denoising method to generate denoised acoustic signals,”**

121. It is my opinion that Andrea, Hussain, and Holzrichter render obvious [1G].

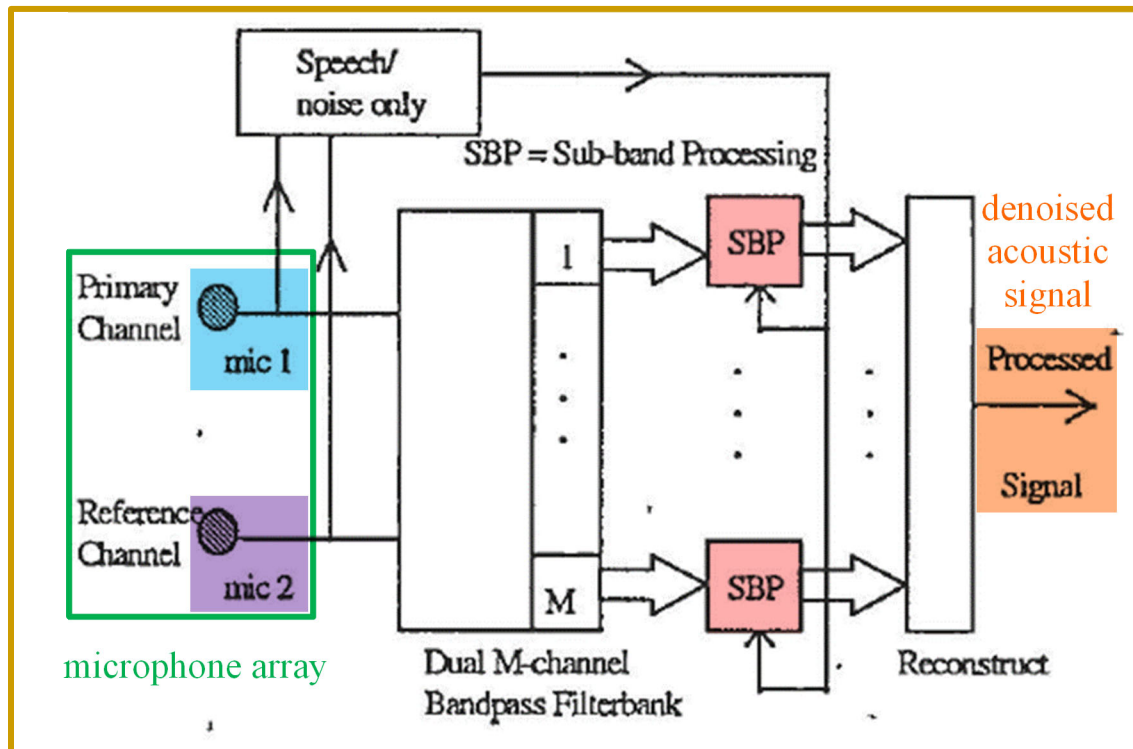
122. Andrea discloses components of the denoising subsystem (op-amp 16) ... processing the acoustic signals ... to generate denoised acoustic signals (subtracting the noise signal from the speech and noise signal and supplying an

electrical signal representing substantially the speech). Ex. 1005, 12:55-66. Andrea discloses that “[t]he op-amp 16 is adapted to subtract the noise signal from the second microphone 14 from the speech and noise signal from the first microphone 12 and to supply therefrom an electrical signal representing substantially the speech to the telephone unit 18.” Ex. 1005, 12:55-66.

123. Hussain and Holzrichter render obvious automatically selecting at least one denoising method appropriate to data of at least one frequency subband of the acoustic signals using the control signals and processing the acoustic signals using the selected denoising method to generate denoised acoustic signals.

124. A POSITA would have found it obvious to apply Hussain’s sub-band processing to Andrea’s noise-cancellation apparatus to improve noise cancellation across frequencies and to improve performance in reverberant environments for the reasons explained above in Section IX.A.4.b.i ([1A]). As shown in Figure 1 below, Hussain uses a filter bank to divide the signals received by the microphones into multiple sub-bands and then applies sub-band processing (“SBP”) to each sub-band. Ex. 1006, 10-11, Fig. 1.

denoising subsystem



Ex. 1006, Fig. 1 (annotated).

125. Hussain discloses the claimed **automatically selecting at least one denoising method appropriate to data of at least one frequency subband** of the acoustic signals because it describes “**automatically select[ing] the best form of processing within each [frequency] sub-band**” to process the data in the sub-band.

Ex. 1006, 10 (emphasis added).

126. Hussain also discloses **processing** the acoustic signals of each sub-band using the selected denoising method to **generate denoised acoustic signals**. As discussed above in [1C], Hussain discloses “**perform[ing] adaptive intermittent noise cancellation**” using a VAD to determine a “noise alone period” and a “speech

plus noise period.” Ex. 1006, 11; *supra* § IX.A.4.d. “[D]uring the noise alone period” (when voicing activity is not detected), Hussain uses “an adaptive filter” to determine a “differential acoustic-path transfer function” for each sub-band. Ex. 1006, 11. Then, “during the speech plus noise period” (when voicing activity is detected), Hussain uses the transfer function “to process the noisy speech signal” and generate and output “a noise reduced, filtered version of the sub-band speech signal” (denoised speech signal). Ex. 1006, 11. Hussain then “[r]econstruct[s]” the denoised acoustic signal by combining each denoised sub-band signal into a single “Processed Signal.” Ex. 1006, 11, 13, Fig. 1.

127. Hussain strongly suggests that this process is performed using the control signals as recited in [1G], which Holzrichter renders obvious. As discussed in [1A]-[1B], Hussain’s sub-band processing adaptive noise-cancellation system relies on a VAD to determine the “noise alone” and “speech plus noise” periods. Ex. 1006, 11; *supra* §§ IX.A.4.b-IX.A.4.c. As discussed above in [1B], it would have been obvious to a POSITA to implement Holzrichter’s EM sensor-based VAD as part of the Andrea-Hussain system. *Supra* § IX.A.4.c. Holzrichter discloses EM sensors that generate control signals (“individual feature vector[s]”) that “provide valuable information ... to determine if voiced speech is occurring.” Ex. 1007, 12:3-6, 17:24-29, Fig. 3. The control signals are provided to implement voice recognition and speech detection in Holzrichter, which a POSITA would

have found obvious to use to identify Hussain's "noise alone" period (when speech is not occurring) and "speech plus noise" period (when speech is occurring) to control the operation (e.g., adapting filters or denoising acoustic signals) in Hussain's adaptive noise cancellation.

i. Motivation and Expectation of Success

128. It is my opinion that a POSITA would have been motivated to implement Hussain's sub-band processing in Andrea's noise-cancellation apparatus and would have had a reasonable expectation of success doing so, as discussed in [1A]. *Supra* § IX.A.4.b.

129. In my opinion, a POSITA would have been further motivated to use Holzrichter's **control signals** ("individual feature vector[s]") in Hussain's sub-band processing noise-cancellation system. As discussed in [1B] above, a POSITA would have been motivated to use Holzrichter's EM sensor as Hussain's VAD to improve the accuracy of the voice activity detection and would have had a reasonable expectation of success in doing so. *Supra* § IX.A.4.c.i. A POSITA would have understood from Hussain that its adaptive noise-cancellation system relies on receiving information about whether a "noise alone period" or a "speech plus noise period" is occurring. Ex. 1006, 11. Holzrichter discloses EM sensors that determine "if voiced speech is occurring" and generate **control signals** ("individual feature vector[s]") based on that detection. Ex. 1007, 12:3-6, 17:24-

29, Figs. 3, 4. Thus, a POSITA would have been motivated to use the **control signals** (“**individual feature vector[s]**”) of Holzrichter to provide Hussain’s sub-band processing with information about whether voiced speech is occurring to control whether Hussain’s processing adapts the transfer functions (when speech is not occurring) or denoises the acoustic signals (when speech is occurring).

130. In my opinion, a POSITA would have reasonably expected to succeed using the **individual feature vector** generated by Holzrichter’s EM sensor to control Hussain’s sub-band processing noise cancellation. A POSITA would have understood Holzrichter’s **individual feature vector** would provide information about whether voiced speech is occurring to Hussain’s sub-band processing adaptive intermittent noise-cancellation system to control Hussain’s two processing types. Ex. 1007, 12:3-6, 17:24-29, Ex. 1006, 10-11. Using Holzrichter’s individual feature vectors in Hussain’s sub-band processing noise-cancellation system would have represented merely the combination of known prior art elements implemented according to their known functions to yield predictable results.

- i. **[1H] “wherein the denoising method includes generating a noise waveform estimate associated with noise of the acoustic signals and subtracting the noise waveform estimate from the acoustic signal when the acoustic signal includes speech and noise,”**

131. It is my opinion that Andrea discloses or suggests [1H].

132. Andrea discloses a denoising method that includes **generating a noise waveform estimate associated with noise** of the acoustic signals (**converting the background noise supplied to the second microphone into a corresponding electrical signal**) and **subtracting the noise waveform estimate from the acoustic signal** when the acoustic signal includes speech and noise (**subtracting the corresponding electrical signal of the noise from the speech and noise signal**). Ex. 1005, 12:55-66, 16:20-23, Fig. 2.

133. Andrea discloses that “[t]he background noise is supplied to the second microphone 14 and **converted therein into a corresponding electrical signal** which is thereafter supplied to the minus terminal of the op-amp 16.” Ex. 1005, 12:59-62, 14:23-29. The op-amp circuit is further configured to match the level of the noise signal received from the second microphone 14 to the noise contained in the speech-plus-noise signal from the first microphone 12. Ex. 1005, 15:29-34. A POSITA would have understood that the “corresponding electrical signal” from the second microphone 14 and/or the level-matched signal from the second microphone 14 is a waveform representing the background noise and, therefore, is a noise waveform estimate of the background noise. Andrea also discloses that “[a]coustic signals composed of speech or the like and background noise are supplied to the first microphone 12” are similarly converted into an electrical signal waveform and “supplied to the plus terminal of the op-amp 16.” Ex. 1005,

12:55-59. Andrea discloses that op-amp 16 “is adapted to subtract the noise signal from the second microphone 14 from the speech and noise signal from the first microphone 12 and to supply therefrom an electrical signal representing substantially the speech to the telephone unit 18” without the noise. Ex. 1005, 12:55-66; *see also* 16:20-23 (“The op-amp 16 subtracts the signal received from the second microphone 14 from that received from the first microphone 12 and outputs the resulting subtracted signal”).

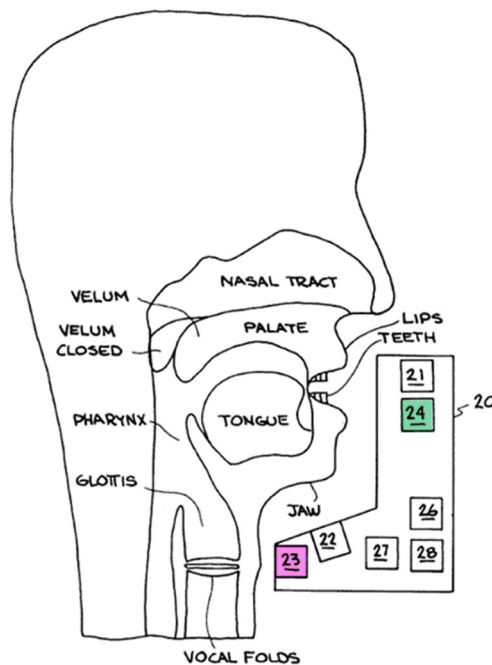
- j. [1I] “wherein the voice detection subsystem is configured to receive the voice activity signals using a sensor independent from the microphone array and to output the control signals generated from the voice activity signals to the denoising system, the denoising system configured to use the control signals to denoise the acoustic signals from the microphone array”

134. It is my opinion that Andrea, Hussain, and Holzrichter render obvious [1I].

135. As discussed in [1A] and [1B], Andrea teaches a voice detection subsystem configured to receive the voice activity signals ... and to output the control signals generated from the voice activity signals, and Hussain and Holzrichter also render these limitations obvious. *Supra* §§ IX.A.4.b-IX.A.4.c.

136. Holzrichter also renders obvious using a sensor independent from the microphone array to receive the voice activity signals and to output the control signals. As discussed above in [1B], Holzrichter discloses a sensor (EM sensor

module 23) that receives voice activity signals because it “is directed at the vocal folds and glottis” and “measure[s] the presence or absence of vocal fold motions.” *Supra* § IX.A.4.c; Ex. 1007, 17:62-63, 12:3-6, Fig. 4. As also discussed in [1B], Holzrichter discloses that the EM sensor outputs control signals by “generat[ing] individual feature vectors” that a POSITA would have understood to be control signals. *Supra* § IX.A.4.c; Ex. 1007, 17:24-29, 16:44-47, 17:54-56, Fig. 3. In Holzrichter EM sensor 23 is independent from the microphone 24, which is “used to obtain simultaneous acoustic information.” Ex. 1007, 17:54-58. Figures 3 and 4 confirm EM sensor 23/2 is independent from acoustic microphone 24/1 because they are shown separately.

**FIG. 4**

Ex. 1007, Fig. 4 (annotated).

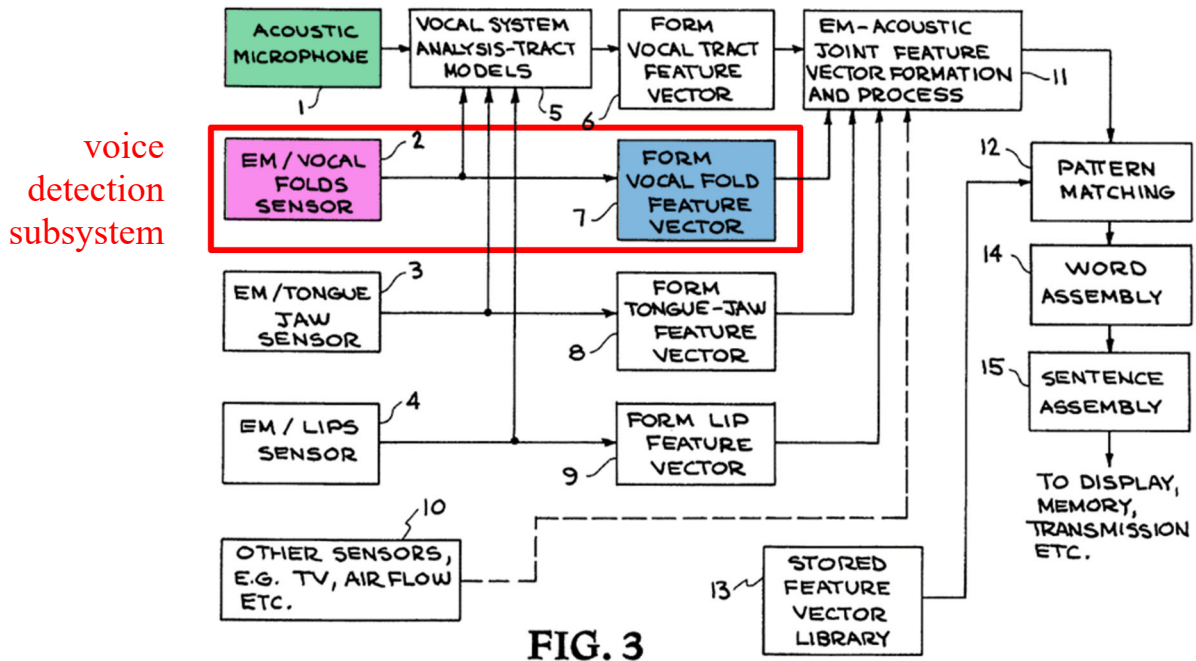


FIG. 3

Ex. 1007, Fig. 3 (annotated).

137. In my opinion, it would have been obvious to a POSITA to use an EM sensor *independent from* Andrea's acoustic microphone array to provide voice activity signals to provide greater accuracy of speech detection. Holzrichter explains:

EM sensor signals provide explicit evidence of specific articulator activities which are very difficult to reliably extract from the acoustic signal. Many speech organ motions are "hidden" and are not extractable from acoustic signals using mathematical techniques, or the moving organ does not affect the speech sound, or important organ motions often occur before or after the speech unit is sounded. Thus, the nonacoustic organ measurements provide important additional information heretofore unavailable for use in increasing the accuracy of speech recognition, coding of speech information, speaker identification, and measuring physiological properties of great importance to the speech technology community.

Ex. 1007, 10:35-47 (emphases added). Holzrichter further explains, “the EM signal can show articulator and thus phonetic conditions directly, in contrast to the acoustic signal which contains a great deal of superfluous information in addition to the phonetic specific information.” Ex. 1007, 10:30-34.

138. A POSITA would have found it obvious to use Holzrichter’s EM sensor independent from an acoustic microphone array in order to improve the accuracy of voice activity detection. A POSITA would have been motivated to implement Holzrichter’s EM sensor independent from the acoustic microphones of the Andrea-Hussain system to improve overall noise-cancellation performance by improving the accuracy of the voice activity detection and would have had a reasonable expectation of success in doing so for the reasons explained here and above in Section IX.A.4.c.i.

139. As discussed in [1C], Andrea and Hussain both disclose a **denoising subsystem**. *Supra* § IX.A.4.c.i. Hussain strongly suggests outputting the control signals generated from the voice activity signals to the denoising system and the denoising system configured to use the control signals to denoise the acoustic signals from the microphone array, which Holzrichter renders obvious.

140. As discussed in [1G], it would have been obvious to a POSITA to use the **control signals** of Holzrichter in Hussain’s sub-band processing noise-cancellation system to provide voice activity information on whether voiced

speech is occurring to control processing based on whether there is a noise-only or speech-plus-noise period occurring. *Supra* § IX.A.4.h. A POSITA would have found it obvious to **output the control signals (individual feature vectors)** of Holzrichter to the **denoising system (adaptive intermittent noise-cancellation system)** of Hussain to control the denoising operations.³ And, for the reasons discussed in [1G], a POSITA would have found it obvious to **use the control signals** of Holzrichter to implement Hussain's sub-band processing and adaptive intermittent noise cancellation to **denoise** the acoustic signals from the microphone array. *Supra* § IX.A.4.h. In fact, Holzrichter explains that its EM sensor information is "usually (but not always) used in conjunction with simultaneous acoustic information." Ex. 1007, 27:55-59. A POSITA would have been motivated to use Holzrichter's **control signals (individual feature vectors)** to implement Hussain's **denoising** and would have had a reasonable expectation of success in doing so, as explained here and above in Section IX.A.4.h.i.

³ I note that element [1I] recites "the denoising system," which does not appear in any preceding claim element. Instead, [1C] recites "the denoising *subsystem*." In my opinion, Hussain discloses an "adaptive intermittent noise cancellation scheme," which is a denoising system that also includes a denoising subsystem.

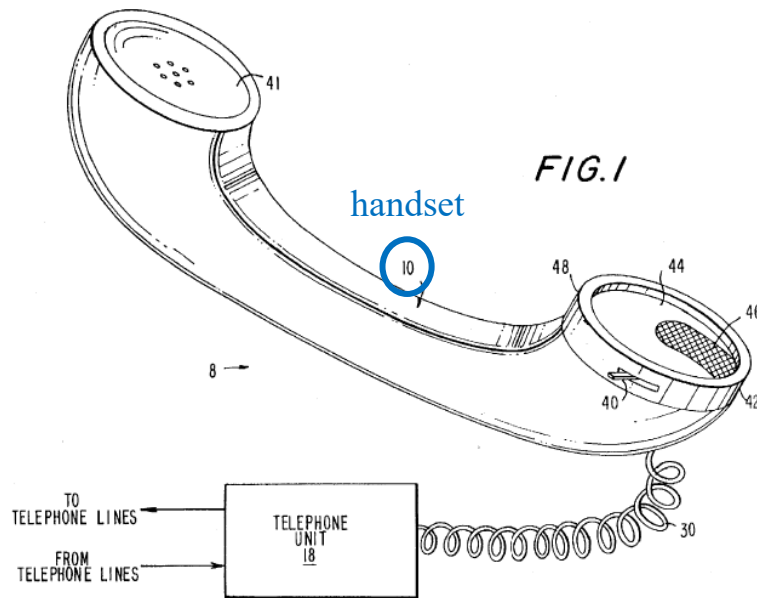
5. Dependent Claims 6-7

- a. Claim 6: “further including a portable handset that includes the microphones, wherein the portable handset includes at least one of cellular telephones, satellite telephones, portable telephones, wireline telephones, Internet telephones, wireless transceivers, wireless communication radios, personal digital assistants (PDAs), and personal computers (PCs)”**

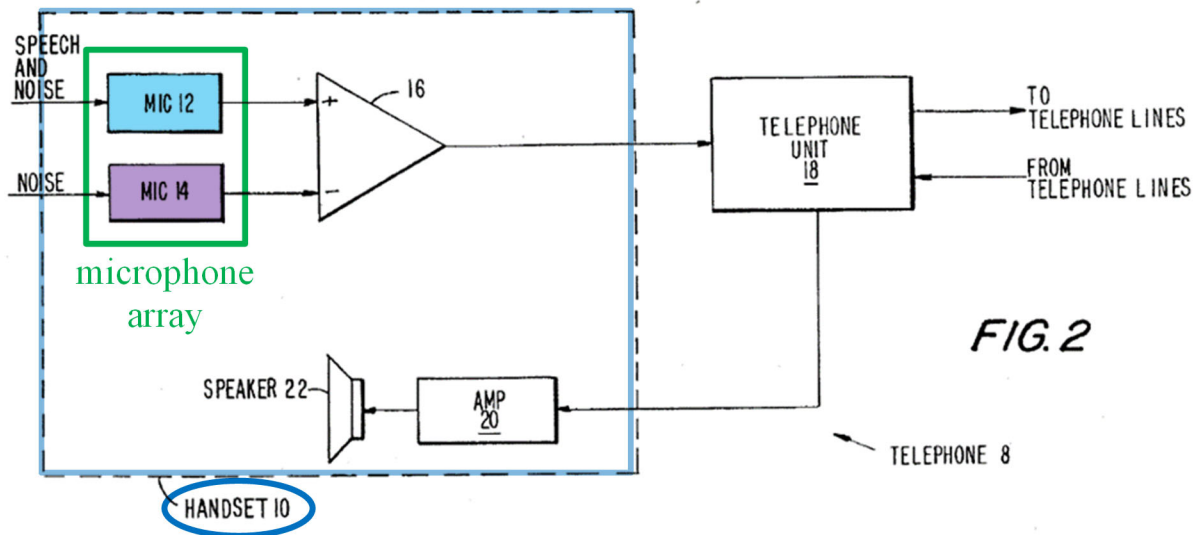
141. It is my opinion that Andrea discloses or suggests claim 6.

142. Andrea discloses a portable [handset \(handset 10\)](#) that includes the microphones ([first](#) and [second](#) microphones [12](#) and [14](#)), wherein the [portable handset \(handset 10\)](#) includes at least one of cellular telephones, satellite telephones, portable telephones (cordless type telephone), wireline telephones (telephone cord 30), Internet telephones, wireless transceivers, wireless communication radios, personal digital assistants (PDAs), and personal computers (PCs). Ex. 1005, 12:35-45, 12:46-54, Figs. 1, 2.

143. As shown in Figures 1 and 2 below, Andrea discloses a [handset 10](#). Ex. 1005, 12:35-38, 12:46-48. Andrea further discloses that “the [handset 10](#) generally includes first [and](#) second [microphones 12](#) and [14](#).” Ex. 1005, 12:47-48.



Ex. 1005, Fig. 1 (annotated).



Ex. 1005, Fig. 2 (annotated).

144. In my opinion, at minimum, including the microphones in a portable handset would have been conventional to a POSITA because the user places the handset near the user's mouth to speak into the handset. For example, during

prosecution, the Examiner recognized, “[i]t was well known to use a two microphone system ... in a portable handset.” Ex. 1002, 216-217.

145. Andrea further discloses that portable [handset 10](#) “may be coupled” to a telephone unit 18 “by way of a telephone cord 30.” Ex. 1005, 12:35-38. Andrea explains that, “[a]lternatively, the telephone may be a cordless type telephone and, therefore, the [handset 10](#) is coupled to the telephone unit 18 by way of RF waves.” Ex. 1005, 12:39-41. A POSITA would have understood that this describes [handset 10](#) of Andrea as including at least portable telephones or wireline telephones.

b. Claim 7: “wherein the portable handset includes at least one of the voice detection subsystem and the denoising subsystem”

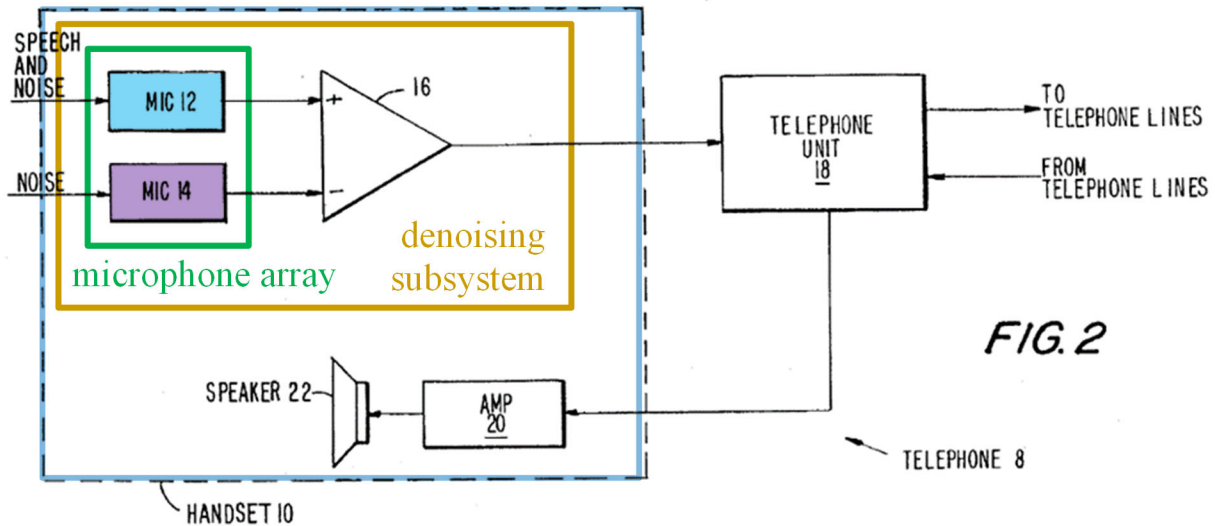
146. It is my opinion that Andrea discloses or suggests claim 7.

147. As discussed in claim 6 above, Andrea discloses a [portable handset \(handset 10\)](#). *Supra* § IX.A.5.a. Andrea further discloses that the [portable handset \(handset 10\)](#) includes at least ... the [denoising subsystem \(noise-cancellation apparatus\)](#). Ex. 1005, 11:20-21, 12:46-54, Fig. 2.

148. Andrea discloses that “[handset 10](#) generally includes first and second microphones 12 and 14, respectively, a subtracting device 16,” which may be “an operational amplifier (‘op-amp’),” and that these components “are preferably contained within the receiver portion 42” of handset 10. Ex. 1005, 12:47-54.

[Handset 10](#) therefore includes the [denoising subsystem](#), which includes the first

microphone 12 and second microphone 14 and the subtracting device 16, as shown below in Figure 2.



Ex. 1005, Fig. 2 (annotated).

6. Dependent Claims 8-13

- a. **Claim 8: “further including a portable headset that includes the microphones along with at least one speaker device”**

149. It is my opinion that Andrea discloses or suggests claim 8.

150. Andrea discloses a portable headset (headset assembly 400) with microphone boom 440, including the microphones (first and second microphones 300 and 302) along with at least one speaker device (speaker). Ex. 1005, 6:50-53, 10:14-15, 36:64-66, 11:39-47, 19:65-20:14, 19:11-18, Figs. 9A, 9C.

151. As shown in Figures 9A and 9C below, Andrea discloses a portable headset assembly 400 with a microphone boom 440, which “includes first and

second microphones 300 and 302.” Ex. 1005, 19:65-20:7; *see also id.*, 19:11-13.

Andrea further discloses “a speaker located in the headset having a[n] acoustic means.” Ex. 1005, 10:14-15; 36:64-65.

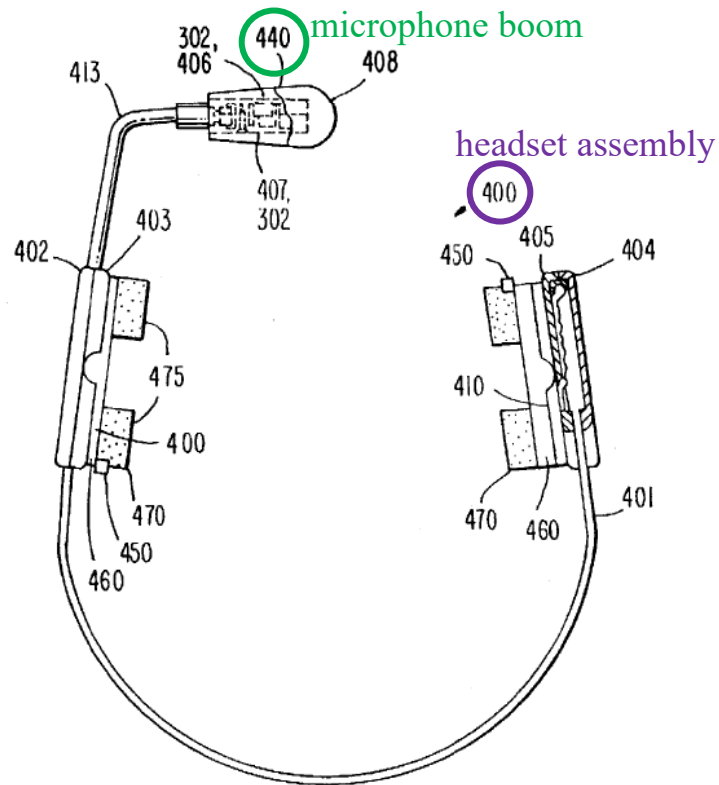
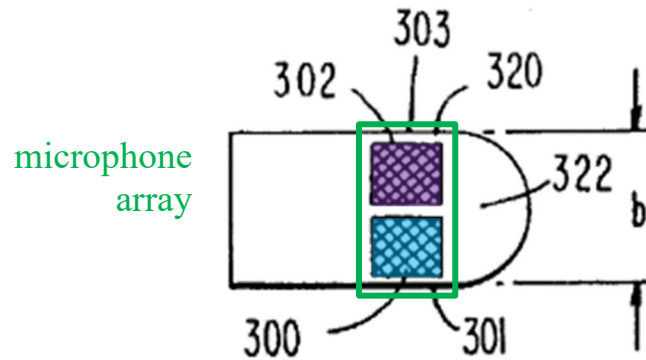


FIG. 9C

Ex. 1005, Fig. 9C (annotated).

**FIG. 9A**

Ex. 1005, Fig. 9A (annotated).

152. In my opinion, at minimum, including the microphones in a portable headset would also have been conventional to a POSITA because the user wears the headset with the speaking boom (and microphones) near the user's mouth to speak into the headset. For example, during prosecution, the Examiner recognized that a "headset having two microphones was well known in the art at the time of the invention." Ex. 1002, at 302.

- b. Claim 9: "wherein the portable headset couples to at least one communication device selected from among cellular telephones, satellite telephones, portable telephones, wireline telephones, Internet telephones, wireless transceivers, wireless communication radios, personal digital assistants (PDAs), and personal computers (PCs)"**

153. It is my opinion that Andrea discloses or suggests claim 9.

154. As discussed in claim 8 above, Andrea discloses a **portable headset (headset assembly 400)**. *Supra* § IX.A.6.a. Andrea further discloses that the **portable headset (headset assembly 400)** couples to (“interfaces with”) at least one **communication device** selected from among cellular telephones, satellite telephones, portable telephones, wireline telephones, Internet telephones, wireless transceivers, wireless communication radios, personal digital assistants (PDAs), and personal computers (PCs) (“**computers, telephones or other equipment**”). Ex. 1005, 26:9-13.

155. Andrea discloses that “the **boom microphone headset [400]** can *interface with* **computers, telephones or other equipment** in the real world.” Ex. 1005, 26:9-13 (emphasis added). A POSITA would have understood that this describes a headset that couples to cellular or portable telephones, wireless transceivers, PDAs, or PCs.

c. Claim 10: “wherein the portable headset couples to the communication device using at least one of wireless couplings, wired couplings, and combination wireless and wired couplings”

156. It is my opinion that Andrea discloses or suggests claim 10.

157. As discussed in claim 9 above, Andrea discloses a **portable headset (boom headset assembly 400)** couples to (“interfaces with”) the **communication device (“computers, telephones or other equipment”)**. *Supra* § IX.A.6.b. Andrea further discloses that the **portable headset (headset assembly 400)** is coupled to the

communication device (“computers, telephones or other equipment”) using at least one of wireless couplings, wired couplings (“cable assembly 411”), and combination wireless and wired couplings. Ex. 1005, 26:9-13, 20:42-48, 26:19-21, 26:55-67, 5:9-14.

158. Andrea discloses that the boom headset assembly 400 has a left case 402 that “includes a cable assembly 411 for supplying signals to and from outside or host equipment (not shown).” Ex. 1005, 20:42-48. The cable assembly 411 is shown below in Figure 9D, which is a “side view of the boom headset assembly 400.” Ex. 1005, 20:42-43.

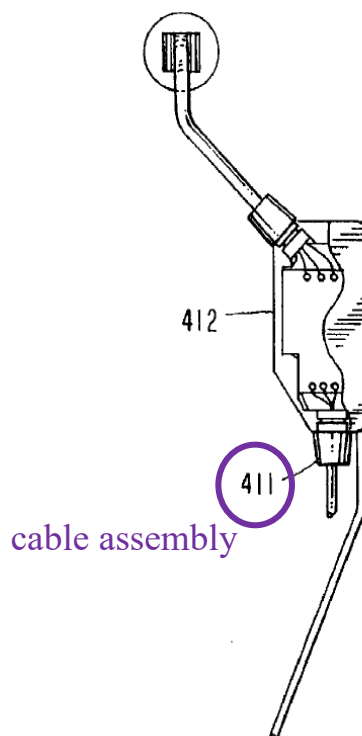


FIG. 9D

Ex. 1005, Fig. 9D (annotated).

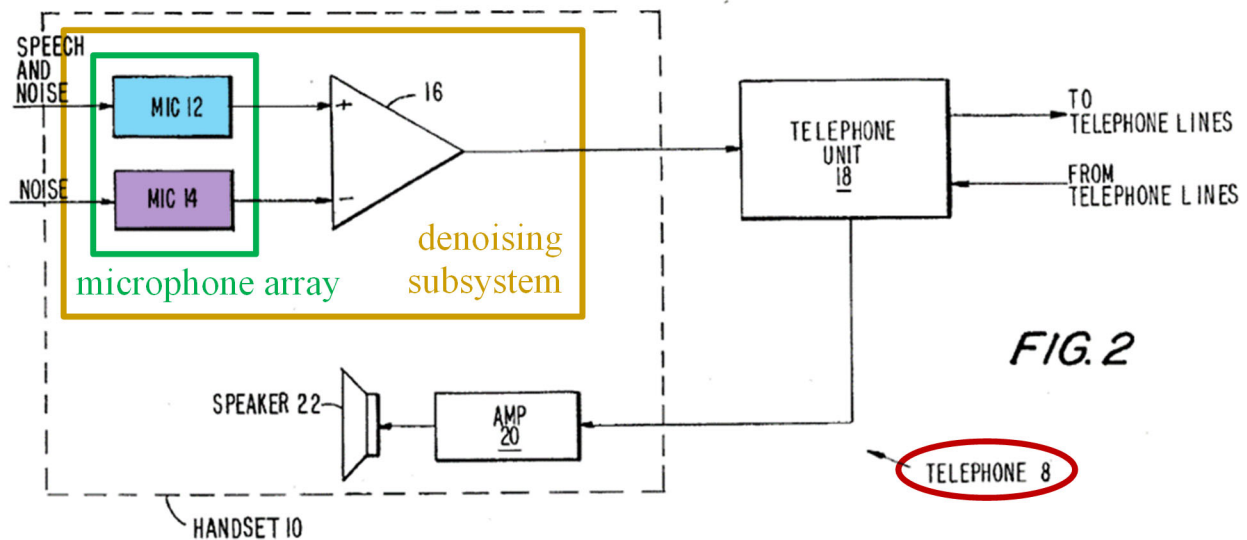
159. Andrea further discloses that the “boom microphone headset preferably is connected to 3 meter cable which terminates in a 3.5 mm miniature plug.” Ex. 1005, 26:19-21; *see also id.*, 26:55-67. A POSITA would have understood that this describes the headset assembly 400 coupling to the communication device (outside or host equipment) using a wired coupling (cable assembly 411).

d. Claim 11: “wherein the communication device includes at least one of the voice detection subsystem and the denoising subsystem”

160. It is my opinion that Andrea discloses or suggests claim 11.

161. As discussed in claim 9 above, Andrea discloses a communication device (“computers, telephones or other equipment”). *Supra* § IX.A.6.b. Andrea further discloses the communication device (telephone) includes at least one of the voice detection subsystem and the denoising subsystem (noise-cancellation apparatus). Ex. 1005, 11:19-20.

162. As shown in Figure 2 below, Andrea discloses that “the noise cancellation apparatus [is] used in the telephone of FIG. 1.” Ex. 1005, 11:19-20.



Ex. 1005, Fig. 2 (annotated).

- e. **Claim 12:** “wherein the portable headset includes at least one of the voice detection subsystem and the denoising subsystem”

163. It is my opinion that Andrea discloses or suggests claim 12.

164. As discussed in claim 8 above, Andrea discloses a **portable headset (headset assembly 400)**. *Supra* § IX.A.6.a. Andrea further discloses that the **portable headset** includes at least one of the voice detection subsystem and the **denoising subsystem (noise reduction apparatus)**. Ex. 1005, 11:39-47, 19:65-66.

165. Andrea discloses that “boom **headset assembly 400** incorporat[es] the **active noise reduction device**” (denoising subsystem). Ex. 1005, 19:65-66; *see also id.*, 11:42-44 (describing “an overview of the **headset, having active noise reduction apparatus**”); *id.*, 11:45-47 (“[T]he **active noise reduction apparatus** [is] utilized in a **headset**”).

- f. **Claim 13: “wherein the portable headset is a portable communication device selected from among cellular telephones, satellite telephones, portable telephones, wireline telephones, Internet telephones, wireless transceivers, wireless communication radios, personal digital assistants (PDAs), and personal computers (PCs)”**

166. It is my opinion that Andrea and Holzrichter render obvious claim 13.

167. As discussed in claim 8 above, Andrea discloses a **portable headset (headset assembly 400)**. *Supra* § IX.A.6.a. And as discussed in claim 9 above, Andrea discloses that **the portable headset (headset assembly 400)** couples to a **communication device (telephones, computers, or other equipment)** using a wired connection (cable assembly 411). *Supra* § IX.A.6.b.

168. Holzrichter renders obvious that the **portable headset (headset assembly 400)** is a **portable communication device** selected from among cellular telephones, satellite telephones, portable telephones, wireline telephones, Internet telephones, wireless transceivers, wireless communication radios, personal digital assistants (PDAs), and personal computers (PCs).

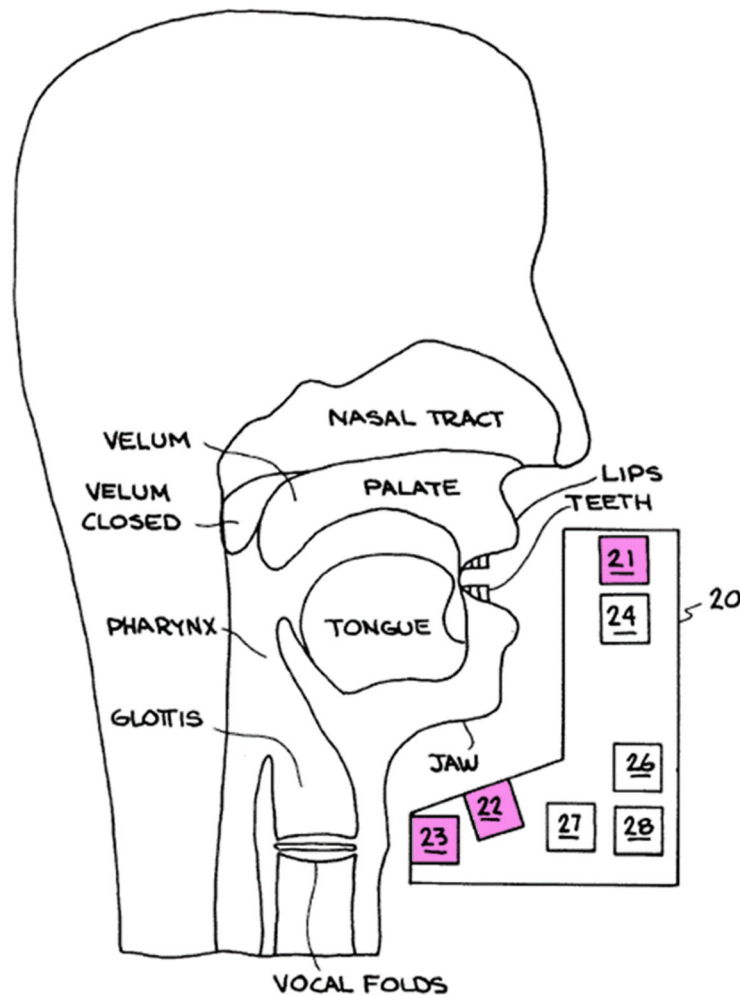
169. Like Andrea, Holzrichter discloses a **portable headset (operator harness/head harness/head helmet)**. Ex. 1007, 8:50-60, 18:26-29, 18:42-48, 18:4-6. The portable headset of Holzrichter is used to hold the microphones and **EM sensors**. Ex. 1007, 8:51-55, 18:26-29, 18:42-48, 18:4-6. For example, Holzrichter discloses that “[f]ive different methods of holding and supporting, simultaneously,

several EM sensor units and microphones against the human face and neck have been considered (front, side, top, and back of head and neck, and under the jaw), including a harness such as a telephone operator uses” Ex. 1007, 8:51-55; *see also id.*, 18:26-29 (describing “a telephone operator-like microphone harness”); *id.*, 18:4-6 (describing “attaching the module to a head harness similar to that used for holding small microphones in front of the lips”); *id.*, 18:42-48 (describing that “EM sensor ranging speech detection modules may be ... attached to harnesses ... or included in head helmets (partial or full head covering) ...”).

170. Holzrichter further discloses that data from the EM sensors can be transferred wirelessly. For example, and as shown in Figure 4 below, Holzrichter discloses that:

“FIG. 4 shows a view of a head with relevant speech organs and an illustrative NASR sensor 20. Three EM sensor transmit/receive modules 21, 22, 23 are shown although there can be as few as one or more than three.... Sensor 20 includes the necessary electronics, e.g. timing and range gate chip 26 and memory chip 27, as well as *means to transfer the data over a wire or wireless*, e.g. driver chip 28.

Ex. 1007, 17:53-61 (emphasis added); *see also id.*, 18:51-53 (“Sensor 20 is connected by a *wireless* (RF or optical) link or cable communication link 31 with a processor 32 and its associated peripheral equipment.” (emphasis added)).

**FIG. 4**

Ex. 1007, Fig. 4 (annotated).

171. A POSITA would have understood that Holzrichter discloses that the portable headset has wireless EM sensors, making it a wireless transceiver or wireless communications radio. A POSITA would have therefore understood that Holzrichter discloses that the portable headset is a portable communication device selected from among cellular telephones, satellite telephones, portable telephones, wireline telephones, Internet telephones, wireless transceivers, wireless

communication radios, personal digital assistants (PDAs), and personal computers (PCs).

i. Motivation and Expectation of Success

172. In my opinion, a POSITA would have been motivated to substitute Holzrichter's wireless data transmission for Andrea's wired data transmission. Andrea and Holzrichter both disclose **portable headsets**. *Compare* Ex. 1005, 19:65-20:7 (Andrea's **headset assembly 400**), *with* Ex. 1007, 8:51-55, 18:26-29, 18:42-48, 18:4-6 (Holzrichter's **operator harness/head harness/head helmet**). As discussed in claim 9 above, Andrea discloses that its **portable headset (headset assembly 400)** uses a *wired connection* (cable assembly 411) to couple to telephones, computers, or other equipment. *Supra* § IX.A.6.b. And as discussed in claim 13 above, Holzrichter discloses that its **portable headset (operator harness/head harness/head helmet)** uses a wired or *wireless connection* to transmit data (sensor 20 that has "means to transfer the data over a wire or *wireless*, e.g. driver chip 28"). *Supra* § IX.A.6.f; Ex. 1007, 17:53-61.

173. In my opinion, a POSITA would have been motivated to substitute a wired connection for a wireless connection to avoid the "drawbacks" of wired headphones. Andrea describes the "drawbacks" of wired headphones, including that when "frictional induced vibrations from connecting cords ... are transmitted to the noise feedback microphone, these vibrational noises are converted to

electrical signals by the microphone.” Ex. 1005, 5:9-14. A POSITA would have looked to Holzrichter’s wireless transmission to avoid the additional noise vibrations described by Andrea and to reduce the noise that must be processed by the denoising system.

174. In my opinion, a POSITA would have also been motivated to use a wireless connection to allow greater freedom of movement without wires that could create obstructions for the user.

175. In my opinion, a POSITA would have understood that Andrea’s *wired transmission* and Holzrichter’s *wireless transmission* were both known means of transmitting data from a portable headset. A POSITA could have substituted Andrea’s wired data transmission with Holzrichter’s wireless data transmission and would have had predictable results in doing so. Substitution of Andrea’s wired data transmission with Holzrichter’s wireless data transmission therefore represents the simple substitution of one known prior art element for another to obtain predictable results.

7. Dependent Claims 14-18

a. **Claim 14: “wherein the first microphone is a unidirectional microphone and the second microphone is a unidirectional microphone”**

176. It is my opinion that Andrea discloses or suggests claim 14.

177. As discussed in [1D] and [1E] above, Andrea discloses a **first microphone** and a **second microphone**. *Supra* §§ IX.A.4.e ([1D]), IX.A.4.f ([1E]).

178. In my opinion, a POSITA would have understood that Andrea describes embodiments where the **first** and **second** microphones in Andrea's handset and headset are unidirectional. Andrea also teaches "microphones with other-than-omnidirectional characteristics" and explains that "[s]uch microphones reject signals from certain directions and thus yield an improvement of the signal-to-noise ratio." Ex. 1005, 7:20-23. A POSITA would have understood that "other-than-omnidirectional" microphones were routinely unidirectional microphones. Accordingly, a POSITA would have understood that Andrea describes embodiments that use unidirectional microphones for the **first** and **second** microphones.

b. Claim 15: "wherein the first microphone and the second microphone are separated by a distance in a range of approximately zero (0) centimeters to 15 centimeters"

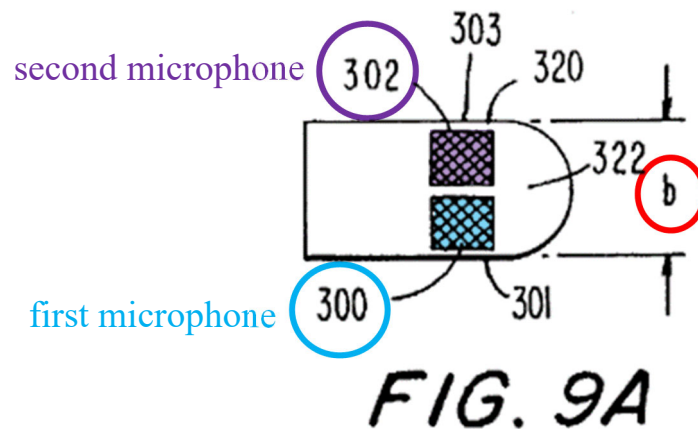
179. It is my opinion that Andrea discloses or suggests claim 15.

180. As discussed in [1D] and [1E] above, Andrea discloses a **first microphone** and a **second microphone**. *Supra* §§ IX.A.4.e ([1D]), IX.A.4.f ([1E]).

181. Andrea further discloses wherein the **first microphone (first microphone 300)** and the **second microphone (second microphone 302)** are

separated by a distance (distance or dimension b) in a range of approximately zero (0) centimeters to 15 centimeters. Ex. 1005, 19:25-28, 19:47-55, Fig. 9A.

182. As shown in Figure 9A below, Andrea discloses that “the first and second microphones 300 and 302, and in particular their respective pressure sensitive surfaces 301 and 303, are located within a distance or dimension b.” Ex. 1005, 19:25-28.



Ex. 1005, Fig. 9A (annotated).

183. Andrea further discloses that “the first and second microphones 300 and 302 are arranged within *relatively close proximity to each other, that is, within the distance b.*” Ex. 1005, 19:47-50 (emphasis added). Andrea discloses that “[a]s an example, such distance b may lie within a range of 0.10 to 0.50, preferably about 0.25 of an inch, or less.” Ex. 1005, 19:50-52. In centimeters, Andrea discloses that distance b “may lie within a range of” 0.254 centimeters to 1.27 centimeters.

184. Andrea discloses a range of distance b—“0.254 centimeters to 1.27 centimeters” (Ex. 1005, 19:50-52)—that overlaps the claimed range of “approximately zero (0) centimeters to 15 centimeters.” I understand that under Federal Circuit law, this overlap anticipates the claimed range, or at least renders it obvious.

185. In my opinion, a POSITA would have also understood (as a matter of common sense) that the first microphone (300) and the second microphone (302) of the headset described in Andrea are separated by more than 0 centimeters (because they are not touching) and less than 15 centimeters (because of the size constraints of the headset and the size of a typical human head).

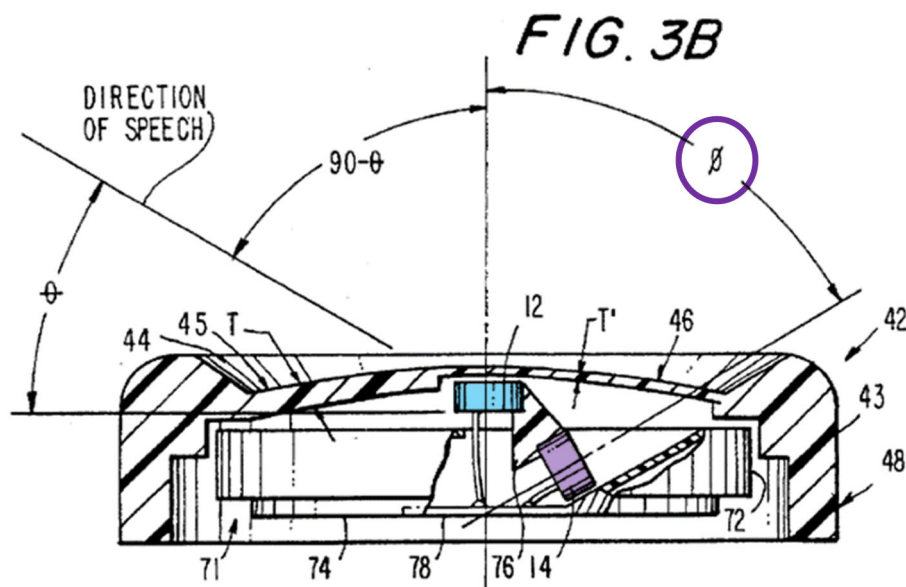
186. In my opinion, at minimum, the claimed “distance in a range of approximately zero (0) centimeters to 15 centimeters” would have been conventional to a POSITA. Andrea discloses that “[s]uitable distance b may be determined by the skilled artisan from this disclosure, without undue experimentation and, the invention is not necessarily limited to a particular value for b.” Ex. 1005, 19:52-55. Moreover, the Examiner recognized this during prosecution, stating that “the claimed distance and angle between microphones” could be realized “without undue experimentation.” Ex. 1002, 215. The claimed distance would have also been obvious to a POSITA to try. As the Examiner stated during prosecution, “it would have been obvious to try to have the microphones

separated at a distance in the range of 0 to 15 centimeters ... with a reasonable expectation of success.” Ex. 1002, 295.

c. Claim 16: “wherein the angle is in a range of approximately greater than zero (0) degrees and one of equal to and less than 180 degrees”

187. It is my opinion that Andrea discloses or suggests claim 16.

188. As discussed in [1E] above, Andrea describes angle ϕ , circled in Figure 3B below, as the angle between the first and second microphones. *Supra* § IX.A.4.f ([1E]); Ex. 1005, 14:9-12.



Ex. 1005, Fig. 3B (annotated).

189. Andrea discloses that angle ϕ “preferably has a value in a range between 30° and 60°.” Ex. 1005, 14:9-12.

190. Andrea’s recited range of angle ϕ —“preferably ... between 30° and 60°” (Ex. 1005, 14:9-12)—overlaps the claimed range of “approximately greater

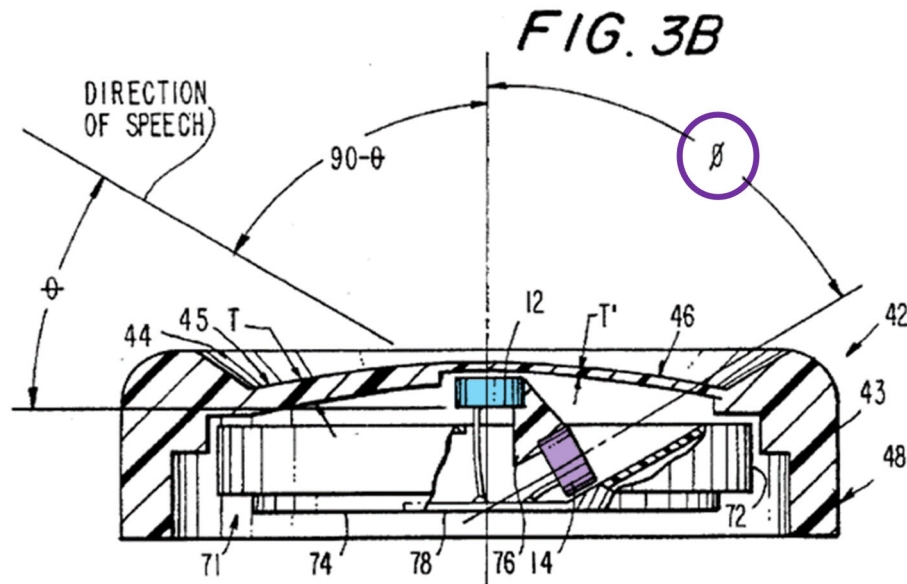
than zero (0) degrees and one of equal to and less than 180 degrees.” This overlap anticipates the claimed range, or at least renders it obvious.

191. In my opinion, at minimum, the claimed range of “approximately greater than zero (0) degrees and one of equal to and less than 180 degrees” would have been conventional to a POSITA because greater than 0 and less than 180 degrees covers nearly all possible angles between the microphones. Moreover, the Examiner recognized this during prosecution, stating that “the claimed distance and **angle** between microphones” could be realized “without undue experimentation.” Ex. 1002, 215. The claimed range would have also been obvious to a POSITA to try. As the Examiner stated during prosecution, “it would have been obvious to try to have the microphones ... having an **angle ... in the range of 0 to 180 degrees** with a reasonable expectation of success.” Ex. 1002, 295.

d. Claim 17: “wherein the angle is in a range of approximately greater than zero (0) degrees and one of equal to and less than 135 degrees”

192. It is my opinion that Andrea discloses or suggests claim 17.

193. As discussed in [1E] and claim 16 above and as shown in Figure 3B below, Andrea describes **angle ϕ** as the angle between the first and second microphones and discloses that **angle ϕ “preferably has a value in a range between 30° and 60°.”** *Supra* §§ IX.A.4.f ([1E]), IX.A.7.c (claim 16); Ex. 1005, 14:9-12.



Ex. 1005, Fig. 3B (annotated).

194. Andrea’s recited range of angle ϕ —“preferably ... between 30° and 60°” (Ex. 1005, 14:9-12)—overlaps the claimed range of “approximately greater than zero (0) degrees and one of equal to and less than 135 degrees.” This overlap anticipates the claimed range, or at least renders it obvious.

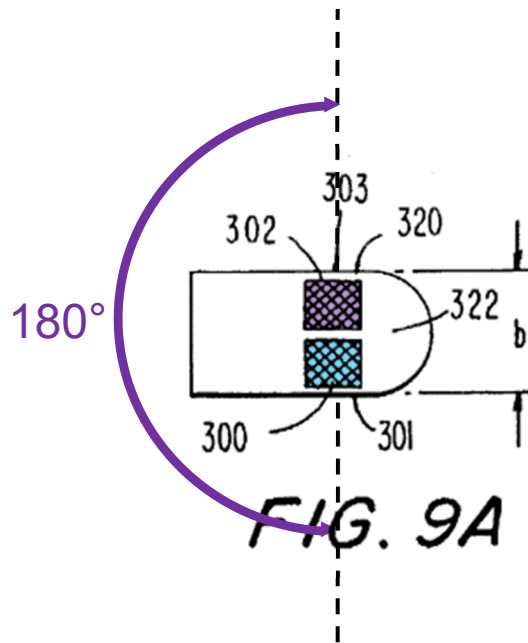
195. In my opinion, at minimum, the claimed range of “approximately greater than zero (0) degrees and one of equal to and less than 135 degrees” would have been conventional to a POSITA for the reasons discussed in Section IX.A.7.c (claim 16).

- e. **Claim 18: “wherein the angle is in a range of approximately greater than zero (0) degrees and one of equal to and greater than 90 degrees”**

196. It is my opinion that Andrea discloses or suggests claim 18.

197. As discussed in [1E] and claims 16 and 17 above, Andrea describes **angle ϕ** as the angle between the first and second microphones and discloses that **angle ϕ** “preferably has a value in a range between 30° and 60°.” *Supra* §§ IX.A.4.f ([1E]), IX.A.7.c (claim 16), IX.A.7.d (claim 17); Ex. 1005, 14:9-12.

198. Andrea also discloses that the microphones may be “arranged so as to have an **angle ϕ which lies outside**” the preferred range of 30° to 60° and “may nevertheless operate satisfactorily.” Ex. 1005, 14:30-34. In fact, and as shown below, Andrea discloses that the angle between the microphones may be up to **180°**. Ex. 1005, 19:14-17, 19:39-43, Fig. 9A. Andrea discloses that “the respective pressure sensitive surfaces 301 and 303 are **substantially 180° apart from each other**.” Ex. 1005, 19:14-17; *see also id.*, 19:39-43 (“[T]he pressure sensitive surface 303 of the second microphone 302 is preferably arranged at an angle of **substantially 180°** from the pressure sensitive surface 301 of the first microphone 300.”).



Ex. 1005, Fig. 9A (annotated).

199. Andrea teaches that the angle between the microphones may be 30° to 60° , but Andrea also teaches that the angle can be outside of this range and can be up to 180° . Andrea, therefore, discloses a range of greater than 60° and up to 180° that overlaps the claimed range of “approximately greater than zero (0) degrees and one of equal to and greater than 90 degrees.” This overlap anticipates the claimed range, or at least renders it obvious.⁴

⁴ Claim 18 recites an angle “in a range of approximately greater than zero (0) degrees and one of equal to and greater than 90 degrees.” No matter how this claim is interpreted, Andrea discloses overlapping ranges of 30° to 60° and greater than 60° and up to 180° .

200. In my opinion, at minimum, the claimed range of “approximately greater than zero (0) degrees and one of equal to and greater than 90 degrees” would have been conventional to a POSITA for the reasons discussed in Section IX.A.7.c (claim 16).

8. Dependent Claims 19-23

a. Claim 19: “wherein the first microphone is an omnidirectional microphone and the second microphone is a unidirectional microphone”

201. It is my opinion that Andrea discloses or suggests claim 19.

202. As discussed in [1D] and [1E] above, Andrea discloses a [first microphone](#) and a [second microphone](#). *Supra* §§ IX.A.4.e ([1D]), IX.A.4.f ([1E]). Andrea discloses that the [first](#) and [second](#) microphones can be unidirectional microphones. *Supra* § IX.A.7.a (claim 14). Andrea also discloses “wherein the [first microphone](#) means is an omnidirectional microphone consisting of speech only,” which a POSITA would have understood describes that the microphones can be mixed types with the first being omnidirectional and the second being unidirectional. Ex. 1005, 38:31-33. Andrea also refers to “omni-directional and directional microphones” being used together. Ex. 1005, 7:31-37.

203. In my opinion, this mix of microphones would have also been obvious to a POSITA. A POSITA would have known that omnidirectional and unidirectional microphones were known means of receiving acoustic signals. A

POSITA would have found it obvious to use an omnidirectional microphone for the first microphone and would have expected to succeed in doing so.

204. In my opinion, a POSITA would have been motivated to use an omnidirectional microphone for the first microphone because omnidirectional microphones are less expensive and easier to mount than unidirectional microphones and because it could improve performance if the speaker's position is unpredictable or changes.

b. Claim 20: “wherein the first microphone and the second microphone are separated by a distance approximately in a range of zero (0) centimeters to 15 centimeters”

205. Claim 20 is substantively the same as claim 15 but recites a “distance approximately in a range of zero (0) centimeters to 15 centimeters” instead of a “distance in a range of approximately zero (0) centimeters to 15 centimeters.” It is my opinion that claim 20 is disclosed or rendered obvious for the reasons discussed in Section IX.A.7.b (claim 15).

c. Claim 21: “wherein the angle is approximately in a range of 30 degrees to 180 degrees”

206. It is my opinion that Andrea discloses or suggests claim 21.

207. Claim 21 overlaps with the ranges in claims 16-18 and is disclosed or rendered obvious for the reasons discussed in Sections IX.A.7.c-IX.A.7.e (claims 16-18).

208. As discussed in [1E] and claims 16-18 above, Andrea describes **angle φ** , as the angle between the first and second microphones and discloses that **angle φ** “preferably has a value in a range between 30° and 60°.” *Supra* §§ IX.A.4.f ([1E]), IX.A.7.c (claim 16)-IX.A.7.e (claim 18); Ex. 1005, 14:9-12.

209. Andrea’s recited range of **angle φ** —“preferably ... between 30° and 60°” (Ex. 1005, 14:9-12)—overlaps the claimed range of “approximately in a range of 30 degrees to 180 degrees.” This overlap anticipates the claimed range, or at least renders it obvious.

210. In my opinion, at minimum, the claimed range of “approximately in a range of 30 degrees to 180 degrees” would have been conventional to a POSITA for the reasons discussed in Section IX.A.7.c (claim 16).

d. Claim 22: “wherein the angle is approximately in a range of 60 degrees to 180 degrees”

211. It is my opinion that Andrea discloses or suggests claim 22.

212. Claim 22 overlaps with the ranges in claims 16-18 and is disclosed or rendered obvious for the reasons discussed in Sections IX.A.7.c-IX.A.7.e (claims 16-18).

213. As discussed in claims 16-17, Andrea discloses or renders obvious claim 22’s recited 60-degree angle. *Supra* §§ IX.A.7.c-IX.A.7.d (claims 16-17). As discussed in claim 18 above, Andrea teaches that the angle between the microphones may be between 30° and 60°, but Andrea also teaches that the angle

can be outside of this range and can be up to 180°. *Supra* §§ IX.A.7.e (claim 18); Ex. 1005, 14:9-12, 14:30-34; 19:14-17, 19:39-43, Fig. 9A.

214. Andrea, therefore, discloses a range of greater than 60° and up to 180° that overlaps the claimed range of “approximately in a range of 60 degrees to 180 degrees.” This overlap anticipates the claimed range, or at least renders it obvious.

215. In my opinion, at minimum, the claimed range of “approximately in a range of 60 degrees to 180 degrees” would have been conventional to a POSITA for the reasons discussed in Section IX.A.7.c (claim 16).

e. Claim 23: “wherein the angle is approximately in a range of 90 degrees to 180 degrees”

216. It is my opinion that Andrea discloses or suggests claim 23.

217. Claim 23 is substantively the same as claim 18 (equal or greater than 90 degrees) and is disclosed or rendered obvious for the reasons discussed in Section IX.A.7.e (claim 18).

218. As discussed in claims 18 and 22 above, Andrea teaches that the angle between the microphones may be 30° to 60°, but Andrea also teaches that the angle can be outside of this range and can be up to 180°. *Supra* §§ IX.A.7.e (claim 18), IX.A.8.d (claim 22).

219. Andrea, therefore, discloses a range of greater than 60° and up to 180° that overlaps the claimed range of “approximately in a range of 90 degrees to 180 degrees.” This overlap anticipates the claimed range, or at least renders it obvious.

220. In my opinion, at minimum, the claimed range of “approximately in a range of 90 degrees to 180 degrees” would have been conventional to a POSITA for the reasons discussed in Section IX.A.7.c (claim 16).

9. Dependent Claims 24-25

a. Claim 24: “wherein the first microphone is a unidirectional microphone and the second microphone is an omnidirectional microphone”

221. It is my opinion that Andrea discloses or suggests claim 24.

222. As discussed in [1D] and [1E] above, Andrea discloses a **first microphone** and a **second microphone**. *Supra* §§ IX.A.4.e ([1D]), IX.A.4.f ([1E]).

223. Andrea discloses that the **first** and **second** microphones can be unidirectional microphones. *Supra* § IX.A.7.a (claim 14). Andrea also discloses that “sensor microphone 450” (second microphone) can be “an omnidirectional microphone, which is receptional to noise from all angles.” Ex. 1005, 20:33-38, 34:43 (“noise omnidirectional microphone”), 38:34-37. Andrea also refers to “omni-directional and directional microphones” being used together. Ex. 1005, 7:31-37.

224. In my opinion, this mix of microphones, which were known means of receiving acoustic signals, would have also been obvious to a POSITA. *Supra* § IX.A.8.a (claim 19). In my opinion, a POSITA would have found it obvious to

use an omnidirectional microphone as the second microphone and would have expected to succeed in doing so.

225. In my opinion, a POSITA would have been motivated to use an omnidirectional microphone for the second microphone because omnidirectional microphones are less expensive and easier to mount than unidirectional microphones and because it would make matching the gains coming from different directions trivial.

b. Claim 25: “wherein the first microphone and the second microphone are separated by a distance approximately in a range of zero (0) centimeters to 15 centimeters”

226. Claim 25 is substantively the same as claim 15 but recites a “distance approximately in a range of zero (0) centimeters to 15 centimeters” instead of a “distance in a range of approximately zero (0) centimeters to 15 centimeters.” It is my opinion that claim 25 is disclosed or rendered obvious for the reasons discussed in Section IX.A.7.b (claim 15).

10. Dependent Claims 2 and 5

a. Claim 2

i. [2P] “wherein the voice detection subsystem further comprises:”

227. It is my opinion that Andrea discloses, or Hussain and Holzrichter render obvious, the voice detection subsystem for the reasons discussed in Sections IX.A.4.b ([1A]) and IX.A.4.c ([1B]).

ii. [2A] “at least one glottal electromagnetic micropower sensor (GEMS) including at least one antenna for receiving the voice activity signals; and”

228. It is my opinion that Andrea, Hussain, and Holzrichter render obvious [2A].

229. It is my opinion that Hussain and Holzrichter render obvious a **glottal electromagnetic micropower sensor (GEMS)** including at least one **antenna** for receiving the voice activity signals.

230. As discussed in [1A] and [1B] above, Hussain “assume[s] ... that an effective voice activity detector (VAD) is available,” and Holzrichter discloses a **sensor (EM sensor module 23)** as a VAD for receiving voice activity signals (measuring the presence or absence of vocal fold motions). *Supra* §§ IX.A.4.b ([1A]), IX.A.4.c ([1B]). Holzrichter further describes that **EM sensor “[m]odule 23** is directed at the vocal folds and **glottis**” and that “[t]he output from **sensor 23** in

FIG. 4 provides the fundamental open and close rate of the **glottis**, as measured by **observing the motions of the glottal tissues**, especially the vocal folds.” Ex. 1007, 17:53-63, 35:2-5, Fig. 4.

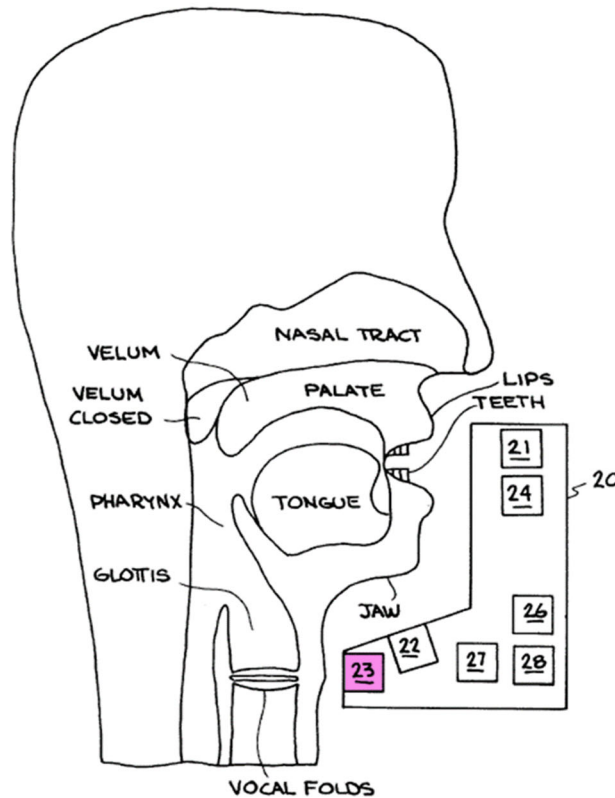


FIG. 4

Ex. 1007, Fig. 4 (annotated).

231. Holzrichter also discloses “**2 GHz micropower**” EM sensors for “direct[ing] EM waves upward into the jaw, tongue, and nasal cavities.” Ex. 1007, 42:8-12 (emphasis added). A POSITA would have understood Holzrichter’s 2 GHz micropower glottal EM sensor to disclose a **GEMS**.

232. Holzrichter also discloses that the **glottal electromagnetic micropower sensor (GEMS)** includes at least one **antenna** for **receiving the voice activity signals**. Holzrichter discloses that the **EM sensor** consists “of a 2 GHz micropower radar *transmitter and receiver unit*, which directed EM waves upward into the jaw, tongue, and nasal cavities.” Ex. 1007, 42:8-12 (emphasis added). Holzrichter also discloses using “**one EM sensor module** and *one antenna*” to “**obtain information from the organs**.” Ex. 1007, 21:35-42 (emphases added); *see also id.*, 50:44-50.

233. In my opinion, a POSITA would have understood that Holzrichter discloses at least one **GEMS (EM sensor module 23)** including at least one **antenna** for **receiving the voice activity signals**.

(a) Motivation and Expectation of Success

234. In my opinion, a POSITA would have been motivated to use Holzrichter’s GEMS including an antenna as the VAD in the Andrea-Hussain system to improve overall noise-cancellation performance by improving the accuracy of the voice activity detection and would have had a reasonable expectation of success in doing so, as discussed in Section IX.A.4.b.i.

235. In my opinion, a POSITA would have been motivated to specifically use a glottal electromagnetic micropower sensor (GEMS), like that disclosed by Holzrichter, to directly and accurately detect movements of the glottal tissues and output accurate voice activity signals. As Holzrichter explains, “[t]he output from

sensor 23 ... provides the fundamental open and close rate of the glottis, as measured by observing the motions of the glottal tissues, especially the vocal folds.” Ex. 1007, 35:2-5.

236. Using Holzrichter’s glottal electromagnetic micropower sensor (GEMS) as the VAD therefore represents the combination of known prior art elements implemented according to their known functions to yield predictable results. For example, I understand that the Examiner took “official notice” during prosecution, which I understand is the Patent Office notifying the applicant that a particular technique is conventional, that “it was known in the art at the time of invention to use glottal electromagnetic sensors ... to generate voice signals.” Ex. 1002, 216; *see also id.*, 295 (“[E]xaminer takes official notice that it was well known in the art at the time of the invention to use glottal electromagnetic sensors ... to generate voice signals.”).

iii. [2B] “at least one voice activity detector (VAD) algorithm for processing the GEMS voice activity signals and generating the control signals”

237. It is my opinion that Andrea, Hussain, and Holzrichter render obvious [2B].

238. Holzrichter renders obvious at least one voice activity detector (VAD) algorithm for processing the GEMS voice activity signals and generating the control signals.

239. As discussed above in [1B] and [2A], Holzrichter discloses a **GEMS** (EM sensor module 23) that receives voice activity signals and generates control signals (“generate[s] [an] individual feature vector”) *Supra* §§ IX.A.4.c([1B]), IX.A.10.a.ii ([2A]). Holzrichter also discloses a VAD algorithm for processing voice activity signals from the **GEMS** (EM sensor module 23) and generating control signals. For example, Holzrichter discloses:

Processing units and algorithms--For each set of received EM wave signals there is a need to process and obtain the information on organ motions (or their new positions) that can be used to associate the unknown speech with the intended speech sound or word sound.... The algorithms normalize and digitize the EM sensor signal intensities and identify one of a few EM signal structures with known reference locations such as the skin under the jaw or the face front. The algorithms then take raw vectorized data, and normalize, quantize, time align, time compact, and construct a normalized vector for each series of signals, with control information, that correspond to a given organ's configuration at each frame of simultaneously measure acoustic speech.

Ex. 1007, 9:23-63.

240. In other words, Holzrichter teaches “algorithms [to] normalize and digitize the EM sensor signal intensities and identify one of a few EM signal structures,” for example, to “take raw vectorized data, and normalize, quantize, time align, time compact” (algorithm) and “construct a normalized vector for each series of signals, with control information” (generating control signals). Ex. 1007, 9:23-63, 10:64 67, 53:22 37.

241. In my opinion, a POSITA would therefore have understood that Holzrichter discloses a voice activity detector (VAD) algorithm for processing the GEMS voice activity signals and generating the control signals.

(a) Motivation and Expectation of Success

242. In my opinion, a POSITA would have been motivated to incorporate Holzrichter's GEMS in the Andrea-Hussain system to improve overall noise-cancellation performance and would have had a reasonable expectation of success doing so, as discussed in Section IX.A.10.a.ii(a) ([2A]). A POSITA would have also been motivated to incorporate Holzrichter's VAD algorithm into the Andrea-Hussain system to "process" Holzrichter's received EM wave signals and "construct a normalized vector for each series of signals, with control information" to improve noise cancellation. Ex. 1007, 9:23-63. In my opinion, a POSITA would have reasonably expected success in this combination because it represents the combination of known prior art elements implemented according to their known functions to yield predictable results.

b. Claim 5: "wherein the voice detection subsystem further comprises at least one manually activated voice activity detector (VAD) for generating the voice activity signals"

243. It is my opinion that Andrea discloses, or Hussain and Holzrichter render obvious, the voice detection subsystem for the reasons discussed in Sections IX.A.4.b ([1A]) and IX.A.4.c ([1B]).

244. Holzrichter renders obvious a **manually activated VAD** for generating the voice activity signals. As discussed above in [1B], Holzrichter discloses a voice detection subsystem including an **EM sensor (EM sensor module 23)**. *Supra* § IX.A.4.c; Ex. 1007, 17:54-56, Figs. 3, 4. Holzrichter further discloses “[using] a finger or other body part to actuate a button or similar sensor device to start the operation of the EM sensor system.” Ex. 1007, 17:43-48. A POSITA would have understood this discloses a manually activated VAD because the finger activation is a manual operation to “start” or activate the EM sensor generating signals.

245. In my opinion, it would have also been obvious to a POSITA to incorporate Holzrichter’s manual finger-activated button to operate the VAD to provide the user with more control over the system.

(a) Motivation and Expectation of Success

246. In my opinion, a POSITA would have been motivated to incorporate Holzrichter’s manually activated EM sensor to generate VAD signals in the Andrea-Hussain system to improve overall noise-cancellation performance by improving the accuracy of the VAD and would have had a reasonable expectation of success doing so, as discussed in Section IX.A.4.b.i.

247. In my opinion, a POSITA would have been further motivated to incorporate Holzrichter’s manual finger-activated button to start the EM sensor system operation to reduce EM radiation on the user, reduce power usage of the

system, and allow the user to control activation to prevent EM sensor activation with non-speech voicing actions. Holzrichter provides this motivation and explains that its finger-activated button to start the operation of the EM sensor system helps “keep the EM irradiation of the human body low and within federal guidelines” and “minimize system power usage, especially for wireless systems.” Ex. 1007, 17:38-48.

11. Independent Claim 26

248. It is my opinion that Andrea, Hussain, and Holzrichter render obvious claim 26.

a. [26P]

249. If the preamble is limiting, [26P] is substantively the same as [1P], and it is my opinion that it is disclosed or rendered obvious for the reasons discussed in Section IX.A.4.a ([1P]).

b. [26A]-[26I]

250. [26A]-[26I] are substantively the same as [1A]-[1I], and it is my opinion that they are disclosed or rendered obvious for the reasons discussed in Sections IX.A.4.b ([1A]) through IX.A.4.j ([1I]).

c. [26J] “a portable headset comprising the plurality of microphones and at least one speaker device,”

251. [26J] is substantively the same as claim 8 but recites “comprising the plurality of microphones and” instead of “that includes the microphones along

with.” It is my opinion that [26J] is disclosed or rendered obvious for the reasons discussed in Section IX.A.6.a (claim 8).

- d. **[26K] “wherein the portable headset couples to at least one communication device selected from among cellular telephones, satellite telephones, portable telephones, wireline telephones, Internet telephones, wireless transceivers, wireless communication radios, personal digital assistants (PDAs), personal computers (PCs), and at least one of the voice detection subsystem and the denoising subsystem”**

252. It is my opinion that Andrea discloses or suggests [26K].

253. [26K] first recites “wherein the portable headset couples to at least one communication device selected from among cellular telephones, satellite telephones, portable telephones, wireline telephones, Internet telephones, wireless transceivers, wireless communication radios, personal digital assistants (PDAs), personal computers (PCs),” which is substantively the same as claim 9, and, in my opinion, is disclosed or rendered obvious by Andrea for the reasons discussed in Section IX.A.6.b (claim 9).

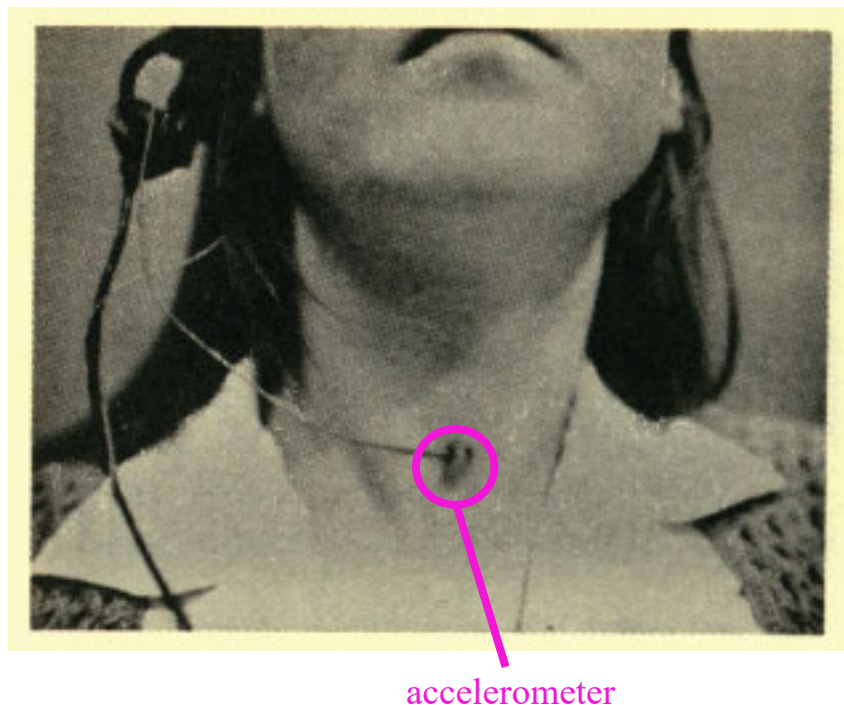
254. [26K] also recites that the portable headset couples to “at least one of the voice detection subsystem and the denoising system.” As discussed in claims 9 and 11 above, Andrea discloses that the **portable headset assembly 400** couples to (interfaces with) the **communication device** and the communication device includes the **denoising subsystem (noise-cancellation apparatus)**. *Supra* § IX.A.6.b, IX.A.6.d.

B. Ground 2: Claim 3 Is Obvious over Andrea, Hussain, Holzrichter, and Stevens

255. In my opinion, claim 3 would have been obvious to a POSITA based on Andrea, Hussain, and Holzrichter or Andrea, Hussain, Holzrichter, and Stevens.

1. Overview of Stevens

256. Stevens discloses speech detection using an “**accelerometer**” in “high-intensity noise environments.” Ex. 1008, 4-5. The “**lightweight accelerometer**” is “attached to the neck of a speaker” and is “used to obtain a waveform related to the glottal acoustic output.” *Id.*, 4. “Figure 1 shows the **accelerometer attached to the neck.**” *Id.*, 4-5.



Id., Fig. 1 (annotated).

257. Stevens explains that “the accelerometer may be easily attached to the neck ... of a speaker by means of a double-sided adhesive tape” and that “the accelerometer is relatively insensitive to airborne sound.” *Id.*, 5.

258. Stevens would have been readily available to POSITAs at the earliest priority date of the '543 patent. Stevens was included in Volume 18, No. 3, of the *Journal of Speech and Hearing Research*, published in 1975 by The American Speech and Hearing Association, which is a well-known publication for speech research that would have been referenced by persons of ordinary skill in the art. Ex. 1008, 1. The *Journal of Speech and Hearing Research* was, and still is,⁵ a regularly published periodical journal made available to general public, including those interested in the field and those with the credentials of a person of ordinary skill in the art.

2. Dependent Claim 3

a. [3P] “wherein the voice detection subsystem further comprises:”

259. It is my opinion that Andrea discloses, or Hussain and Holzrichter render obvious, the voice detection subsystem for the reasons discussed in Sections IX.A.4.b ([1A]) and IX.A.4.c ([1B]).

⁵ The Journal of Speech and Hearing Research is now published under the name The Journal of Speech Language and Hearing Research.

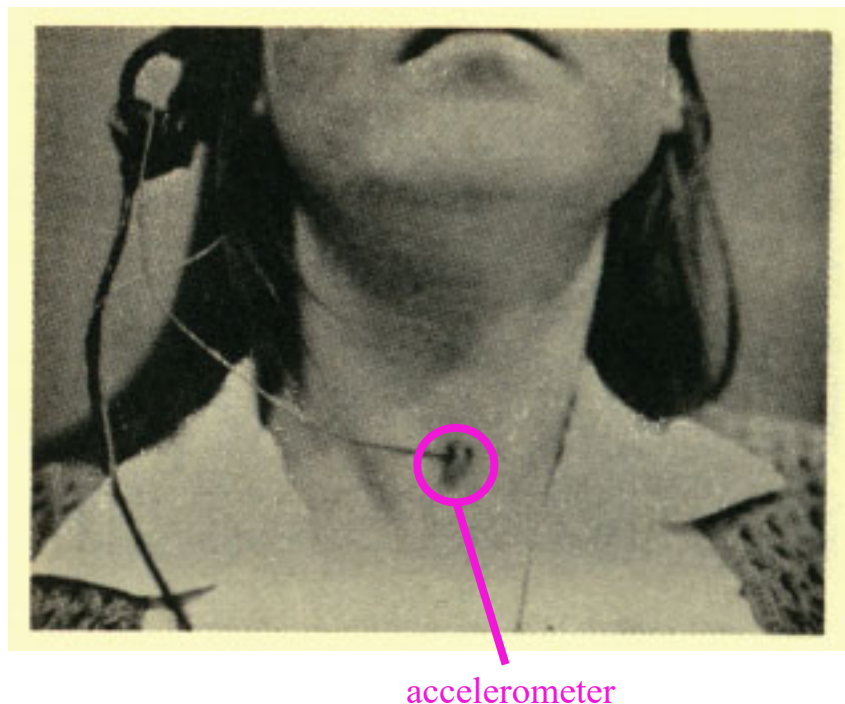
b. [3A] “at least one accelerometer sensor in contact with skin for receiving the voice activity signals; and”

260. It is my opinion that Andrea, Hussain, and Holzrichter render obvious [3A]. If Patent Owner argues that Holzrichter does not disclose an “accelerometer sensor,” Stevens renders this limitation obvious.

261. Holzrichter renders obvious an “effective voice activity detector,” *supra* § IX.A.4.c ([1B]), using EM sensor (EM sensor module 23) that receives voice activity signals (“measure[s] the presence or absence of vocal fold motions”). Holzrichter further discloses that “EM sensor ranging speech detection modules may be located against ... the body” in contact with the skin. Ex. 1007, 18:42-44. Holzrichter further discloses “attaching the EM sensor module(s) to the head or neck.” Ex. 1007, 23:47-51; *see also id.*, 18:24-26 (“taped-on sensors”). Holzrichter further discloses “obtaining organ velocity or acceleration information from the detected EM radiation.” Ex. 1007, 58:58-60. For example, Holzrichter discloses the EM sensor “measuring ... velocity of an organ interface over two separate times provides organ interface acceleration information,” which a POSITA would have understood describes an accelerometer sensor receiving voice activity signals. Ex. 1007, 24:19-21; *see also id.*, 51:57-52:17. A POSITA would have found it obvious to incorporate Holzrichter’s EM sensor as Hussain’s VAD for the reasons explained above in Section IX.A.4.c ([1B]).

262. Alternatively, Stevens renders obvious [3A]. Stevens discloses an accelerometer sensor in contact with skin (accelerometer attached to the neck) for receiving the voice activity signals (glottal signals). Ex. 1008, 4-5, Fig. 1.

263. As shown below, Stevens discloses an “accelerometer attached to the neck” of a user.” Ex. 1008, 4-5; *see also id.*, 4-5 (disclosing that the “lightweight accelerometer” is “attached to the neck of a speaker”).



Ex. 1008, Fig. 1 (annotated).

264. Stevens further discloses that the accelerometer is positioned “for detection of glottal ... signals” and is “used to obtain a waveform related to the glottal acoustic output.” *Id.*, 4-5. A POSITA would have understood that Stevens

describes an accelerometer sensor in contact with skin for receiving the voice activity signals.

265. In my opinion, a POSITA would have found it obvious to incorporate Stevens's **accelerometer** as Hussain's VAD because it is efficient at "speech pick-up in high-intensity noise environments, since the accelerometer is relatively insensitive to airborne sound," thereby improving speech detection efficiency. Ex. 1006, 10-13; Ex. 1008, 4-5. In my opinion, a POSITA would have looked to Stevens's accelerometer because it has "light weight, good sensitivity, wide band width, ruggedness, and low power consumption" and is "suitable in applications where speech-related signals need to be extracted." Ex. 1008, 4.

266. Moreover, the Examiner recognized during prosecution that "it would have been obvious to one of ordinary skill in the art at the time of invention to ... have an accelerometer ... for the purpose of generating voice activity signals directly from the source." Ex. 1002, 216.

(a) Motivation and Expectation of Success

267. As discussed above in [1A]-[1B], Hussain assumes an efficient VAD is available to determine noise alone and speech plus noise periods to perform adaptive noise cancellation. *Supra* §§ IX.A.4.b-IX.A.4.c ([1A]-[1B]).

268. In my opinion, a POSITA would have been motivated to use Holzrichter's EM sensor as a skin-contact accelerometer sensor to receive voice

activity signals to improve overall noise-cancellation performance by improving the accuracy of the VAD as discussed in Section IX.A.4.b.i. And a POSITA would have reasonably expected to succeed in doing so because it represents the combination of known prior art elements implemented according to their known functions to yield predictable results as discussed in Section IX.A.4.b.i.

269. In my opinion, a POSITA would also have been motivated to incorporate Stevens's skin-contact accelerometer to improve overall noise-cancellation performance and voice activity detection accuracy because Stevens's accelerometer has "light weight, good sensitivity, wide band width, ruggedness, and low power consumption." Ex. 1008, 4. Holzrichter teaches reducing power consumption and EM radiation, which would have further motivated a POSITA to use Stevens's skin contact accelerometer to detect voice activity signals. Ex. 1007, 17:38-48.

270. In my opinion, a POSITA would have been motivated to use an accelerometer sensor as a VAD because the accelerometer is designed for "speech pick-up in high-intensity noise environments" Ex. 1008, 4-5. A POSITA would have reasonably expected to succeed incorporating Holzrichter's or Stevens's skin-contact accelerometers into the Andrea-Hussain-Holzrichter system because using the accelerometer as a VAD represents the combination of known prior art

elements implemented according to their known functions to yield predictable results.

c. [3B] “at least one voice activity detector (VAD) algorithm for processing the accelerometer sensor voice activity signals and generating the control signals”

271. It is my opinion that Andrea, Hussain, and Holzrichter render obvious [3B].

272. [3B] is similar to [2B] in that both recite “at least one voice activity detector (VAD) algorithm for processing ... voice activity signals and generating the control signals.” [3B] differs from [2B] because it recites processing “the accelerometer sensor voice activity signals” instead of “the GEMS voice activity signals.”

273. As discussed above in [2B], a POSITA would have understood that Holzrichter discloses a voice activity detector (VAD) algorithm for processing the GEMS voice activity signals and generating the control signals. *Supra*

§ IX.A.10.a.iii. A POSITA would have understood that Holzrichter’s voice activity detector (VAD) algorithm (Ex. 1007, 9:23-63) would have applied equally to processing Holzrichter’s or Stevens’s accelerometer sensor voice activity signals and generating control signals and this would have been obvious to a POSITA.

(a) Motivation and Expectation of Success

274. In my opinion, a POSITA would have been motivated to use Holzrichter's or Stevens's accelerometer in the Andrea-Hussain system and process those signals using a VAD algorithm and generate control signals to improve overall noise-cancellation performance and would have had a reasonable expectation of success doing so, as discussed in Section IX.B.2.b(a). A POSITA would have been further motivated to use the algorithm of Holzrichter to "process" Holzrichter's or Stevens's accelerometer sensor voice activity signals and generate the control signals to output to the noise-cancellation system.

275. In my opinion, a POSITA would have had a reasonable expectation of success in using Holzrichter's voice activity detector (VAD) algorithm (Ex. 1007, 9:23-63) to process Holzrichter's or Stevens's accelerometer sensor voice activity signals and generate control signals because the algorithm of Holzrichter would have performed in the same way that it did in processing Holzrichter's GEMS voice activity signals and generating control signals as discussed in [2B]. *Supra* § IX.A.10.a.iii(a).

C. Ground 3: Claim 4 Is Obvious over Andrea, Hussain, Holzrichter, and Alcivar

276. In my opinion, claim 4 would have been obvious to a POSITA based on Andrea, Hussain, Holzrichter, and Alcivar.

1. Overview of Alcivar

277. Alcivar discloses speech detection using a “tissue-conduction microphone” in “high noise environment voice communication systems.”

Ex. 1009, Abstract. “The tissue-conduction microphone is positioned in contact with the user’s neck tissue in the vicinity of the larynx” to detect “tissue vibrations due to modulation of the vocal chords [sic] (speech).” *Id.*, Abstract, 4:67-5:6.

Alcivar isolates the tissue-conduction microphone 54 from environmental noise with “a layer of sound absorbing material 56” to accurately detect speech occurrence, as shown below. *Id.*, 5:21-23.

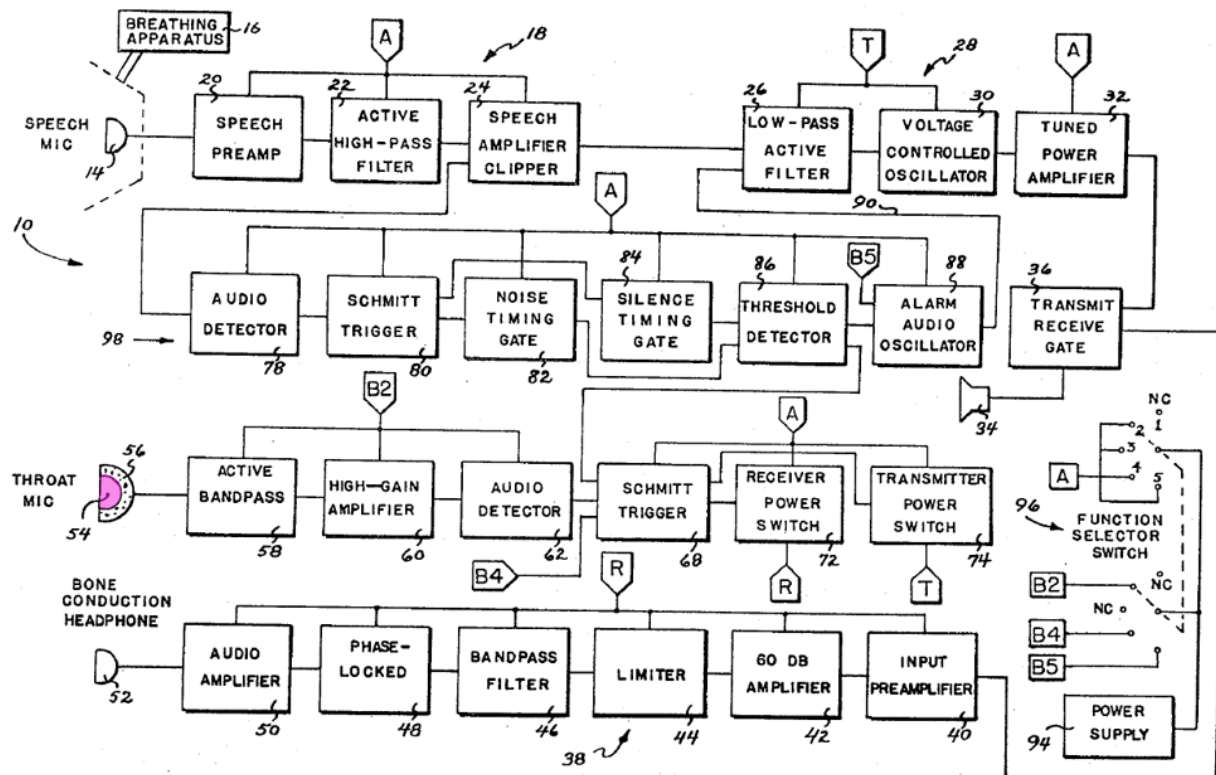


FIG. 1

Id., Fig. 1 (annotated).

278. Alcivar’s **tissue-conduction microphone** detects speech “at very favorable signal-to-noise ratios” to accurately determine when speech occurs, and acts as a VAD signal, to activate a transmitter power switch 74 to initiate voice communications. *Id.*, 5:8-12, 1:5-24, 4:45-59, 5:45-55, 6:1-11, 8:3-16.

2. Dependent Claim 4

a. [4P] “wherein the voice detection subsystem further comprises:”

279. It is my opinion that Andrea discloses, or Hussain and Holzrichter render obvious, the voice detection subsystem for the reasons discussed in Sections IX.A.4.b ([1A]) and IX.A.4.c ([1B]).

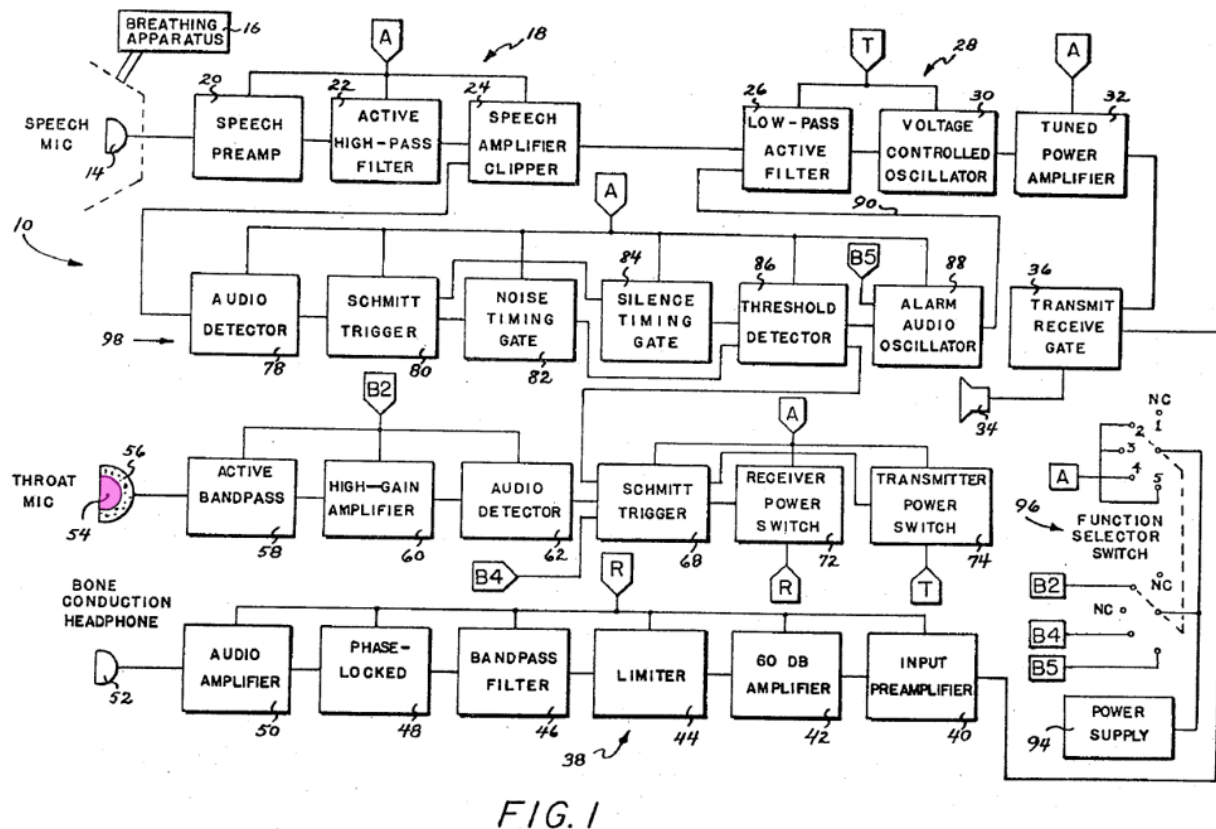
b. [4A] “at least one skin-surface microphone sensor in contact with skin for receiving the voice activity signals; and”

280. It is my opinion that Andrea, Hussain, and Alcivar render obvious [4A].

281. Alcivar discloses a **skin-surface microphone sensor (tissue-conduction microphone 54) in contact with skin (in contact with the user’s neck)** for receiving the voice activity signals (“tissue vibrations due to modulation of the vocal chords [sic] (speech)”). Ex. 1009, Abstract, 4:66-5:6, 5:16-17.

282. As shown below, Alcivar discloses a “**tissue-conduction microphone ... positioned in contact with the user’s neck tissue** in the vicinity of the larynx.”

Ex. 1009, 4:67-5:6; *see also id.*, 5:16-17 (“The tissue-conduction throat microphone 54 should be in good contact with the diver’s neck tissue.”).



Ex. 1009, Fig. 1 (annotated).

283. Alcivar’s tissue-conduction microphone 54 receives voice activity signals because it positioned to detect “the tissue vibrations due to modulation of the vocal chords [sic] (speech).” Ex. 1009, 4:67-5:6.

284. In my opinion, a POSITA would have found it obvious to incorporate Alcivar’s tissue-conduction microphone as Hussain’s VAD to improve noise-cancellation because Alcivar’s tissue-conduction microphone 54 is isolated from the surrounding environment and therefore efficient at detecting speech with

fewer errors. Ex. 1006, 10-13; Ex. 1009, 5:8-31. A POSITA would have looked to Alcivar's tissue-conduction microphone, which responds quickly and accurately to detect speech within "1 millisecond" from "the start of the word." Ex. 1009, 6:6-9.

(a) Motivation and Expectation of Success

285. As discussed above, Hussain assumes an effective VAD is available to perform noise cancellation. *Supra* §§ IX.A.4.b-IX.A.4.c ([1A]-[1B]); Ex. 1006, 11. In my opinion, a POSITA would have been motivated to use Alcivar's tissue-conduction microphone to improve overall noise-cancellation performance by improving the accuracy of the voice activity detection.

286. In my opinion, a POSITA would have been motivated to incorporate Alcivar's tissue-conduction throat microphone in Hussain's noise-cancellation system because it is an "effective" VAD to accurately and efficiently detect when the user is speaking to avoid speech-detection errors that could prevent the user from sending or receiving communications. Ex. 1009, 6:1-11, 8:3-16, 9:29-10:4.

287. In my opinion, a POSITA would have also recognized that Alcivar's tissue-conduction microphone would be advantageous for noise-cancellation processing because the tissue-conduction microphone improves performance in "high noise environment[s]" because it detects speech at "very favorable signal-to-noise ratios" such that it is "possible to discriminate against unwanted noises on the basis of amplitude alone, without having to resort to more elaborate

signal processing techniques.” Ex. 1009, 1:51-61, 5:8-12. Alcivar also discloses isolating the microphone from environmental noise and employs a bandpass filter “to eliminate high or low-frequency noises” that may accidentally be interpreted as speech. Ex. 1009, 5:21-44.

288. In my opinion, a POSITA would have reasonably expected to succeed in incorporating Alcivar’s tissue-conduction microphone as a VAD because this incorporation uses the same principles as Alcivar and represents the combination of known prior art elements implemented according to their known functions to yield predictable results. For example, I understand that the Examiner took “official notice” during prosecution, which I understand is the Patent Office notifying the applicant that a particular technique is conventional, that “it was known in the art at the time of invention to use ... skin microphones to generate voice signals.” Ex. 1002, 216; *see also id.*, 295 (“[E]xaminer takes official notice that it was well known in the art at the time of the invention to use ... skin microphones to generate voice signals.”).

c. [4B] “at least one voice activity detector (VAD) algorithm for processing the skin-surface microphone sensor voice activity signals and generating the control signals”

289. It is my opinion that Andrea, Hussain, and Holzrichter render obvious [4B].

290. [4B] is similar to [2B] in that both recite “at least one voice activity detector (VAD) algorithm for processing ... voice activity signals and generating the control signals.” [4B] differs from [2B] because it recites processing “the skin-surface microphone sensor voice activity signals” instead of “the GEMS voice activity signals.”

291. As discussed above in [2B], a POSITA would have understood that Holzrichter discloses a voice activity detector (VAD) algorithm for processing the GEMS voice activity signals and generating the control signals. *Supra*

§ IX.A.10.a.iii. A POSITA would have understood that Holzrichter’s voice activity detector (VAD) algorithm (Ex. 1007, 9:23-63) would have applied equally to processing Alcivar’s skin-surface microphone sensor voice activity signals and generating control signals, and this would have been obvious to a POSITA.

(a) Motivation and Expectation of Success

292. In my opinion, a POSITA would have been motivated to use Alcivar’s tissue-conduction microphone in the Andrea-Hussain system to improve overall noise-cancellation performance and would have had a reasonable expectation of success doing so for the reasons discussed in Section IX.C.2.b(a). A POSITA would have been further motivated to use the algorithm of Holzrichter to “process” Alcivar’s skin-surface microphone sensor voice activity signals and generate the control signals to output to the noise-cancellation system.

293. In my opinion, a POSITA would have had a reasonable expectation of success in using Holzrichter's voice activity detector (VAD) algorithm (Ex. 1007, 9:23-63) to process Alcivar's skin-surface microphone sensor voice activity signals and generate control signals because the algorithm of Holzrichter would have performed in the same way that it did in processing Holzrichter's GEMS voice activity signals and generating control signals.

X. CONCLUSION

294. For the reasons set forth in Section IX, it is also my opinion that one skilled in the art would have found claims 1-26 of the '543 patent obvious to a POSITA.

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

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

Respectfully submitted,

Date: May 21, 2022

By: _____

David V. Anderson

LISTING OF CHALLENGED CLAIMS

Claim Reference	Claim Language
Claim 1	
[1P]	A communications system, comprising:
[1A]	a voice detection subsystem configured to receive voice activity signals that includes information associated with human voicing activity,
[1B]	the voice detection subsystem configured to automatically generate control signals using the voice activity signals; and
[1C]	a denoising subsystem coupled to the voice detection subsystem, the denoising subsystem comprising a microphone array including a plurality of microphones,
[1D]	wherein a first microphone of the array is fixed at a first position relative to a mouth, wherein the first position orients a front of the first microphone towards the mouth,
[1E]	wherein a second microphone of the array is fixed at a second position relative to the mouth, wherein the second position orients a front of the second microphone away from the mouth such that the second position forms an angle relative to the first position, wherein the angle is greater than zero degrees,
[1F]	the microphone array providing acoustic signals of an environment to components of the denoising subsystem,
[1G]	components of the denoising subsystem automatically selecting at least one denoising method appropriate to data of at least one frequency subband of the acoustic signals using the control signals and processing the acoustic signals using the selected denoising method to generate denoised acoustic signals,
[1H]	wherein the denoising method includes generating a noise waveform estimate associated with noise of the acoustic signals and subtracting the noise waveform estimate from the acoustic signal when the acoustic signal includes speech and noise,

Claim Reference	Claim Language
[1I]	wherein the voice detection subsystem is configured to receive the voice activity signals using a sensor independent from the microphone array and to output the control signals generated from the voice activity signals to the denoising system, the denoising system configured to use the control signals to denoise the acoustic signals from the microphone array.
Claim 2	
[2P]	The system of claim 1, wherein the voice detection subsystem further comprises:
[2A]	at least one glottal electromagnetic micropower sensor (GEMS) including at least one antenna for receiving the voice activity signals; and
[2B]	at least one voice activity detector (VAD) algorithm for processing the GEMS voice activity signals and generating the control signals.
Claim 3	
[3P]	The system of claim 1, wherein the voice detection subsystem further comprises:
[3A]	at least one accelerometer sensor in contact with skin for receiving the voice activity signals; and
[3B]	at least one voice activity detector (VAD) algorithm for processing the accelerometer sensor voice activity signals and generating the control signals.
Claim 4	
[4P]	The system of claim 1, wherein the voice detection subsystem further comprises:
[4A]	at least one skin-surface microphone sensor in contact with skin for receiving the voice activity signals; and
[4B]	at least one voice activity detector (VAD) algorithm for processing the skin-surface microphone sensor voice activity signals and generating the control signals.

Claim Reference	Claim Language
Claim 5	The system of claim 1, wherein the voice detection subsystem further comprises at least one manually activated voice activity detector (VAD) for generating the voice activity signals.
Claim 6	The system of claim 1, further including a portable handset that includes the microphones, wherein the portable handset includes at least one of cellular telephones, satellite telephones, portable telephones, wireline telephones, Internet telephones, wireless transceivers, wireless communication radios, personal digital assistants (PDAs), and personal computers (PCs).
Claim 7	The system of claim 6, wherein the portable handset includes at least one of the voice detection subsystem and the denoising subsystem.
Claim 8	The system of claim 1, further including a portable headset that includes the microphones along with at least one speaker device.
Claim 9	The system of claim 8, wherein the portable headset couples to at least one communication device selected from among cellular telephones, satellite telephones, portable telephones, wireline telephones, Internet telephones, wireless transceivers, wireless communication radios, personal digital assistants (PDAs), and personal computers (PCs).
Claim 10	The system of claim 9, wherein the portable headset couples to the communication device using at least one of wireless couplings, wired couplings, and combination wireless and wired couplings.
Claim 11	The system of claim 9, wherein the communication device includes at least one of the voice detection subsystem and the denoising subsystem.

Claim Reference	Claim Language
Claim 12	The system of claim 8, wherein the portable headset includes at least one of the voice detection subsystem and the denoising subsystem.
Claim 13	The system of claim 8, wherein the portable headset is a portable communication device selected from among cellular telephones, satellite telephones, portable telephones, wireline telephones, Internet telephones, wireless transceivers, wireless communication radios, personal digital assistants (PDAs), and personal computers (PCs).
Claim 14	The system of claim 1, wherein the first microphone is a unidirectional microphone and the second microphone is a unidirectional microphone.
Claim 15	The system of claim 14, wherein the first microphone and the second microphone are separated by a distance in a range of approximately zero (0) centimeters to 15 centimeters.
Claim 16	The system of claim 14, wherein the angle is in a range of approximately greater than zero (0) degrees and one of equal to and less than 180 degrees.
Claim 17	The system of claim 14, wherein the angle is in a range of approximately greater than zero (0) degrees and one of equal to and less than 135 degrees.
Claim 18	The system of claim 14, wherein the angle is in a range of approximately greater than zero (0) degrees and one of equal to and greater than 90 degrees.
Claim 19	The system of claim 1, wherein the first microphone is an omnidirectional microphone and the second microphone is a unidirectional microphone.

Claim Reference	Claim Language
Claim 20	The system of claim 19, wherein the first microphone and the second microphone are separated by a distance approximately in a range of zero (0) centimeters to 15 centimeters.
Claim 21	The system of claim 19, wherein the angle is approximately in a range of 30 degrees to 180 degrees.
Claim 22	The system of claim 19, wherein the angle is approximately in a range of 60 degrees to 180 degrees.
Claim 23	The system of claim 19, wherein the angle is approximately in a range of 90 degrees to 180 degrees.
Claim 24	The system of claim 1, wherein the first microphone is a unidirectional microphone and the second microphone is an omnidirectional microphone.
Claim 25	The system of claim 24, wherein the first microphone and the second microphone are separated by a distance approximately in a range of zero (0) centimeters to 15 centimeters.
Claim 26	
[26P]	A communications system, comprising:
[26A]	a voice detection subsystem configured to receive voice activity signals that include information associated with human voicing activity,
[26B]	the voice detection subsystem configured to automatically generate control signals using the voice activity signals;
[26C]	a denoising subsystem coupled to the voice detection subsystem, the denoising subsystem comprising a microphone array including a plurality of microphones,
[26D]	wherein a first microphone of the array is fixed at a first position relative to a mouth, wherein the first position orients a front of the first microphone towards the mouth,

Claim Reference	Claim Language
[26E]	wherein a second microphone of the array is fixed at a second position relative to the mouth, wherein the second position orients a front of the second microphone away from the mouth such that the second position forms an angle relative to the first position, wherein the angle is greater than zero degrees,
[26F]	the microphone array providing acoustic signals of an environment to components of the denoising subsystem,
[26G]	components of the denoising subsystem automatically selecting at least one denoising method appropriate to data of at least one frequency subband of the acoustic signals using the control signals and processing the acoustic signals using the selected denoising method to generate denoised acoustic signals,
[26H]	wherein the denoising method includes generating a noise waveform estimate associated with noise of the acoustic signals and subtracting the noise waveform estimate from the acoustic signal when the acoustic signal includes speech and noise,
[26I]	wherein the voice detection subsystem is configured to receive the voice activity signals using a sensor independent from the microphone array and to output the control signals generated from the voice activity signals to the denoising system, the denoising system configured to use the control signals to denoise the acoustic signals from the microphone array; and
[26J]	a portable headset comprising the plurality of microphones and at least one speaker device,
[26K]	wherein the portable headset couples to at least one communication device selected from among cellular telephones, satellite telephones, portable telephones, wireline telephones, Internet telephones, wireless transceivers, wireless communication radios, personal digital assistants (PDAs), personal computers (PCs), and at least one of the voice detection subsystem and the denoising subsystem.