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(12) **United States Patent**  
**Senkiw**

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(54) **FLOW-THROUGH OXYGENATOR**

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This patent is subject to a terminal disclaimer.

(21) Appl. No.: **12/023,431**

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**Related U.S. Application Data**

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(51) **Int. Cl.**

**C02F 1/48** (2006.01)  
**C02F 1/00** (2006.01)  
**C25B 1/02** (2006.01)  
**C25B 1/04** (2006.01)

(52) **U.S. Cl.** ..... **210/748**; 210/600; 210/243; 204/245; 204/232; 205/628

(58) **Field of Classification Search** ..... 210/748, 210/600, 243; 204/278, 242, 243, 275.1, 204/232, 286.1, 554, 660; 205/633-638

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,071,447 A 1/1978 Ramirez  
4,225,401 A 9/1980 Divisek et al.

(Continued)

FOREIGN PATENT DOCUMENTS

EP 0 723 936 A2 7/1996

(Continued)

OTHER PUBLICATIONS

Mohyuddin Mirza et al., "Effect of Oxygenated Water on the Growth & Biomass Development of Seedless Cucumbers and Tomato Seedlings under Greenhouse Conditions," Seair Diffusion Systems, 2003, 5 pages, www.seair.ca.

*Primary Examiner*—Walter D Griffin

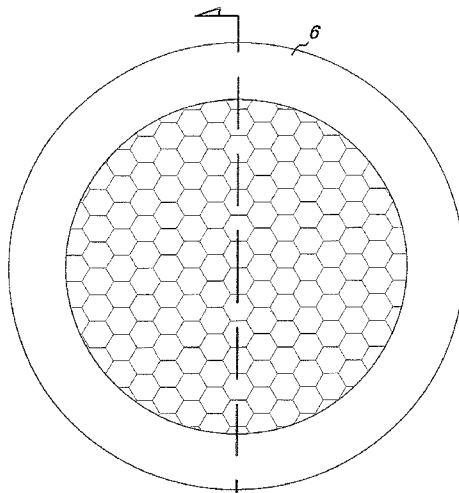
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(57) **ABSTRACT**

An oxygen emitter which is an electrolytic cell is disclosed. When the anode and cathode are separated by a critical distance, very small microbubbles and nanobubbles of oxygen are generated. The very small oxygen bubbles remain in suspension, forming a solution supersaturated in oxygen. A flow-through model for oxygenating flowing water is disclosed. The use of supersaturated water for enhancing the growth of plants is disclosed. Methods for applying supersaturated water to plants manually, by drip irrigation or in hydroponic culture are described. The treatment of waste water by raising the dissolved oxygen with the use of an oxygen emitter is disclosed.

**12 Claims, 8 Drawing Sheets**



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## U.S. PATENT DOCUMENTS

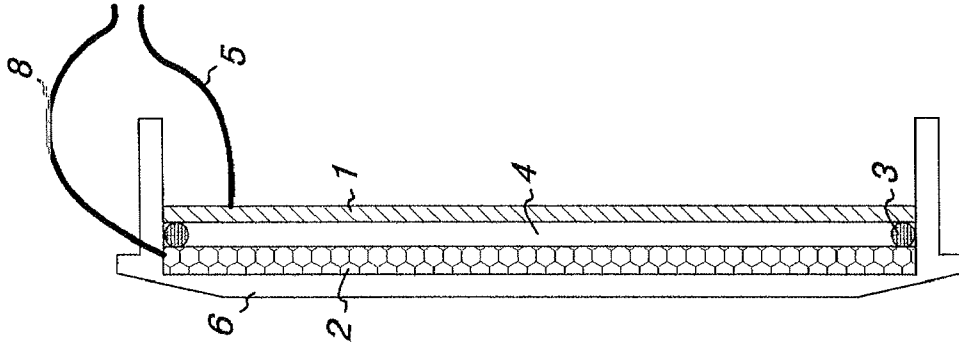
4,252,856 A 2/1981 Sara  
4,257,352 A 3/1981 Habegger  
4,587,001 A 5/1986 Cairns et al.  
5,015,354 A 5/1991 Nishiki et al.  
5,148,772 A 9/1992 Kirschbaum  
5,534,143 A 7/1996 Portier et al.  
5,982,609 A 11/1999 Evans  
6,171,469 B1 1/2001 Hough et al.  
6,315,886 B1 11/2001 Zappi  
6,328,875 B1 12/2001 Zappi et al.  
6,394,429 B2 5/2002 Gañan-Cálvo  
6,524,475 B1 2/2003 Herrington et al.  
6,689,262 B2\* 2/2004 Senkiw ..... 204/278.5

7,396,441 B2\* 7/2008 Senkiw ..... 204/278  
2002/0074237 A1 6/2002 Takesako et al.  
2003/0164306 A1 9/2003 Senkiw  
2004/0118701 A1\* 6/2004 Senkiw ..... 205/633  
2006/0150491 A1 7/2006 Senkiw  
2008/0202995 A1 8/2008 Senkiw

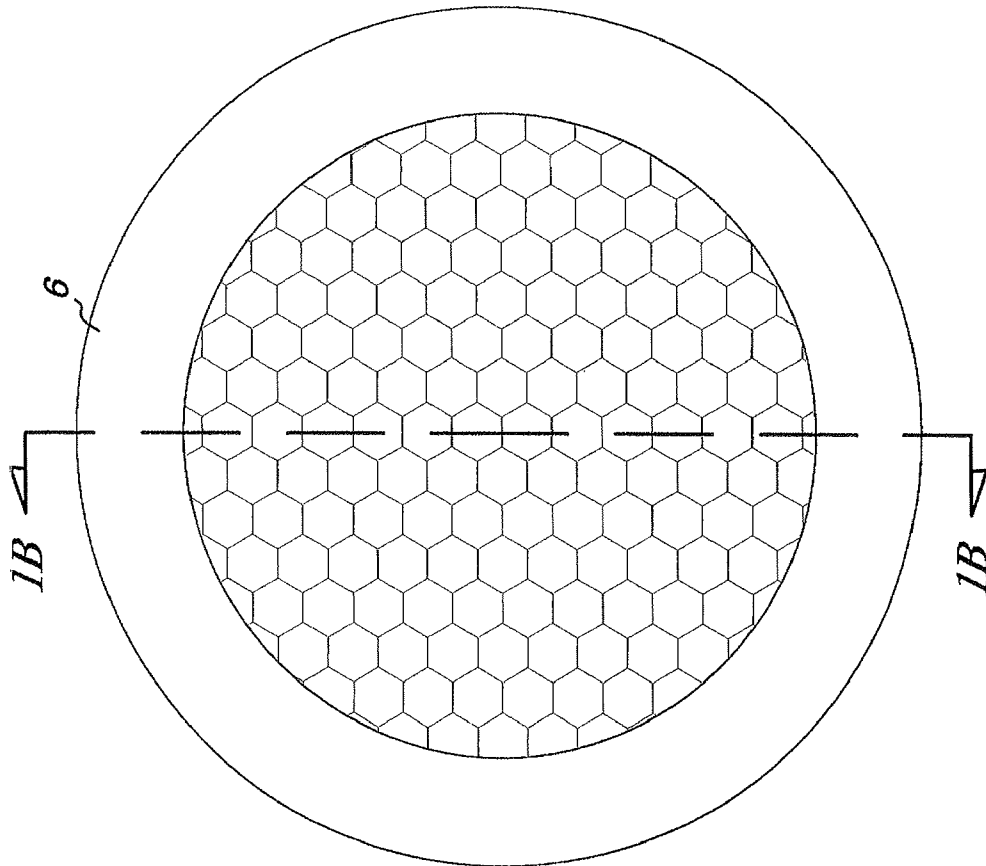
## FOREIGN PATENT DOCUMENTS

GB 1 522 188 8/1978  
WO WO 99/39561 8/1999  
WO WO 01/89997 A2 11/2001  
WO WO 03/072507 A1 9/2003

\* cited by examiner



*Fig. 1B*



*Fig. 1A*

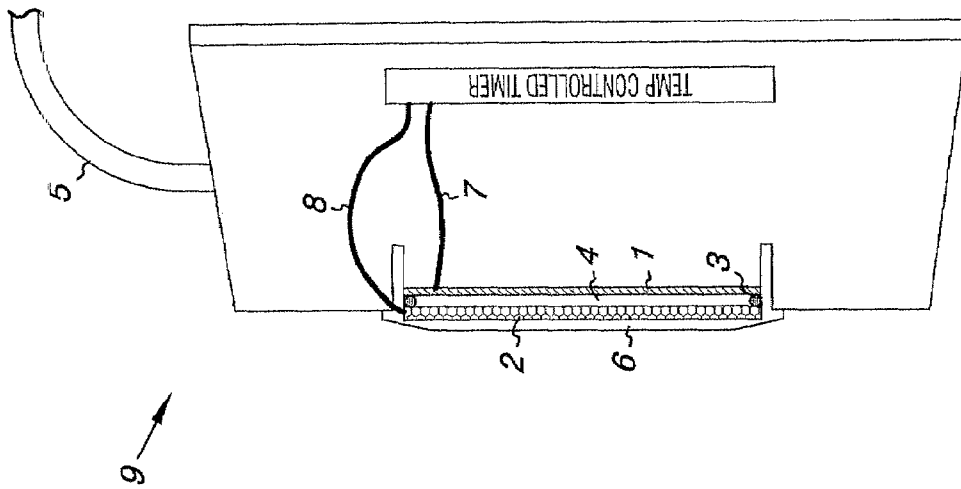


Fig. 2B

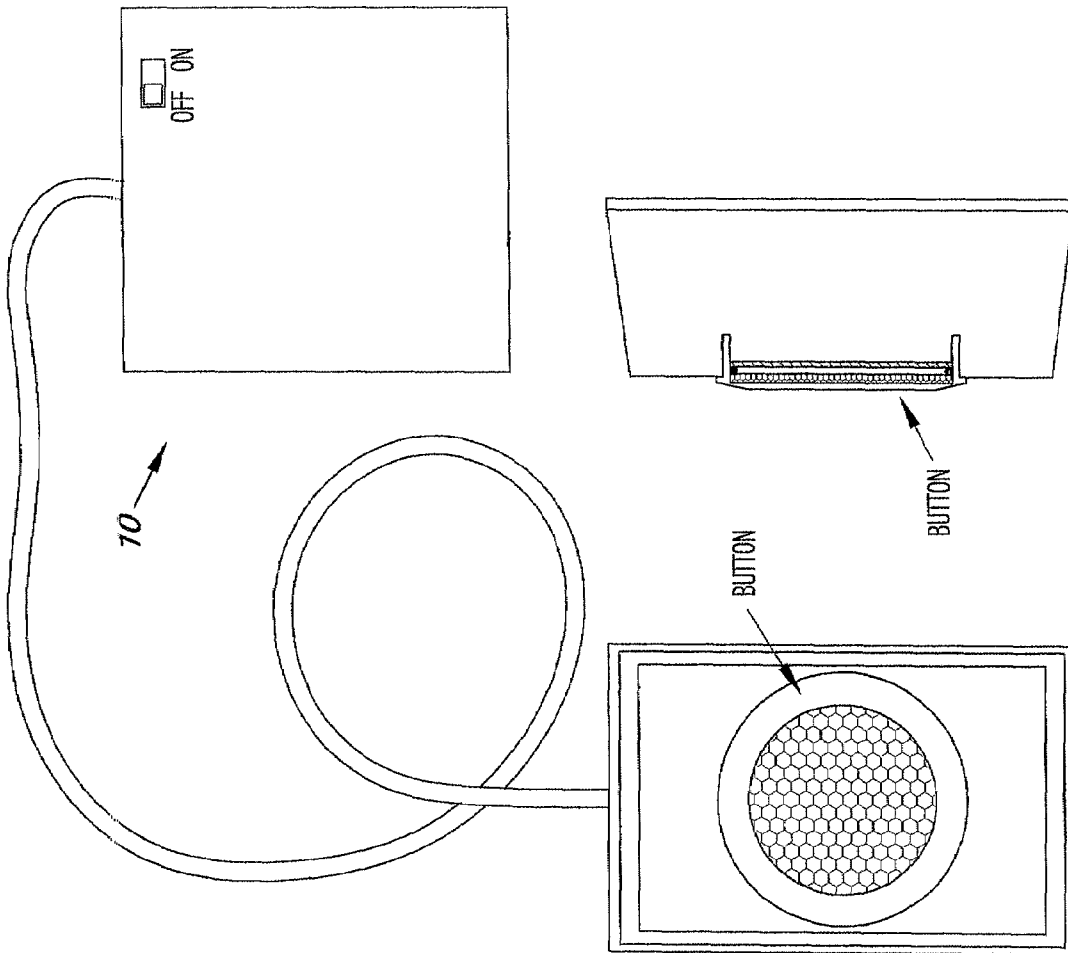
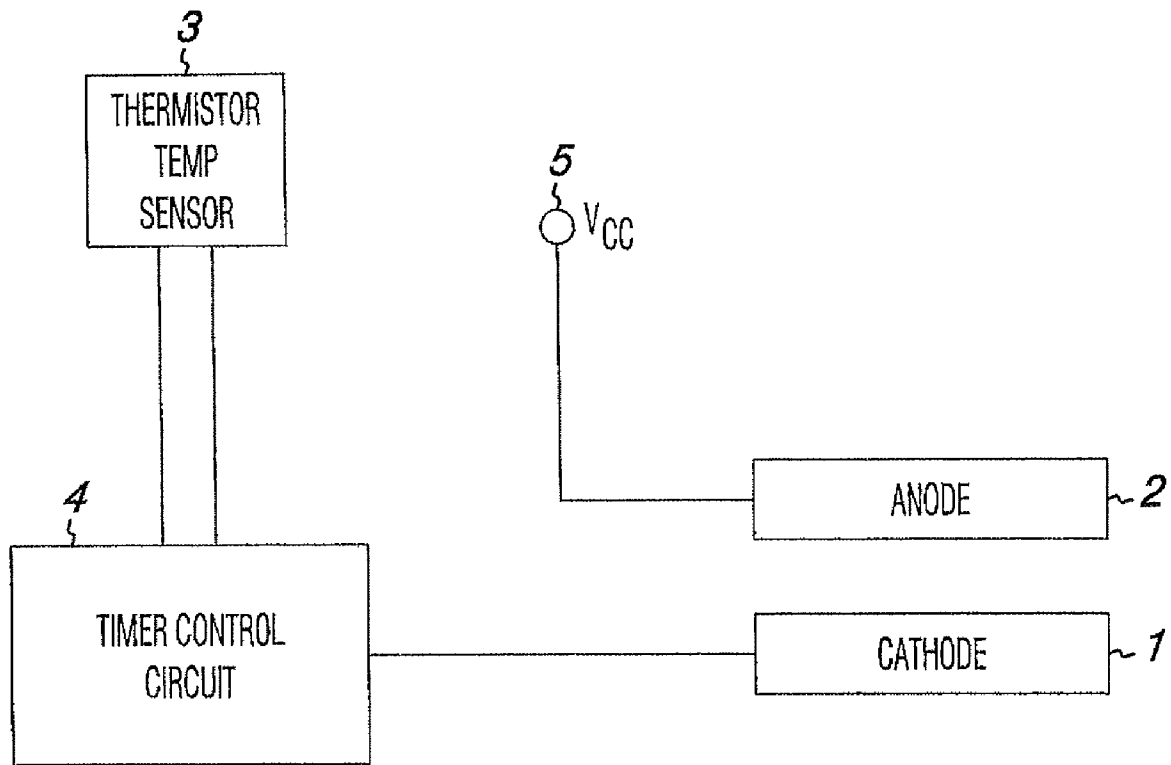


Fig. 2A



*Fig. 3*

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