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- [54] **APPARATUS AND METHOD OF STIMULATING BREATHING SOUNDS**
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Related U.S. Application Data

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- [52] U.S. Cl. **434/266; 434/262**
- [58] Field of Search **434/262, 265, 434/266, 267**

[56] References Cited

U.S. PATENT DOCUMENTS

3,520,071	7/1970	Abrahamson et al.	
3,564,729	2/1971	Ackerman	434/266
3,661,052	5/1972	Lucien et al.	
3,808,706	5/1974	Mosley et al.	
3,849,909	11/1974	Ravin	434/266
4,167,070	9/1979	Orden	
4,561,851	12/1985	Ferreira et al.	
4,570,640	2/1986	Barsa	
4,878,388	11/1989	Loughlin et al.	
4,907,973	3/1990	Hon	
5,403,192	4/1995	Kleinwaks et al.	

OTHER PUBLICATIONS

M.L. Good, M.D., and J. S. Gravenstein, M.D., *Anesthesia Simulators and Training Device*, International Anesthesiology Clinics 27:161-164 (1989).

Good, et al., *Hybrid Lung Model for Use in Anesthesia Research and Education*, *Anesthesiology*, Hybrid Lung Model for Use in Anesthesia Research and Education, 71:982-984 (1989).

D.M. Gaba, M.D. and A. DeAnda, *A Comprehensive Anesthesia Simulation Environment: Re-creating the Operating Room for Research and Training*, *Anesthesiology*, 69:387-389 (1988).

M.L. Good, et al., *Critical Events Simulation for Training in Anesthesiology*, *Journal of Clinical Monitoring*, 4:140 (1988).

S. Lampotang, et al., *A lung model of carbon dioxide concentrations with mechanical or spontaneous ventilation*, *Critical Care Medicine*, 14:1055-1057, (1986).

S. Abrahamson, *Chapter 31: Human Simulation for Training in Anesthesiology*, *Medical Engineering*, pp. 370-374.

J. S. Densen, M.D. and S. Abrahamson, Ph.D., *A Computer-Controlled Patient Simulator*, *JAMA*, 208:504-508, (1969).

Ross et al., *Servocontrolled Closed Circuit Anaesthesia: A method for the automatic control of anaesthesia produced by a volatile agent in oxygen*, *British Journal of Anesthesia*, 44:1053-1060 (1983).

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[57] ABSTRACT

An apparatus and method of simulating breathing sounds in real time involves the use of a manikin having a lung bellows. A sensor associated with the lung bellows is used to continuously determine the volume such that, using standard mathematical procedures based on the time and volume determined, a first derivative of the bellows volume over time can be calculated to determine the phase of the respiratory cycle (e.g. inhalation or exhalation). In addition, by calculating a second derivative of the bellows volume over time, a transition in phase of the respiratory cycle can be determined. Based upon the first and second derivatives of the bellows volume over time, a sound is output through an output device, such as a speaker, located proximate the mouth of the manikin. The outputted sounds are pre-recorded audible sounds of breathing corresponding to appropriate physiological sounds.

4 Claims, 7 Drawing Sheets

