關於self-calibration，簡單來說是依據儀器的內部循環氣路，通過差值法得到樣本的濃度，同時對儀器進行標定，詳細方案見專利：PCT/CN2013/000718

US009970894B2

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

(10) **Patent No.: US 9,970,894 B2**
(45) **Date of Patent: May 15, 2018**

(54) **METHOD AND DEVICE FOR MEASURING CONCENTRATION OF SUBSTANCE IN FLUID**

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(73) Assignee: **Sunvou Medical Electronics Co., Ltd.**, Woxi, Jiangsu (CN)

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PCT Pub. Date: **Dec. 27, 2013**

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G01N 27/26 (2006.01)
G01N 33/00 (2006.01)

(52) **U.S. Cl.**
CPC ***G01N 27/26*** (2013.01); ***G01N 33/0006*** (2013.01)

(58) **Field of Classification Search**
CPC G01N 27/26; G01N 27/4045; G01N 27/4074; G01N 27/3274; G01N 33/0006;
(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,829,809 A 5/1989 Tantram et al.
4,833,909 A 5/1989 Matthiessen
(Continued)

FOREIGN PATENT DOCUMENTS

CN 101368921 A 2/2009
CN 101368927 A 2/2009
(Continued)

OTHER PUBLICATIONS

PCT International Search Report, PCT/CN2013/000718 dated Oct. 3. 2013.

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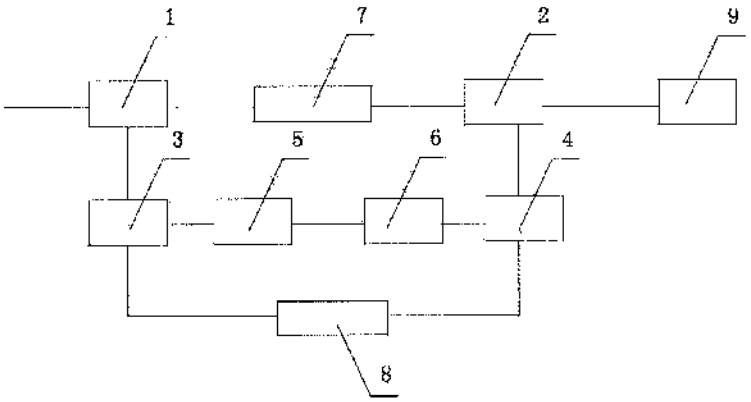
(74) *Attorney, Agent, or Firm* — TraskBritt, P.C.

(57) **ABSTRACT**

A method and device for measuring a substance's concentration in a fluid. The method includes first passing a sample to be measured through a chemical sensor at least twice and recording the response value each time; forming a simultaneous equation set using the equation relation between the response value obtained during each measurement and the concentration of the substance, and the mass equation relation satisfied by the concentration change caused by a physical, chemical reaction during each measurement and by the change of the mass. electric quantity. and heat; solving for the concentration of the substance measured and the sensor calibration parameter. The method, used as an absolute measurement method, can be applied to calibrate the sample concentration of a fluid, overcomes the effects on the measurements caused by temperature, humidity. pressure. and some interfering gas, requires no sensor calibra-
(Continued)



tion, and substantially enhances the measurements' stability and reliability.

3 Claims, 3 Drawing Sheets

(58) **Field of Classification Search**
CPC G01N 33/497; G01N 33/007; G01N 33/4925; A61B 5/14542
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,055,840	A	5/2000	Warburton
6,918,281	B2	7/2005	Sussman et al.
7,071,386	B2	7/2006	Bintrim et al.
7,401,493	B2	7/2008	Forrest
7,581,425	B2	9/2009	Forrest
7,645,362	B2	1/2010	Kato et al.
7,655,186	B2	2/2010	Tobias
7,661,290	B2	2/2010	Gu et al.
7,704,356	B2	4/2010	Kühn et al.
7,975,525	B2	7/2011	Bonne et al.
2004/0082872	A1	4/2004	von Bahr et al.
2005/0241959	A1	11/2005	Ward et al.
2005/0262924	A1	12/2005	Wood
2006/0042351	A1	3/2006	Liu et al.
2006/0266097	A1	11/2006	Eickhoff
2007/0079025	A1	4/2007	Gloekler et al.
2011/0197649	A1*	8/2011	Han G01N 33/0006 73/1.06

FOREIGN PATENT DOCUMENTS

CN	101393199	A	3/2009
CN	102778541	A	11/2012
CN	202631479	U	12/2012
CN	202631480	U	12/2012
CN	202676655	U	1/2013
CN	202676656	U	1/2013
CN	202676663	U	1/2013
CN	202693516	U	1/2013
WO	2007079025	A2	7/2007
WO	2013189175	A1	6/2013

* cited by examiner

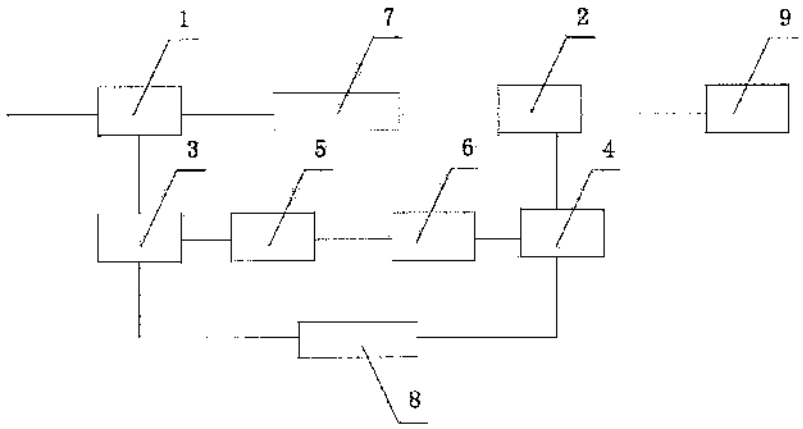


FIG. 1

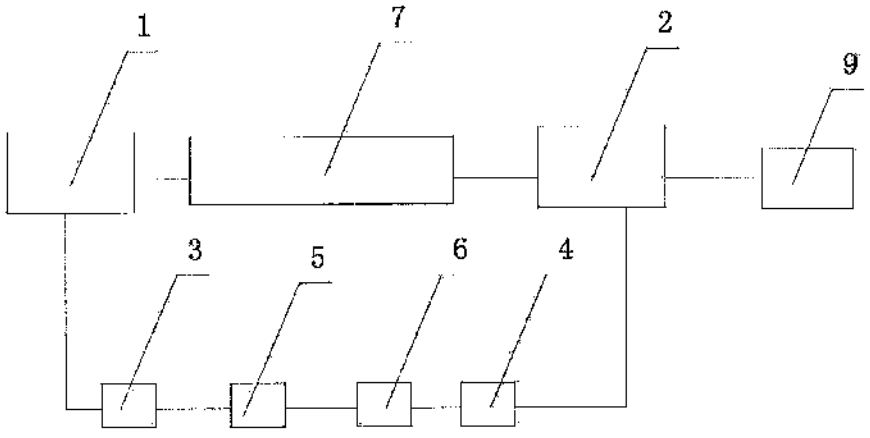


FIG. 2

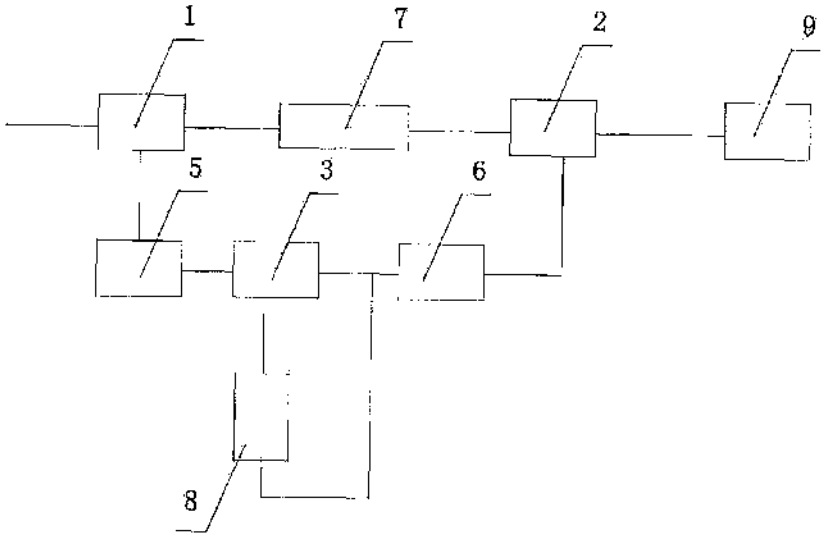


FIG. 3

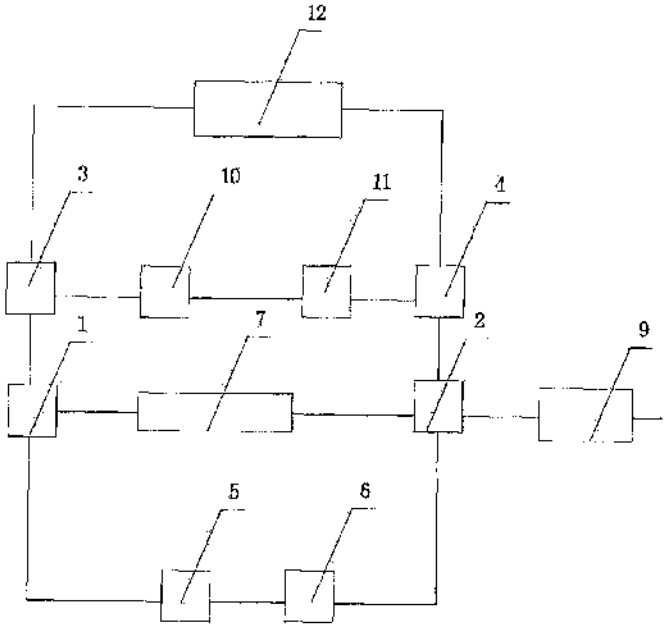


FIG. 4

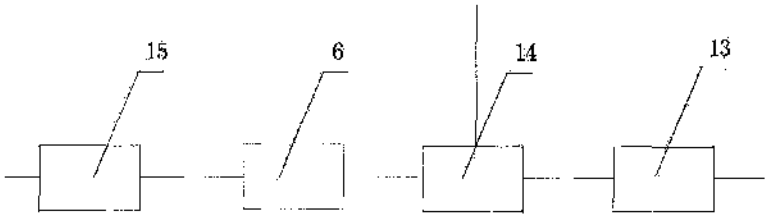

15
6
14
13

FIG. 5

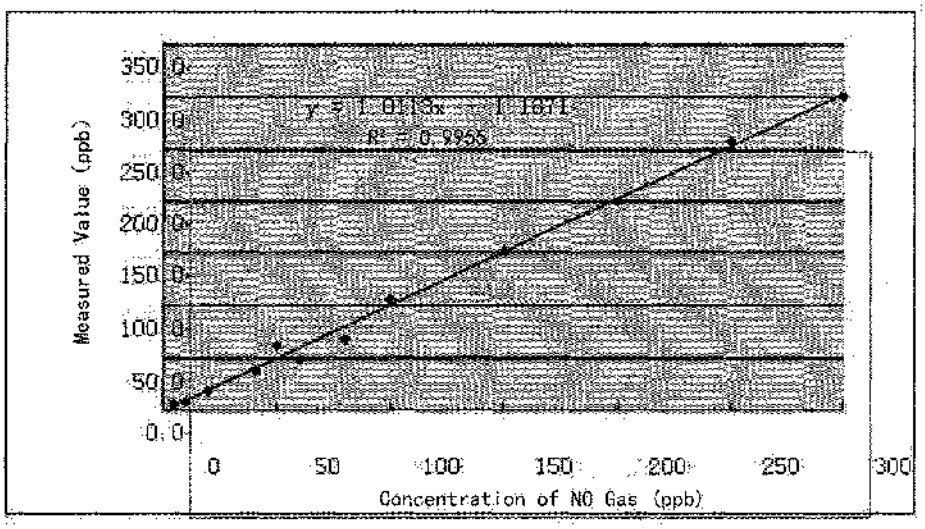

Measured Value (ppb)
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
0
50
100
150
200
250
300
Concentration of NO Gas (ppb)

FIG. 6