



US008942387B2

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

(10) **Patent No.:** **US 8,942,387 B2**
(45) **Date of Patent:** **Jan. 27, 2015**

(54) **NOISE-REDUCING DIRECTIONAL MICROPHONE ARRAY**

2410/07 (2013.01); H04R 2430/20 (2013.01);
H04R 2430/21 (2013.01); H04R 2430/23
(2013.01)

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USPC **381/94.2**; 381/94.1; 381/92
(58) **Field of Classification Search**
USPC 381/94.1, 94.2, 92.3, 92, 56
See application file for complete search history.

(73) Assignee: **MH Acoustics LLC**, Summit, NJ (US)

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1194 days.

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(21) Appl. No.: **12/281,447**

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(22) PCT Filed: **Mar. 9, 2007**

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(86) PCT No.: **PCT/US2007/006093**

§ 371 (c)(1),
(2), (4) Date: **Sep. 2, 2008**

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(87) PCT Pub. No.: **WO2007/106399**

PCT Pub. Date: **Sep. 20, 2007**

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(65) **Prior Publication Data**

US 2009/0175466 A1 Jul. 9, 2009

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Assistant Examiner — Kile Blair

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Related U.S. Application Data

(63) Continuation-in-part of application No. PCT/US2006/044427, filed on Nov. 15, 2006, and a continuation-in-part of application No. 10/193,825, filed on Jul. 12, 2002, now Pat. No. 7,171,008.

(Continued)

(57) **ABSTRACT**

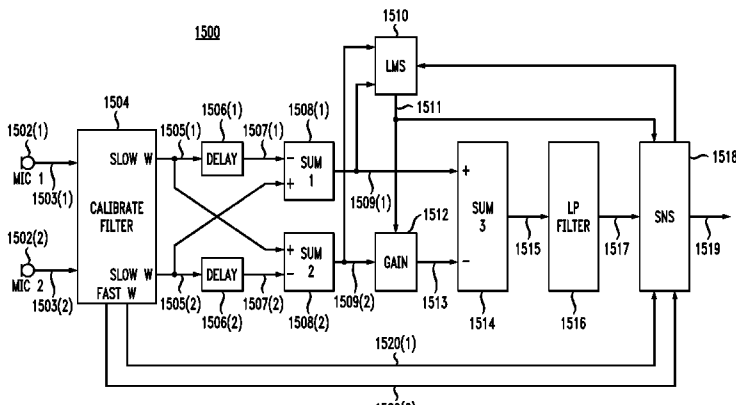
In one embodiment, a directional microphone array having (at least) two microphones generates forward and backward cardioid signals from two (e.g., omnidirectional) microphone signals. An adaptation factor is applied to the backward cardioid signal, and the resulting adjusted backward cardioid signal is subtracted from the forward cardioid signal to generate a (first-order) output audio signal corresponding to a beampattern having no nulls for negative values of the adaptation factor. After low-pass filtering, spatial noise suppression can be applied to the output audio signal. Microphone arrays having one (or more) additional microphones can be designed to generate second- (or higher-) order output audio signals.

(51) **Int. Cl.**
H04B 15/00 (2006.01)
H04R 3/00 (2006.01)

(Continued)

55 Claims, 15 Drawing Sheets

(52) **U.S. Cl.**
CPC **H04R 3/005** (2013.01); **H04R 25/407** (2013.01); **G10L 2021/02166** (2013.01); **H04R**



Related U.S. Application Data

(60) Provisional application No. 60/781,250, filed on Mar. 10, 2006, provisional application No. 60/737,577, filed on Nov. 17, 2005, provisional application No. 60/354,650, filed on Feb. 5, 2002.

(51) **Int. Cl.**
H04R 25/00 (2006.01)
G10L 21/0216 (2013.01)

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FIG. 1

100

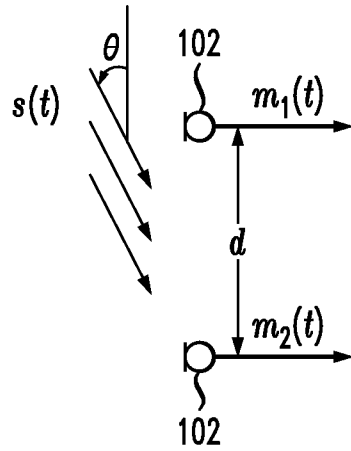


FIG. 2

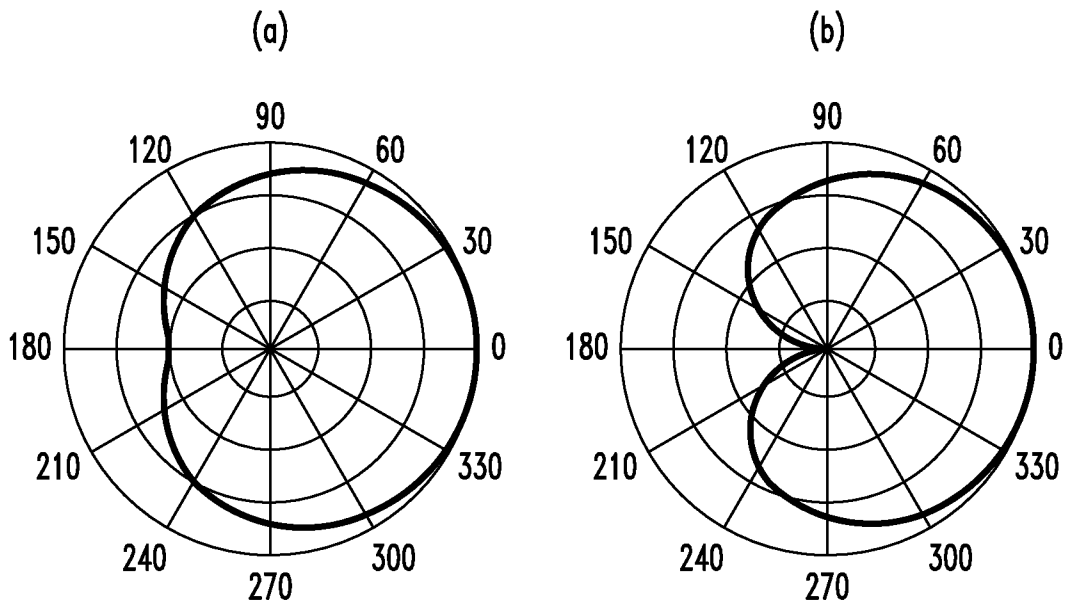


FIG. 3

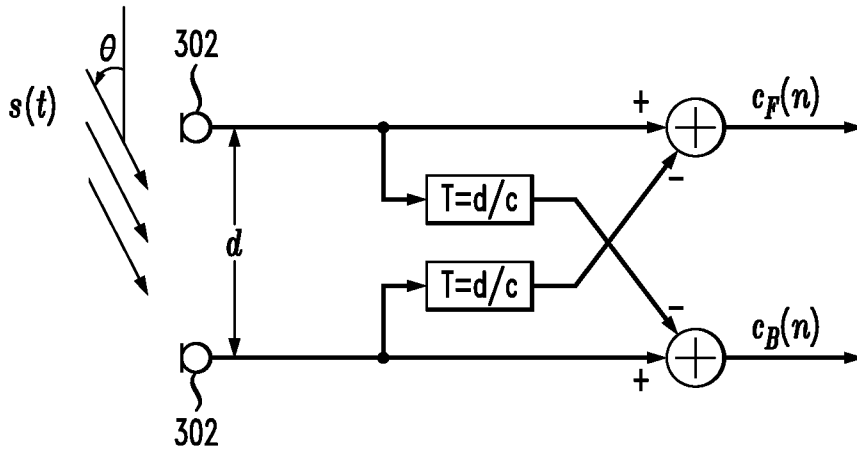


FIG. 4

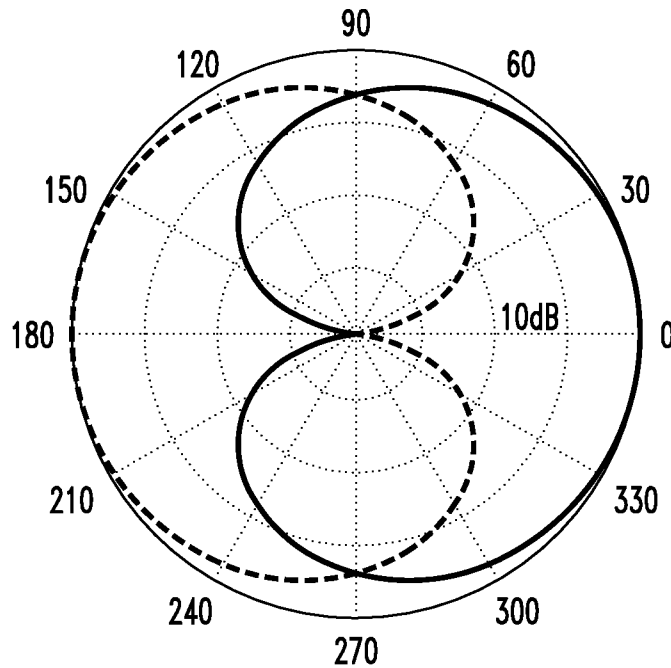


FIG. 5

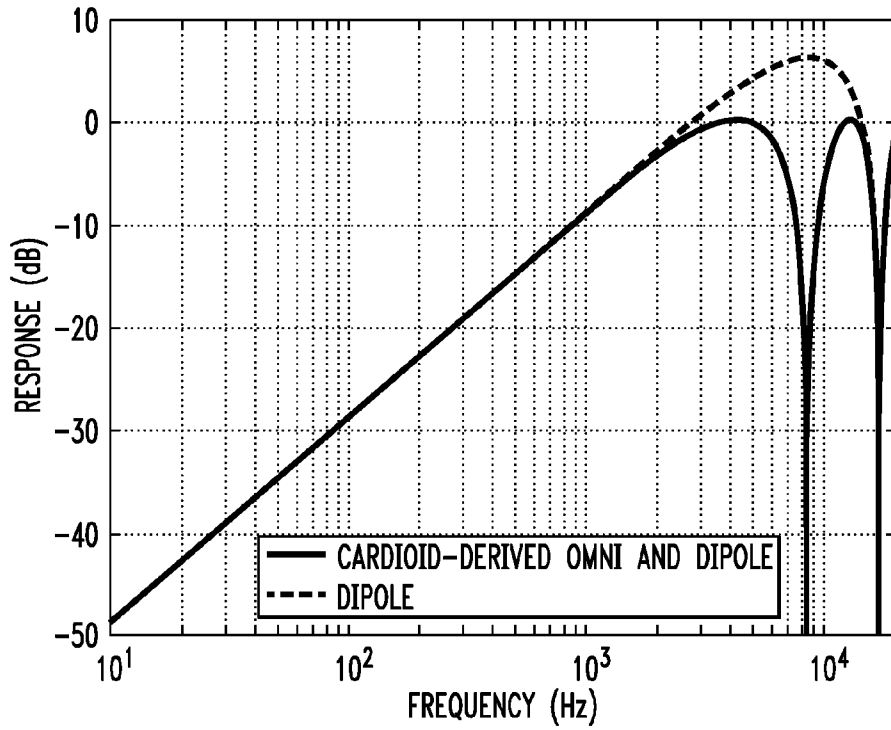
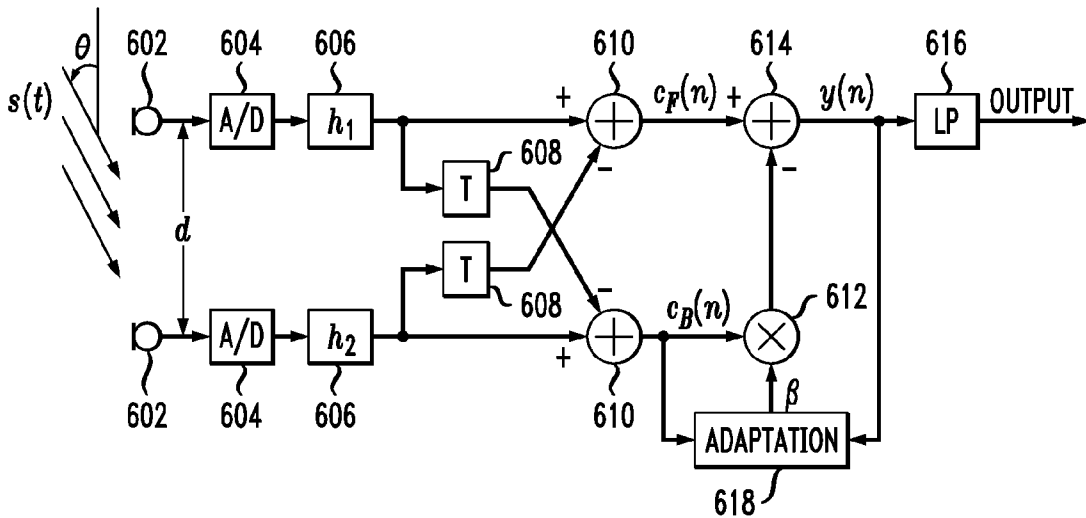


FIG. 6

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