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(12) **United States Patent**  
**Burnett**

(10) **Patent No.:** **US 11,122,357 B2**  
(45) **Date of Patent:** **\*Sep. 14, 2021**

(54) **FORMING VIRTUAL MICROPHONE ARRAYS USING DUAL OMNIDIRECTIONAL MICROPHONE ARRAY (DOMA)**

(58) **Field of Classification Search**  
CPC .... H04R 3/005; H04R 2410/05; H04R 3/002;  
H04R 3/04; H04R 1/1091; H04R 1/406;  
(Continued)

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(73) Assignee: **Jawbone Innovations, LLC**, Marshall, TX (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 0 days.

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This patent is subject to a terminal disclaimer.

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(21) Appl. No.: **13/959,708**

Weiss, Howard; Office Action mailed by U.S. Patent and Trademark Office dated Apr. 10, 2012 for U.S. Appl. No. 12/139,333.  
(Continued)

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*Primary Examiner* — Marcos D. Pizarro

(65) **Prior Publication Data**  
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(74) *Attorney, Agent, or Firm* — Nutter McClennen & Fish LLP

**Related U.S. Application Data**

(57) **ABSTRACT**

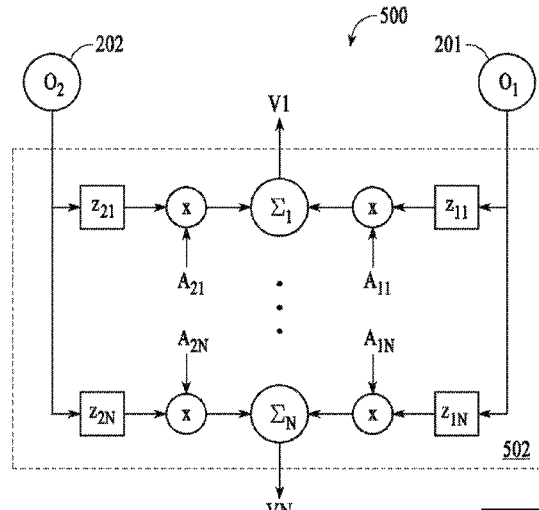
(63) Continuation of application No. 12/139,333, filed on Jun. 13, 2008, now Pat. No. 8,503,691.  
(Continued)

A dual omnidirectional microphone array noise suppression is described. Compared to conventional arrays and algorithms, which seek to reduce noise by nulling out noise sources, the array of an embodiment is used to form two distinct virtual directional microphones which are configured to have very similar noise responses and very dissimilar speech responses. The only null formed is one used to remove the speech of the user from  $V_2$ . The two virtual microphones may be paired with an adaptive filter algorithm and VAD algorithm to significantly reduce the noise without distorting the speech, significantly improving the SNR of the desired speech over conventional noise suppression systems.

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

(52) **U.S. Cl.**  
CPC ..... **H04R 1/1091** (2013.01); **G10L 21/0208** (2013.01); **H04R 1/406** (2013.01);  
(Continued)

**20 Claims, 17 Drawing Sheets**



**Related U.S. Application Data**

(60) Provisional application No. 60/934,551, filed on Jun. 13, 2007, provisional application No. 60/953,444, filed on Aug. 1, 2007, provisional application No. 60/954,712, filed on Aug. 8, 2007, provisional application No. 61/045,377, filed on Apr. 16, 2008.

(51) **Int. Cl.**

**G10L 21/0208** (2013.01)  
**H04R 1/40** (2006.01)  
**H04R 3/04** (2006.01)  
**G10L 21/0216** (2013.01)

(52) **U.S. Cl.**

CPC ..... **H04R 3/002** (2013.01); **H04R 3/005** (2013.01); **H04R 3/04** (2013.01); **G10L 2021/02165** (2013.01); **H04R 2460/01** (2013.01)

(58) **Field of Classification Search**

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 USPC ..... 381/92, 94.7; 704/233, E21.004  
 See application file for complete search history.

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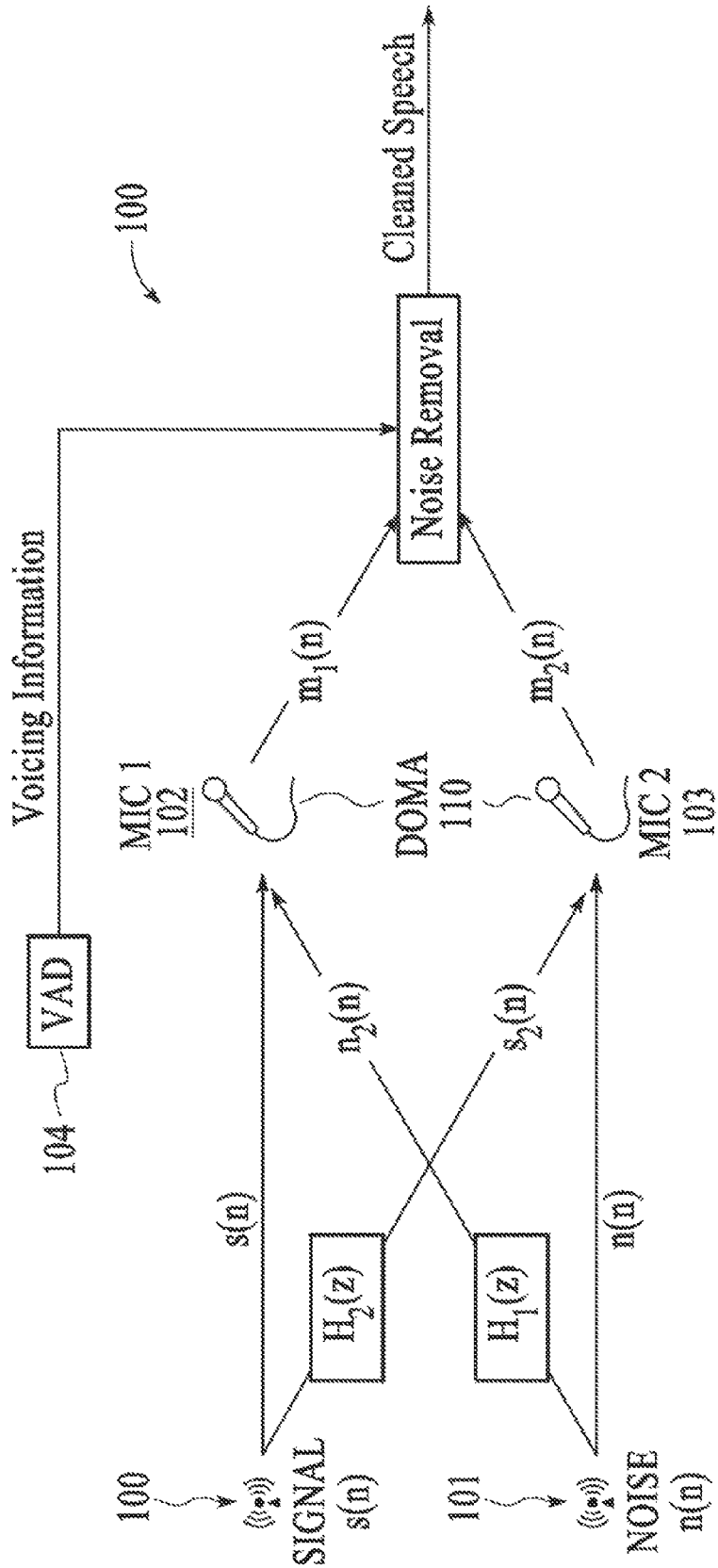


FIG. 1

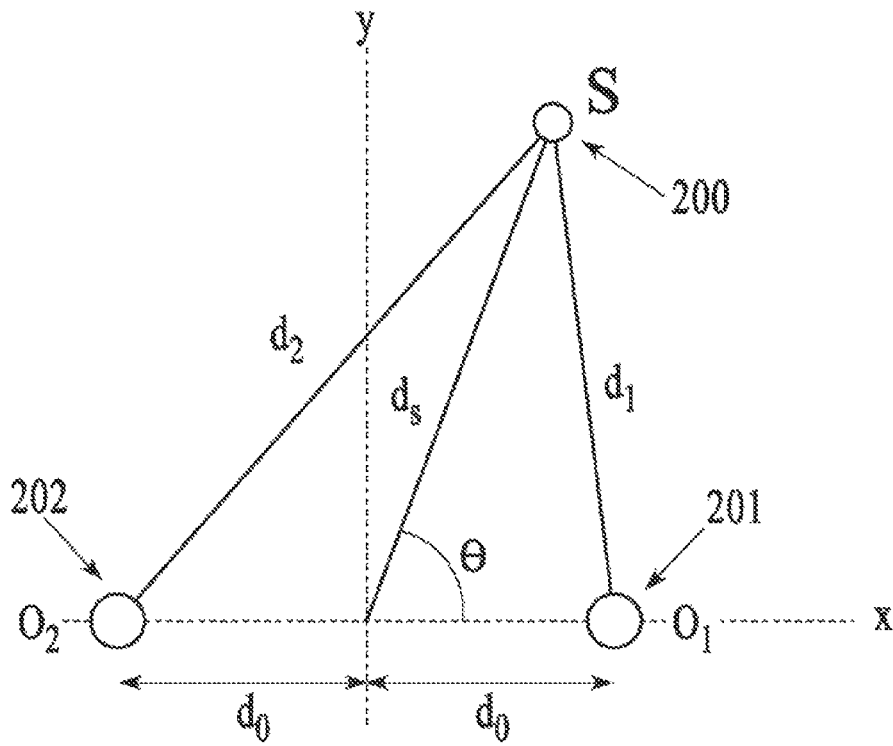


FIG.2

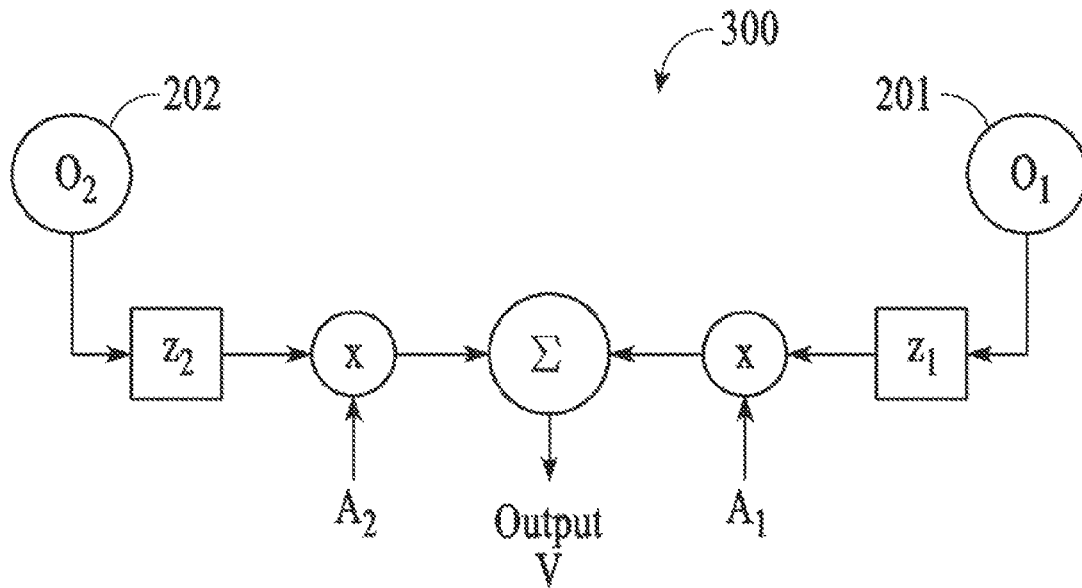


FIG.3

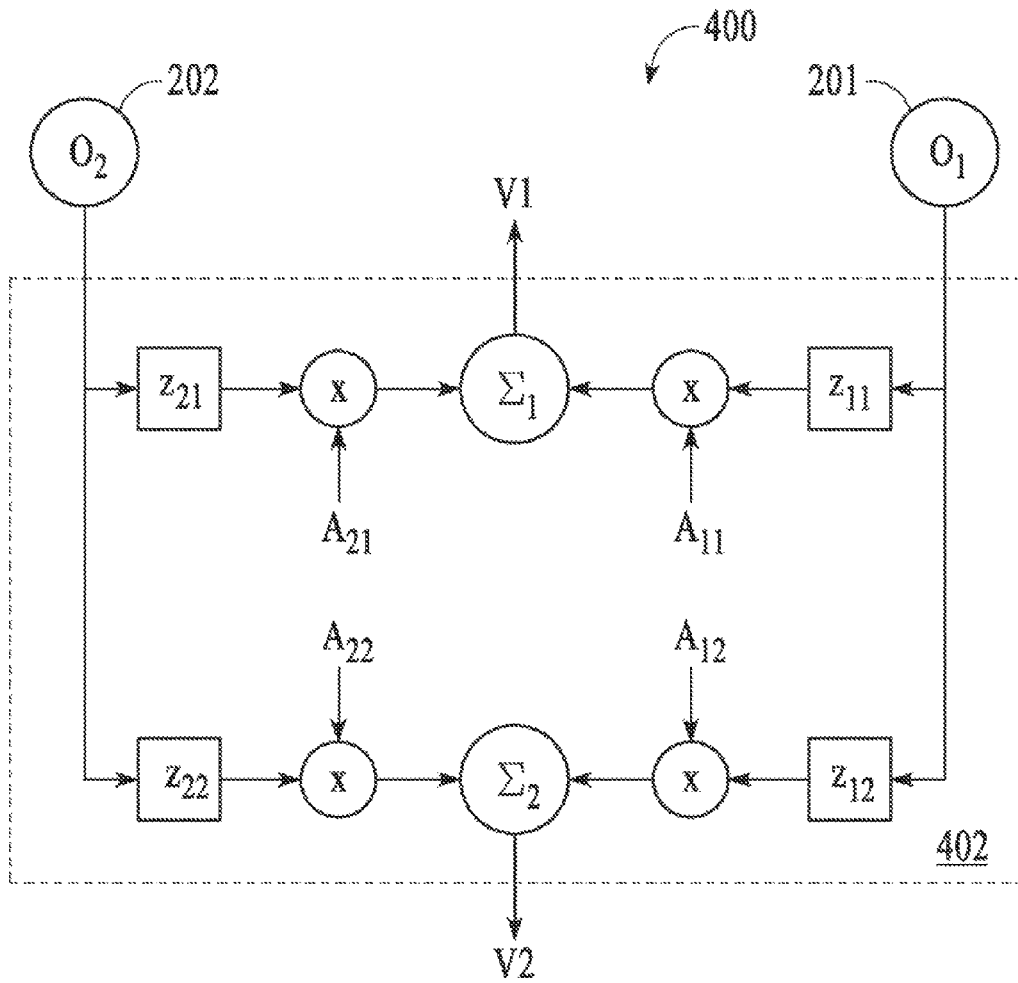


FIG.4

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