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(54) **DETERMINATION OF LEAK DURING CPAP TREATMENT**

2006/0249150 A1* 11/2006 Dietz A61M 16/0051
128/204.18
2010/0186743 A1 7/2010 Kane et al.
2011/0036352 A1 2/2011 Estes et al.

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See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,490,502 A 2/1996 Rapoport et al.
6,152,129 A * 11/2000 Berthon-Jones A61M 16/00
128/200.24
6,659,101 B2 12/2003 Berthon-Jones
2002/0023644 A1* 2/2002 Berthon-Jones A61B 5/085
128/204.22
2006/0070624 A1 4/2006 Kane et al.

FOREIGN PATENT DOCUMENTS

AU 00737302 B2 8/2001
DE 10023473 A1 12/2001
EP 714670 A2 6/1996
EP 1005829 A1 6/2000
EP 1005830 A1 6/2000
JP 2000516491 A 12/2000
JP 2005-103311 A 4/2005
JP 2005193063 A 7/2005
WO 9812965 A1 4/1998

OTHER PUBLICATIONS

European Office Action for Application No. 07800212.8 dated Jan. 2, 2014.
Extended European Search Report for Application No. EP 14176792 dated Nov. 21, 2014.
Chinese Office Action for Application No. 20120225981.0 dated Dec. 12, 2014.
Extended European Search Report for Application No. EP07800212 dated Jun. 4, 2014.
Japanese Office Action for Application No. P2012-137024 dated Sep. 10, 2013.
Japanese Office Action for Application No. P2013-24033 dated Jun. 2, 2015.
Chinese Office Action for Application No. 200780031961.7 dated Feb. 17, 2011.
International Search Report for Application No. PCT/AU2007/001237 dated Dec. 7, 2007.
Chinese Office Action for Application No. 20130282065.5 dated Feb. 28, 2015.
Extended European Search Report for Application No. EP15199456 dated Apr. 11, 2016.

* cited by examiner

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(57) **ABSTRACT**

A respiratory treatment apparatus and method in which a leak is determined by using an averaging window. The window starts at the present time and extends back in time to a point determined according to a current one of progressively detected phase measures of a first respiratory cycle and a corresponding phase measure attributable to a preceding second respiratory cycle. In another aspect, a jamming index indicates whether the leak is rapidly changing. To the extent that jamming is high, the leak estimate used progressively changes from that using sliding breath-window averaging to a more robust and faster responding low-pass filter method, and adjustment of ventilatory support based on measures employing estimated respiratory flow is slowed down or stopped.

17 Claims, 2 Drawing Sheets