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

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(45) **Date of Patent:** Dec. 30, 2003

(54) **APPARATUS AND METHOD FOR ELECTRONICALLY PREDICTING PLEURAL PRESSURE FROM PULSE WAVE SIGNALS**

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(73) Assignees: **Denso Corporation**, Kariya (JP); **Toshiaki Shiomi**, Nagoya (JP)

Argod et al. "Comparison of Esophageal Pressure with Pulse Transit Time as a Measure of Respiratory Effort for Scoring Obstructive Nonapneic Respiratory Events", American Journal of Respiratory and Critical Care Medicine 2000; 162:87-93.\*

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 84 days.

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(21) Appl. No.: **10/101,835**

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(22) Filed: **Mar. 21, 2002**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

(57) **ABSTRACT**

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A pleural pressure is predicted from pleural pressure based upon pulse wave signals, which are continuously produced and picked up in a time sequential manner. A first variation signal indicative of a condition of a variation contained in the pulse wave signals is acquired based upon the pulse wave signals. A second variation signal representative of a condition of a variation contained in the first variation signal is acquired based upon the first variation signal. The pleural pressure is predicted based on a difference between the first variation signal and the second variation signal.

(51) **Int. Cl.**<sup>7</sup> ..... **A61B 5/02**

(52) **U.S. Cl.** ..... **600/300; 600/500; 600/529; 600/561**

(58) **Field of Search** ..... 600/300, 485, 600/500-507, 529-543, 561

(56) **References Cited**

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**26 Claims, 9 Drawing Sheets**

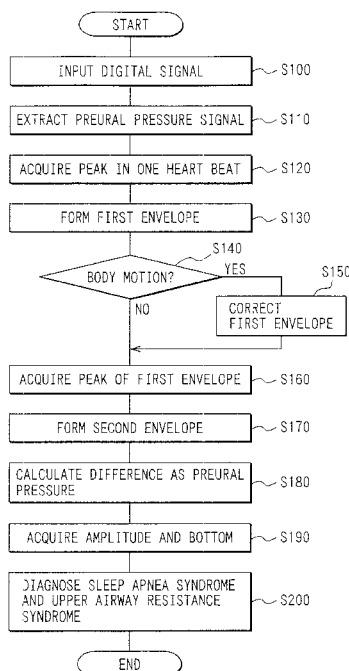


FIG. 1B

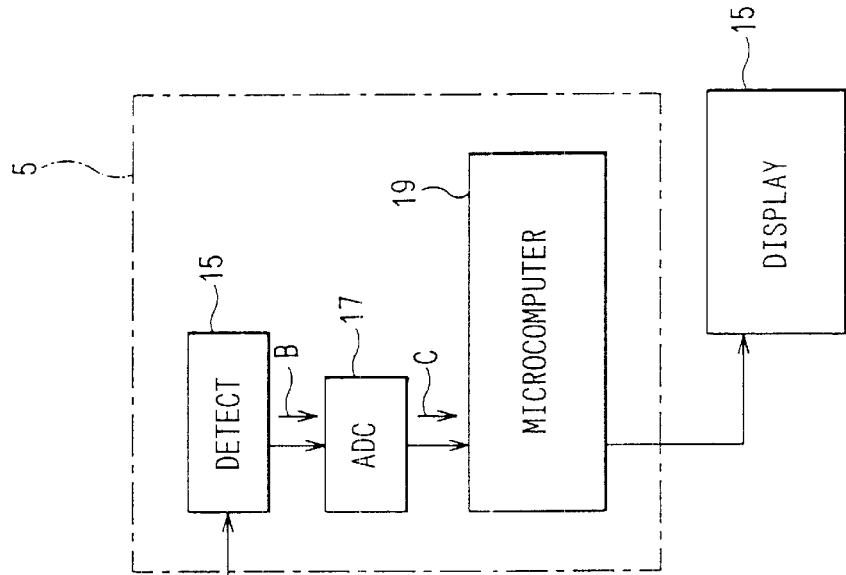


FIG. 1A

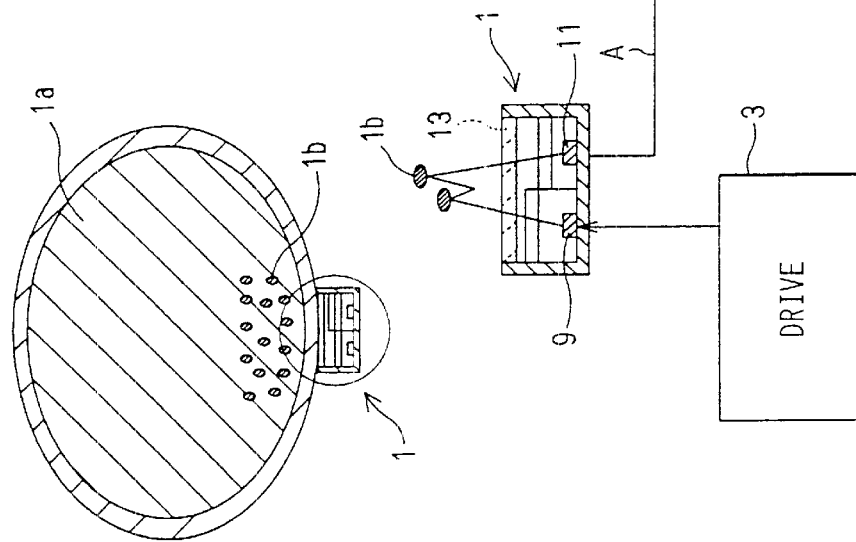


FIG. 2

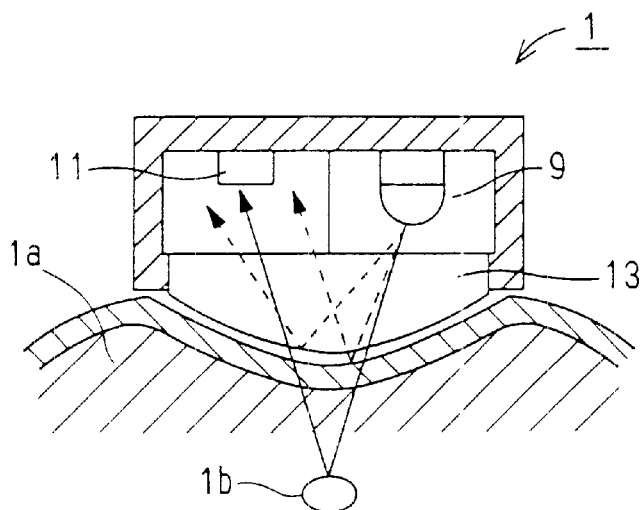


FIG. 3

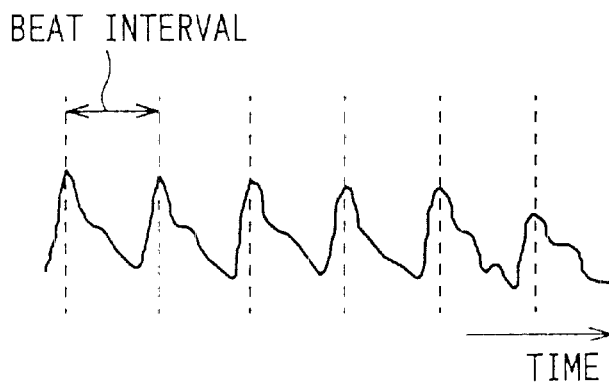


FIG. 4

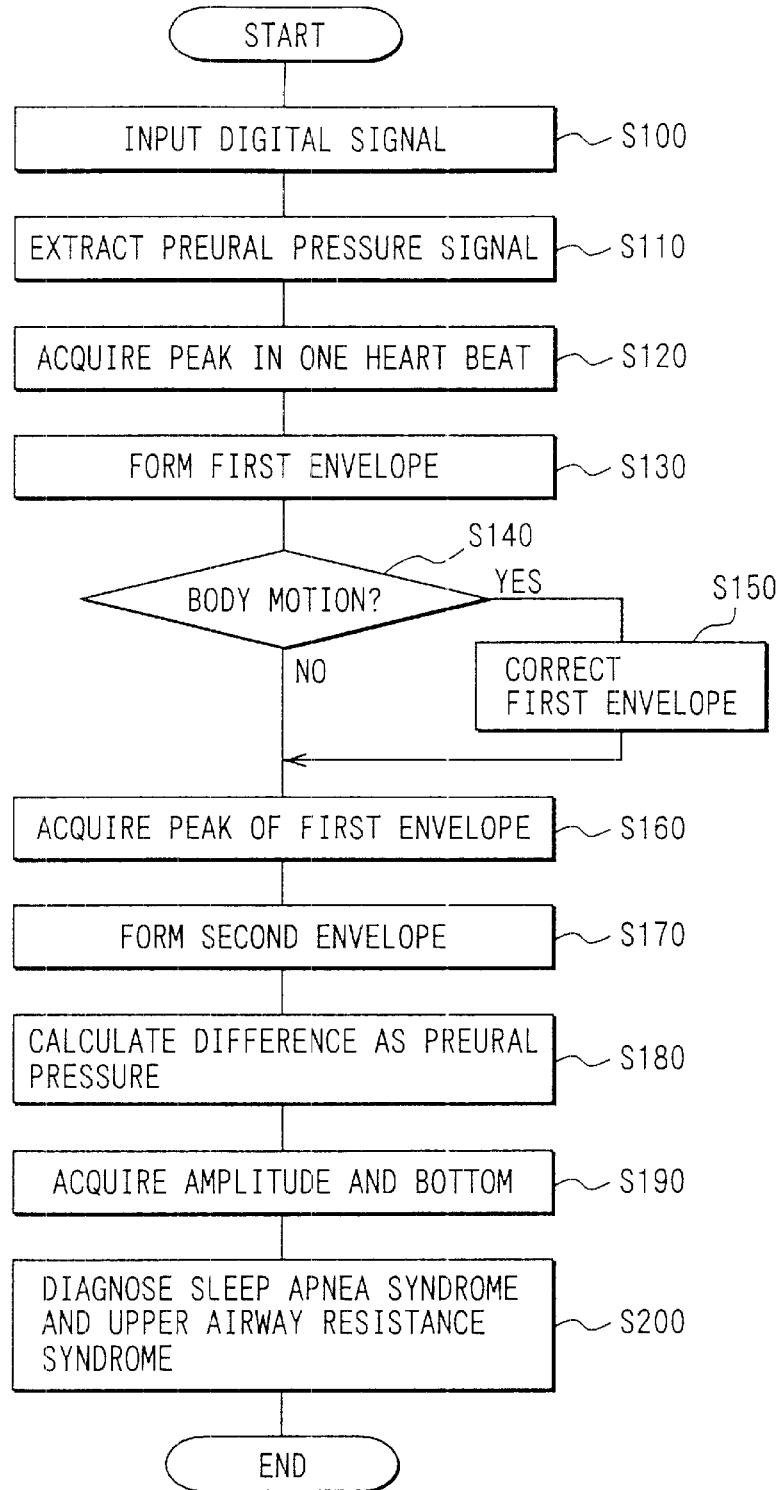
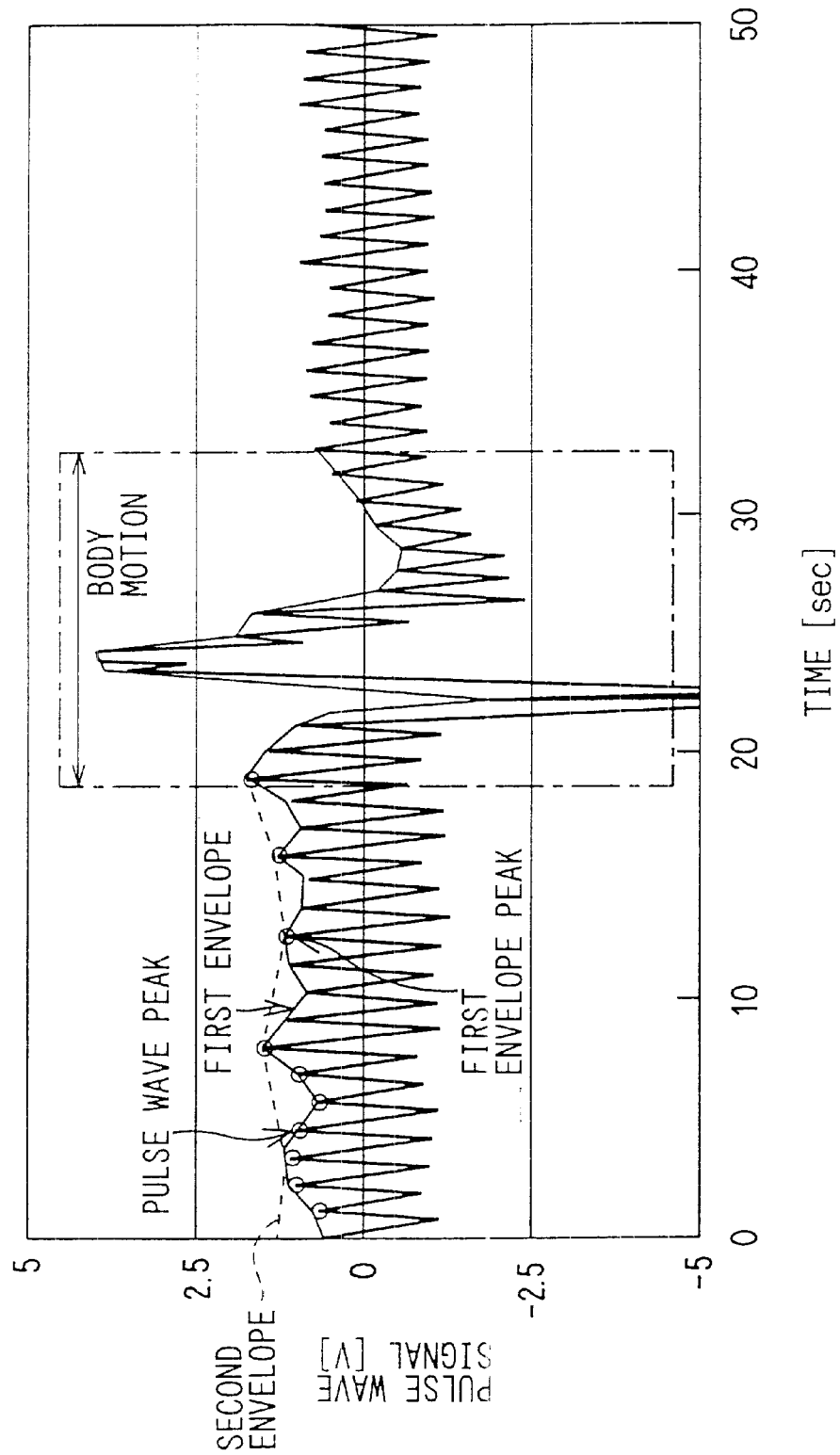


FIG. 5



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