US005473701A

United States Patent [19]

Cezanne et al.

[11] **Patent Number: 5,473,701**

[45] **Date of Patent: Dec. 5, 1995**

[54] **ADAPTIVE MICROPHONE ARRAY**

[75] Inventors: **Juergen Cezanne**, New Providence; **Gary W. Elko**, Summit, both of N.J.

[73] Assignee: **AT&T Corp.**, Murray Hill, N.J.

[21] Appl. No.: **148,750**

[22] Filed: **Nov. 5, 1993**

[51] **Int. Cl.**[6] **H04R 3/00**

[52] **U.S. Cl.** **381/92**; 381/94

[58] **Field of Search** 381/92, 94; 367/121, 367/123, 125

[56] **References Cited**

U.S. PATENT DOCUMENTS

4,485,484	11/1984	Flanagan	381/92
4,536,887	8/1985	Kaneda et al.	381/92
4,653,102	3/1987	Hansen	381/94
4,802,227	1/1989	Elko et al.	381/94
4,956,867	9/1990	Zurek et al.	381/94.1
5,267,320	11/1993	Fukumizu	381/94

OTHER PUBLICATIONS

European Search Report dated Feb. 21, 1995, corresponding European Patent Application 94307855.0.

L. J. Griffiths et al., "An Alternative Approach to Linearly Constrained Adaptive Beamforming," *IEEE Trans. Antennas Propag.*, vol. AP–30, 27–34 (Jan. 1982).

O. L. Frost III, "An Algorithm for Linearly Constrained Adaptive Array Processing," *Proc. IEEE*, vol. 60, 926–935 (Aug. 1972).

L. J. Griffiths, "A Simple Adaptive Algorithm for Real–Time Processing in Antenna Arrays," *Proc. IEEE*, vol. 57, 1696–1704 (Oct. 1969).

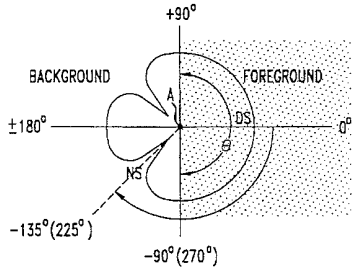
Primary Examiner—Stephen Brinich

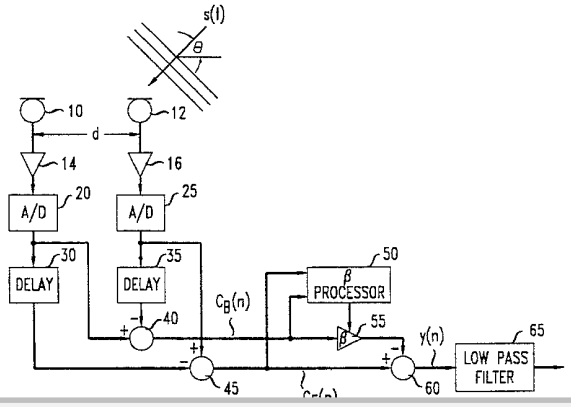
Attorney, Agent, or Firm—Thomas A. Restaino

[57] **ABSTRACT**

The present invention is directed to a method of apparatus of enhancing the signal-to-noise ratio of a microphone array. The array includes a plurality of microphones and has a directivity pattern which is adjustable based on one or more parameters. The parameters are evaluated so as to realize an angular orientation of a directivity pattern null. This angular orientation of the directivity pattern null reduces microphone array output signal level. Parameter evaluation is performed under a constraint that the null be located within a predetermined region of space. Advantageously, the predetermined region of space is a region from which undesired acoustic energy is expected to impinge upon the array, and the angular orientation of a directivity pattern null substantially aligns with the angular orientation of undesired acoustic energy. Output signals of the array microphones are modified based on one or more evaluated parameters. An array output signal is formed based on modified and unmodified microphone output signals. The evaluation of parameters, the modification of output signals, and the formation of an array output signal may be performed a plurality of times to obtain an adaptive army response. Embodiments of the invention include those having a plurality of directivity patterns corresponding to a plurality of frequency subbands. Illustratively, the array may comprise a plurality of cardioid sensors.

23 Claims, 6 Drawing Sheets





DOCKET ALARM

Find authenticated court documents without watermarks at docketalarm.com.

FIG. 1a

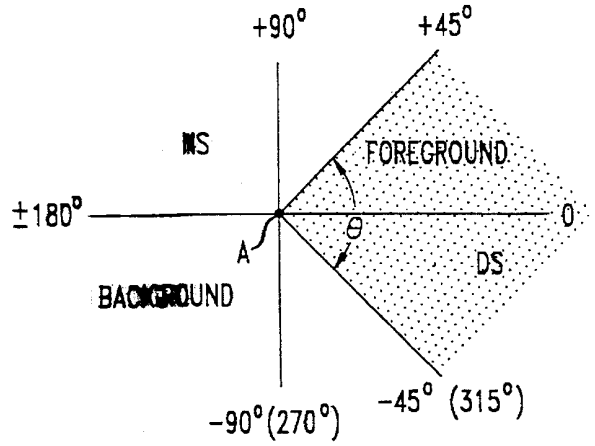


FIG. 1b

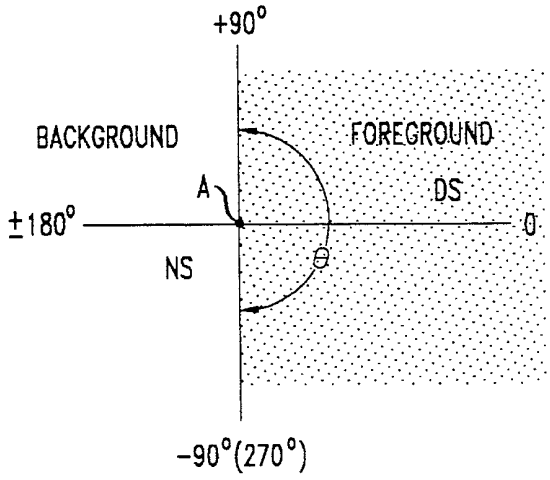
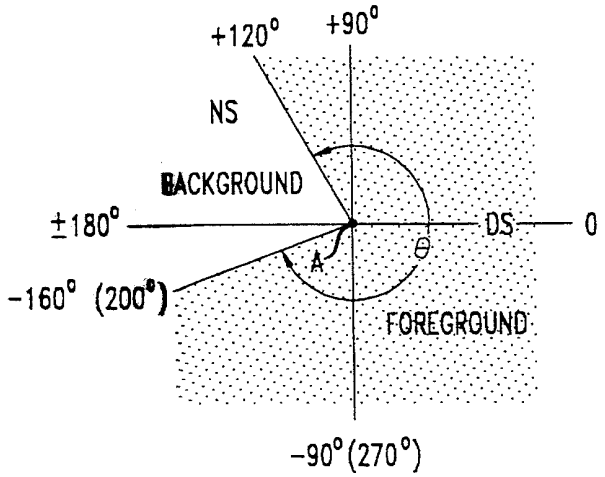


FIG. 1c



DOCKET ALARM Find authenticated court documents without watermarks at docketalarm.com.

FIG. 2

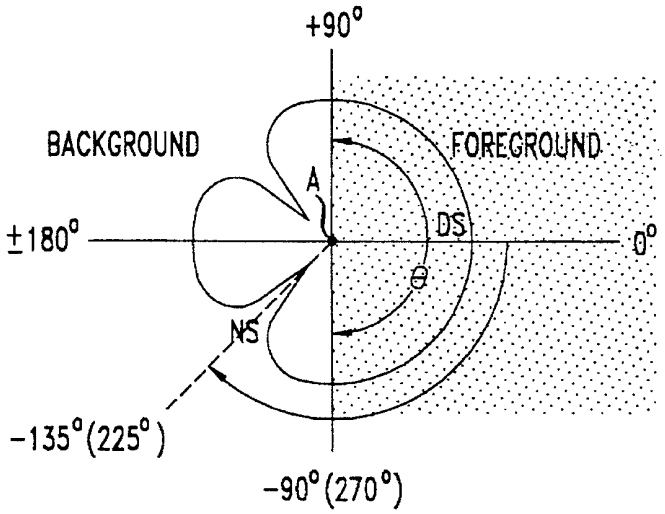
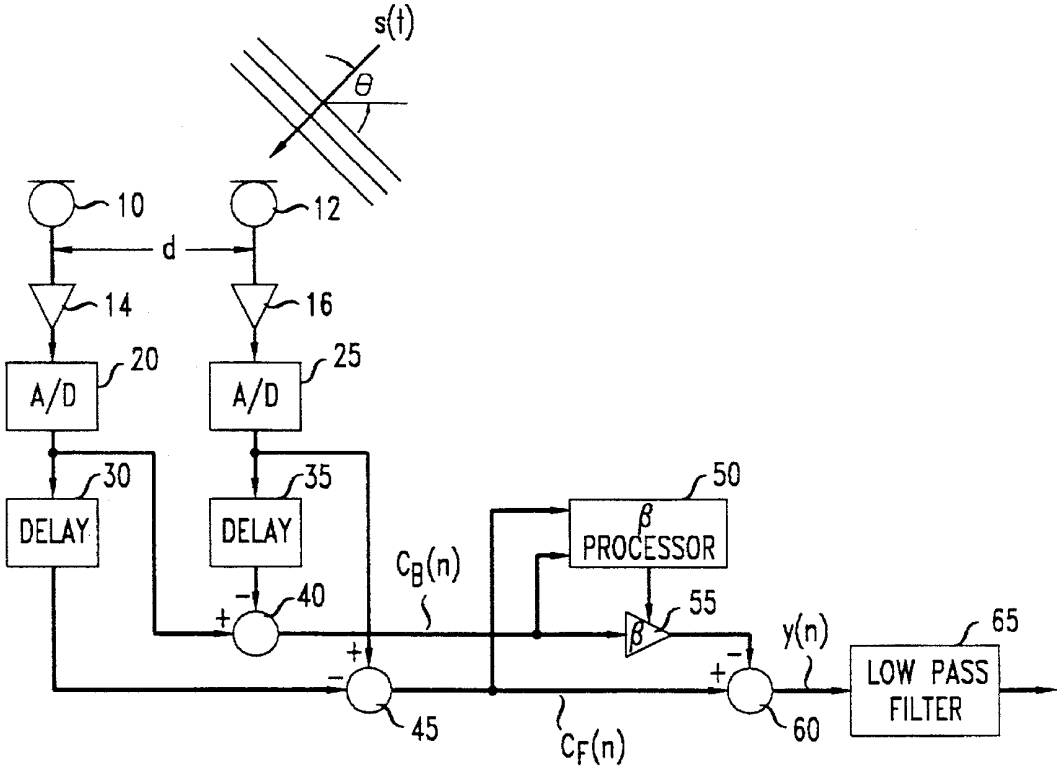


FIG. 3



DOCKET ALARM Find authenticated court documents without watermarks at docketalarm.com.

FIG. 4

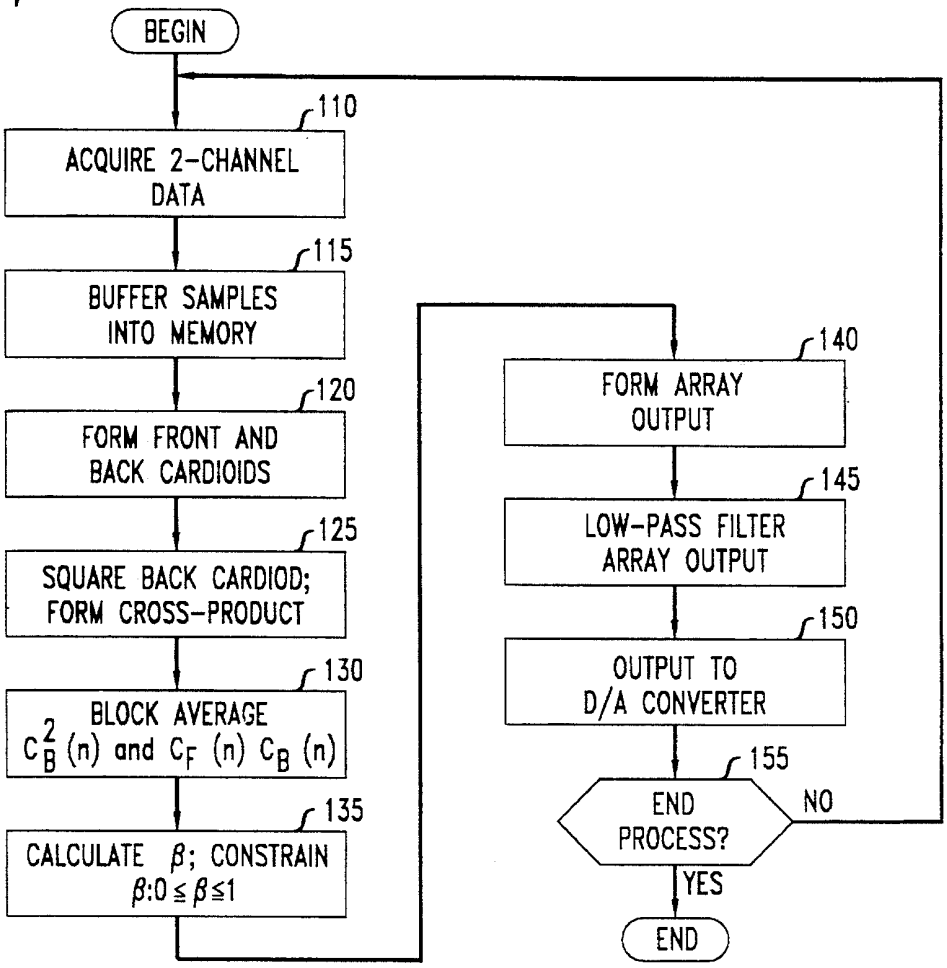
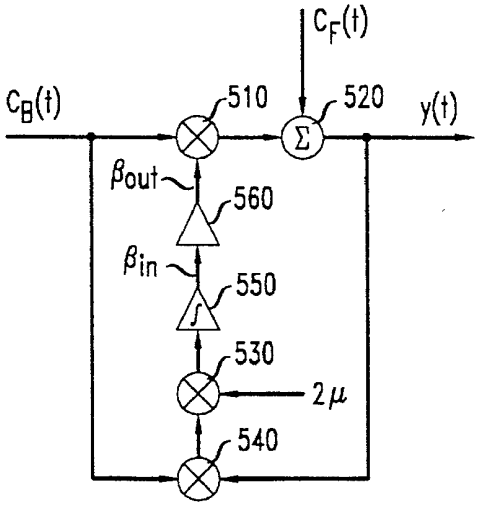


FIG. 5



DOCKET ALARM
Find authenticated court documents without watermarks at docketalarm.com.

FIG. 6a

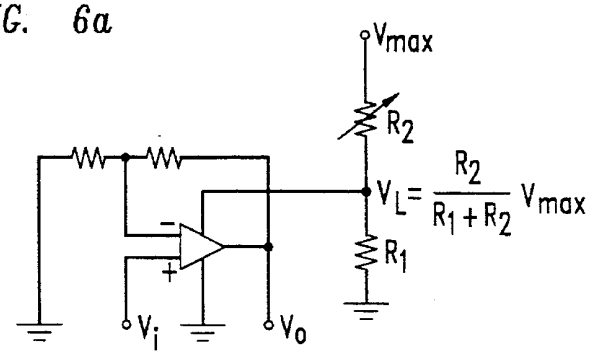


FIG. 6b

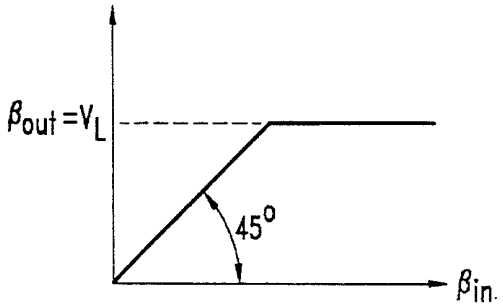
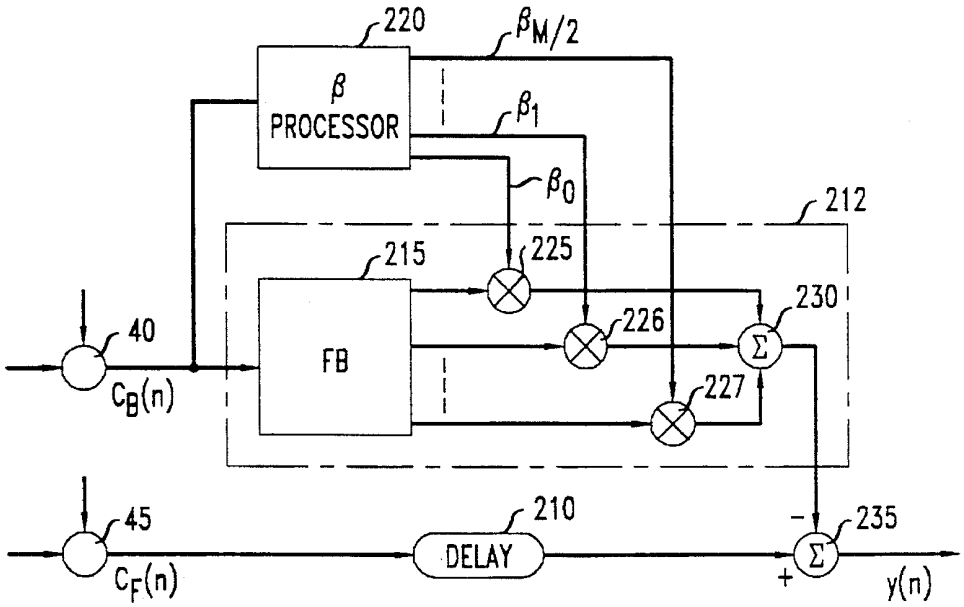


FIG. 7



DOCKET ALARM Find authenticated court documents without watermarks at docketalarm.com.

DOCKET ALARM

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts

Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research

With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips

Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS
Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS
Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS
Sync your system to PACER to automate legal marketing.