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(54) **AUTOMATIC LUNG PARAMETER ESTIMATOR**

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See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,354,488 A 10/1982 Bartos

(Continued)

FOREIGN PATENT DOCUMENTS

DE 251706 11/1987

(Continued)

OTHER PUBLICATIONS

Andreassen, S., Egeberg, J., Schroter, M.P., Andersen, P.T. (1996). Estimation of pulmonary diffusion resistance and shunt in an oxygen status model. Comput Methods Programs Biomed, vol. 51, pp. 95-105.

(Continued)

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(57) **ABSTRACT**

A device for determining one or more respiratory parameters relating to an individual is disclosed, as well as a method for determining one or more respiratory parameters by means of the device, wherein the individual is suffering from hypoxemia or is at risk of hypoxemia. However, the method and the device may also be applied to healthy individual e.g. for testing of medicaments. The device is controlled by a computer equipped with suitable software and includes functionality for on-line continuous data collection, automatic assessment of the timing of measurements, automatic assessment of the next target (oxygen saturation of arterial blood (SpO2)), automatic assessment of the appropriate fraction of oxygen in inspired gas (FIO2) settings to achieve the target SpO2, automatic control of the FIO2, on-line parameter estimation, and automatic assessment of the number of measurememts requied.

58 Claims, 10 Drawing Sheets
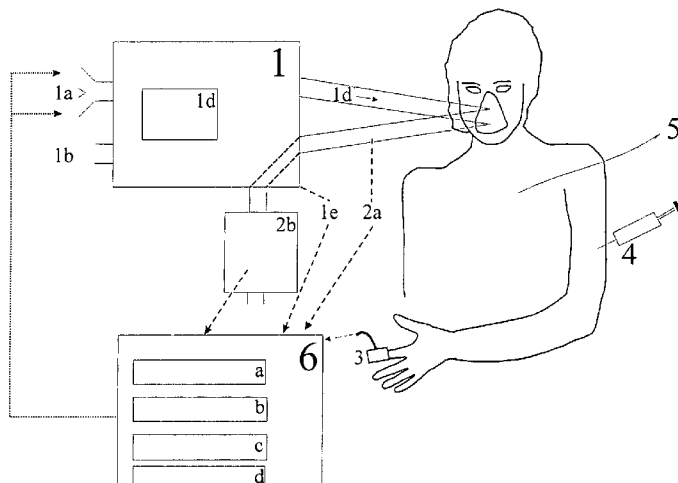
U.S. PATENT DOCUMENTS

5,103,814 A		4/1992	Maher
5,237,990 A		8/1993	Psaros et al.
5,251,632 A	*	10/1993	Delpy 600/323
5,282,464 A		2/1994	Brain
5,353,788 A	*	10/1994	Miles 128/204.23
5,365,922 A	*	11/1994	Raemer 128/204.23
5,388,575 A		2/1995	Taube
5,429,123 A	*	7/1995	Shaffer et al. 128/204.23
5,596,986 A		1/1997	Goldfarb
5,682,877 A	*	11/1997	Mondry 128/204.23

FOREIGN PATENT DOCUMENTS

EP	0342443	11/1989
EP	0502270	9/1992
EP	A1502270	9/1992
EP	0753320	1/1997
EP	A1753320	1/1997
FR	2599977	12/1987
GB	209321 B	8/1982

OTHER PUBLICATIONS

Andreassen, S., Rees, S.E., Kjaeraard, S., Thorgaard, P., Winter, S.M., Morgan, C.J., Alstrup, P., and Toft, E. (1999). Hypoxemia after coronary bypass surgery modeled by resistance to oxygen diffusion. Critical Care Medicine, vol. 27, pp. 2445-2453.

De Gray, L., Rush, E.M., Jones, J.G. (1997). A non-invasive method for evaluating the effect of thoracotomy on shunt and ventilation perfusion inequality. Anaesthesia, vol. 52, pp. 630-635.

King, T.K.C., Weber, B. Okinaka, A., Friedman, S.A., Smith, J.P. Briscoe, W.A. (1974). Oxygen transfer in catastrophic respiratory failure. Chest, vol. 65, pp. 40S-44S.

Rees, S.E., Rutledge, G.W., Andersen, P.T., Andreassen, S. (1997). Are alveolar block and ventilation-perfusion mismatch distinguishable in routine clincal data. In: Proceedings of the European society of computers in anaesthesia and intensive care conference, Erlangen, Germany, Sep. 18-19, 1997.

Riley, R.L., Counard, A. (1951a) Analysis of factors affecting partial pressure of oxygen and carbon dioxide in gas and blood of the lungs: Theory. J. Applied Physiol., vol. 4, pp. 77-101.

Riley, R.L., Counard, A., Donald, K.W. (1951b). Analysis of factors affecting partial pressure of oxygen and carbon dioxide in gas and blood of the lungs: Method. J. Applied Physiol., vol. 4, pp. 102-120.

Roe, P.G., Galdelrab, R., Sapsford, D., Jones, J.G. (1997). Intra-operative gas exchange and post-operative hypoxaemia. European Journal of Anaesthesiology, vol. 14, pp. 203-210.

Sapsford, D.J., Jones, J.G. (1995). The PiO_2 vs. SpO_2 diagram: a non-invasive measure of pulmonary oxygen exchange. European Journal of Anaesthesiology, vol. 12, pp. 369-374.

Siggaard-Andersen, M., Siggaard-Andersen, O. (1995). Oxygen status algorithm, version 3, with some applications, Acta Anaesthesiol Scand. vol. 39, Supp. 107, pp. 13-20.

Wagner, P.D., Saltzman, H.A., West, J.B. (1974). Measurement of continuous distributions of ventilation-perfusion ratios: theory. J. Appl. Physiol. vol. 36 (5) :588-599.

Wagner, P.D., Hendenstierna, G., Bylin, G. (1987). Ventilation-perfusion inequality in chronic asthna. Am. Rev. Respir. Dis., vol. 136, pp. 605-612.
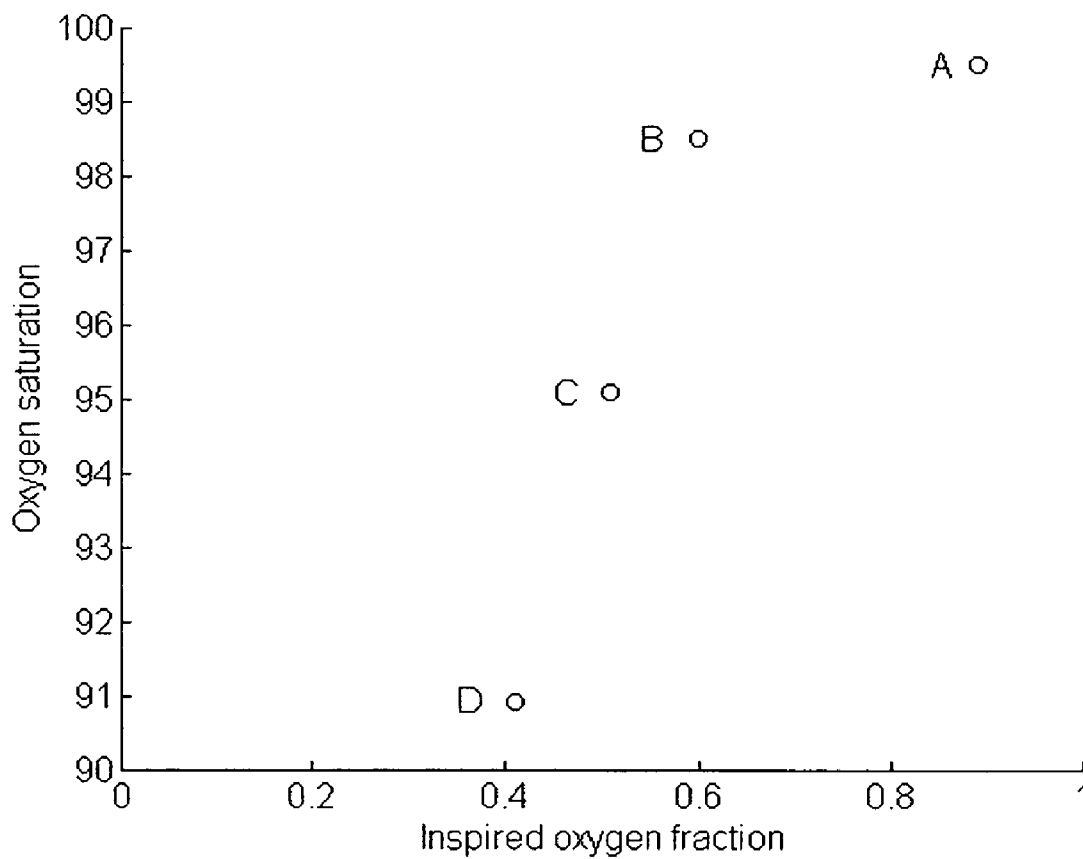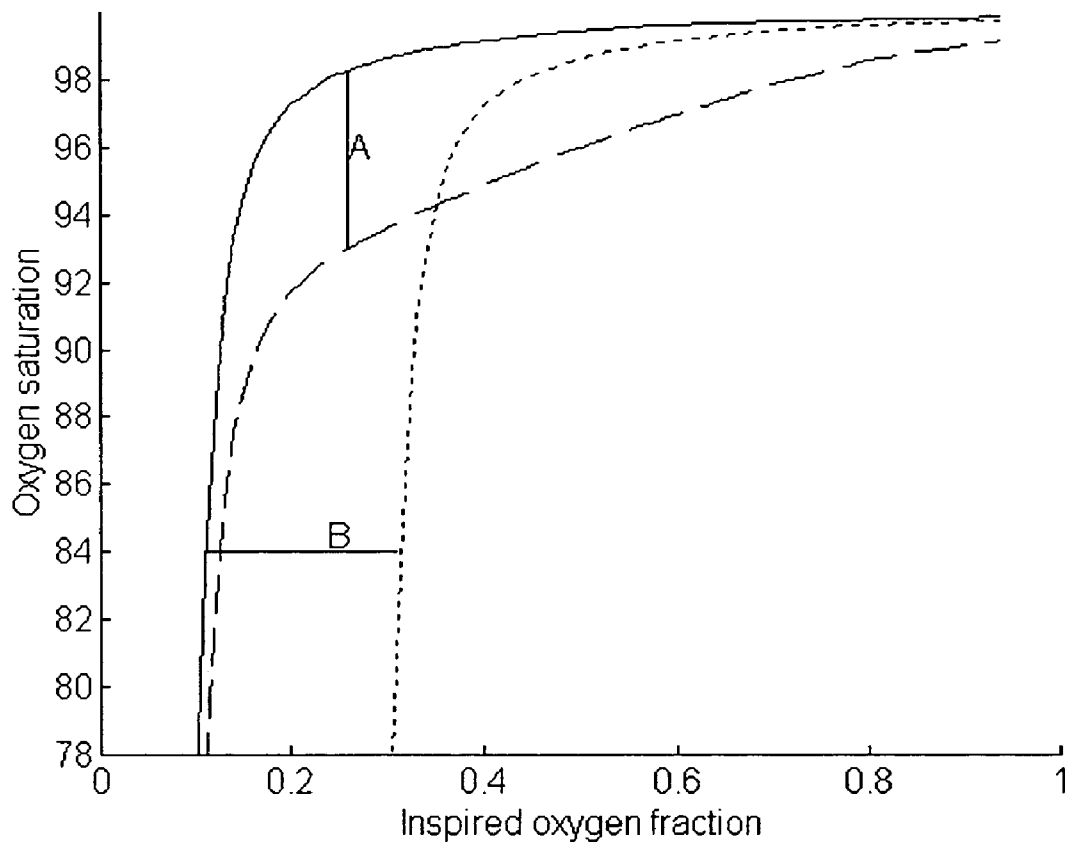
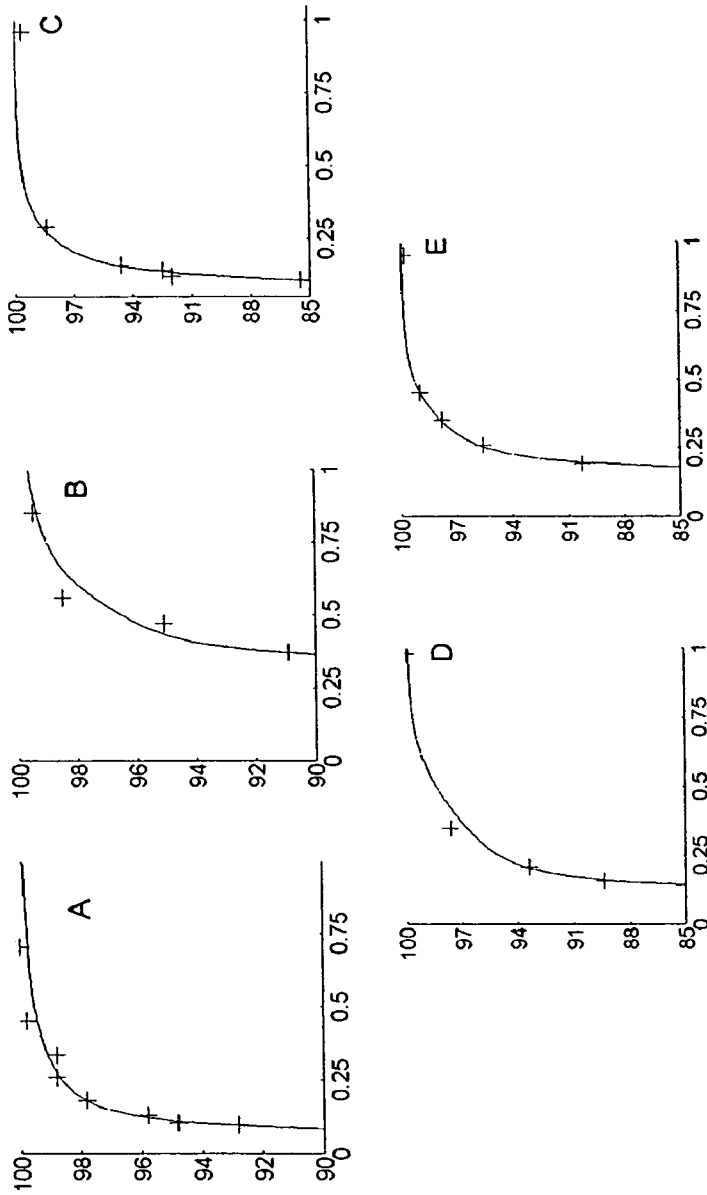* cited by examiner

Fig. 1

Fig. 2

Fig. 3

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