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(54) **METHOD AND APPARATUS FOR NULLIFYING THE IMPOSED WORK OF BREATHING**

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This patent is subject to a terminal disclaimer.

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(58) **Field of Search** 128/202.22, 204.18, 128/204.21, 204.22, 204.23, 204.26, 205.23

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,565,194 A		1/1986	Weerda et al.	
4,957,107 A		9/1990	Sipin	
5,316,009 A		5/1994	Yamada	
5,546,935 A	*	8/1996	Champeau	128/205.23
5,582,163 A		12/1996	Bonassa	
5,692,497 A		12/1997	Schnitzer et al.	
5,803,066 A		9/1998	Rapoport et al.	
5,941,710 A		8/1999	Lampotang et al.	
5,954,050 A		9/1999	Christopher	
6,182,657 B1		2/2001	Brydon et al.	
6,390,091 B1	*	5/2002	Banner et al.	128/204.21
6,450,164 B1	*	9/2002	Banner et al.	128/204.21
6,571,796 B2	*	6/2003	Banner et al.	128/204.26

FOREIGN PATENT DOCUMENTS

WO	WO 97/10868	3/1997

* cited by examiner

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(57) **ABSTRACT**

A method and corresponding medical ventilator for nullifying the work of breathing imposed by the ventilation breathing apparatus during ventilation support of a patient having a source of breathing gas, a pressure sensor, a microprocessor, at least one actuator of a pneumatic system, and driver circuits. The medical ventilator is in fluid communication with the source of breathing and an endotracheal tube which is in fluid communication with the lungs of the patient. At least one driver circuit adjusts at least one actuator to change the supply of the breathing gas. The pressure sensor measures the pressure of the gas proximate the distal end of the endotracheal tube and generates an output based on the sensed pressure. The microprocessor controls the supply of the breathing gas exiting the pneumatic system of the ventilator and is electrically coupled to the output of the pressure sensor. The microprocessor compares the output of the pressure sensor to a predetermined baseline pressure that is greater than zero and, as a result, adjusts the actuator so that the pressure of the gas proximate the distal end of the endotracheal tube is maintained at the predetermined baseline pressure.

36 Claims, 12 Drawing Sheets