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Senkiw

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(54) **FLOW-THROUGH OXYGENATOR**

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This patent is subject to a terminal disclaimer.

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(51) **Int. Cl.**

C25B 1/02 (2006.01)

C25B 1/04 (2006.01)

C02F 1/00 (2006.01)

(52) **U.S. Cl.** **204/278**; 204/242; 204/275.1; 204/232; 204/286.1; 204/554; 204/660; 205/633; 205/742; 210/243; 210/748

(58) **Field of Classification Search** 205/628-639, 205/742; 204/242, 245, 275.1, 278.5, 290.1, 204/232, 278, 286.1, 554, 660; 210/243, 210/748

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,225,401 A * 9/1980 Divisek et al. 205/354
4,252,856 A 2/1981 Sara
4,587,001 A * 5/1986 Cairns et al. 204/290.14
5,015,354 A * 5/1991 Nishiki et al. 204/254

(Continued)

FOREIGN PATENT DOCUMENTS

WO WO 99/39561 8/1999

(Continued)

OTHER PUBLICATIONS

Effect of Oxygenated Water on the Growth and Biomass Development of Seedless Cucumbers and Tomato Seedlings under Greenhouse Conditions: Mohyuddin Mirza et al. www.seair.ca, 2003.

Primary Examiner—Roy King

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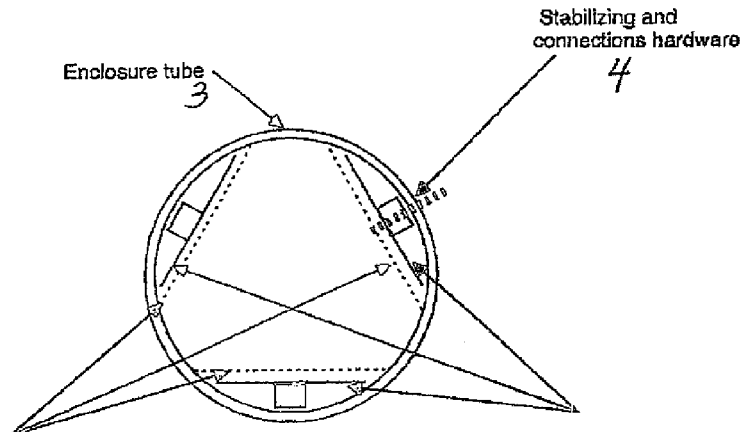
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(57)

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.

17 Claims, 8 Drawing Sheets



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U.S. PATENT DOCUMENTS

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. 205/743
6,315,886 B1 11/2001 Zappi et al.
6,328,875 B1* 12/2001 Zappi et al. 205/500
6,394,429 B2 5/2002 Ganán-Calvo

6,689,262 B2 2/2004 Senkiw
2002/0074237 A1* 6/2002 Takesako et al. 205/628

FOREIGN PATENT DOCUMENTS

WO WO 03/072507 A1 9/2003

* cited by examiner

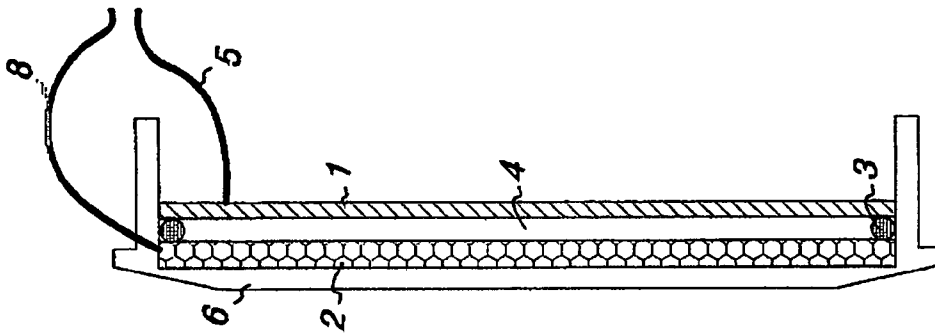


Fig. 1B

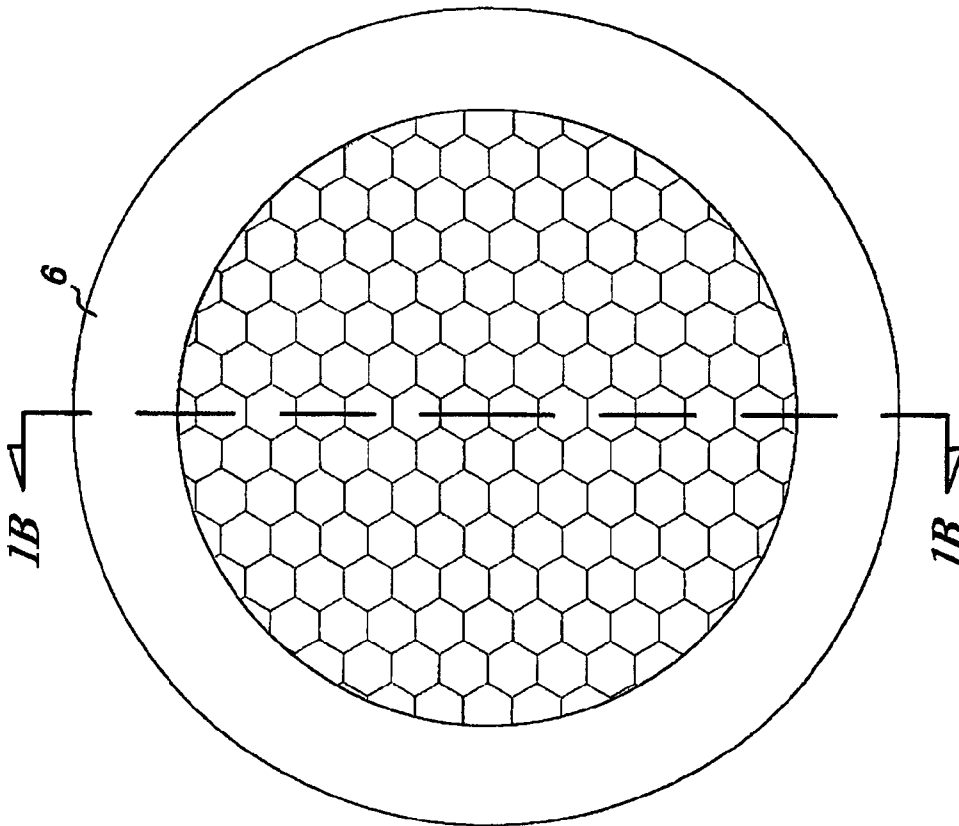


Fig. 1A

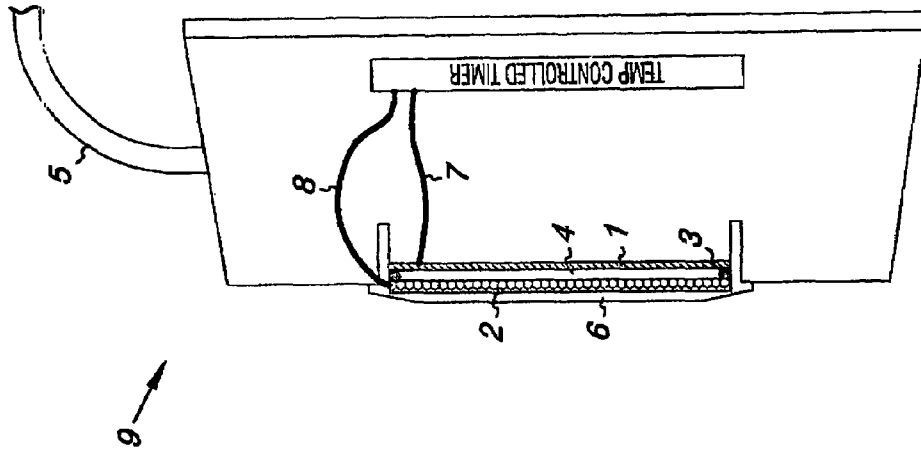


Fig. 2B

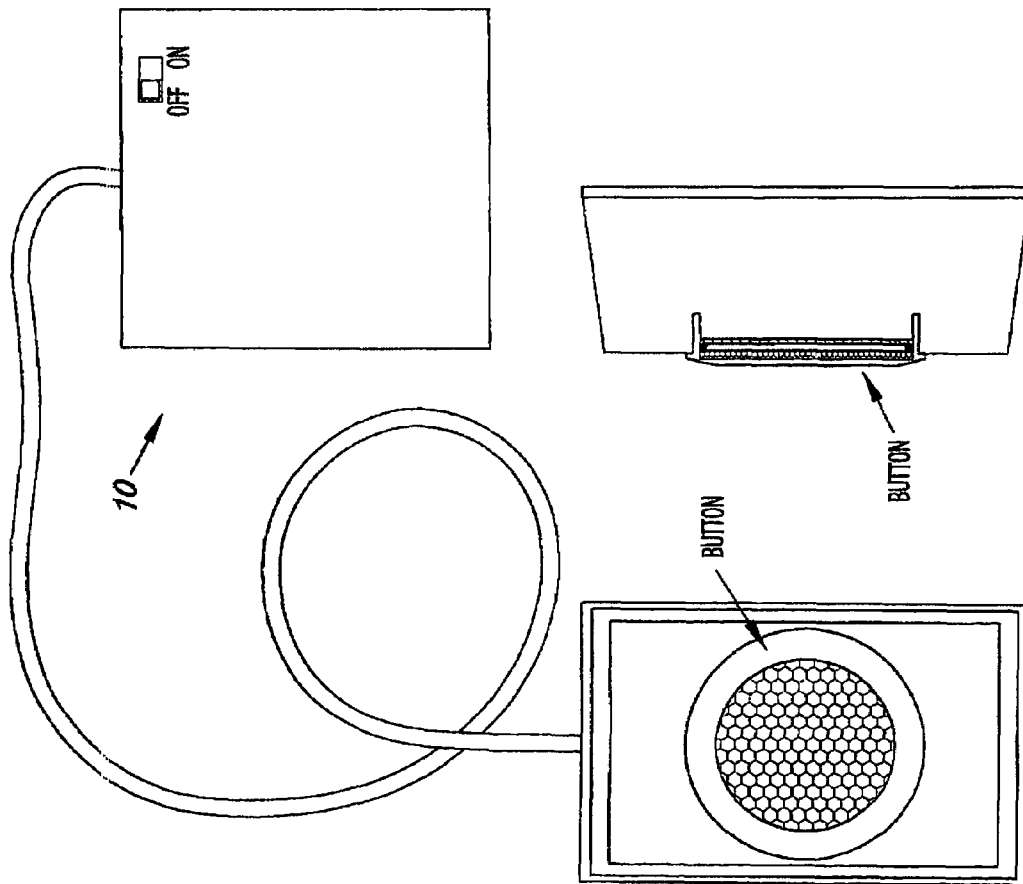


Fig. 2A

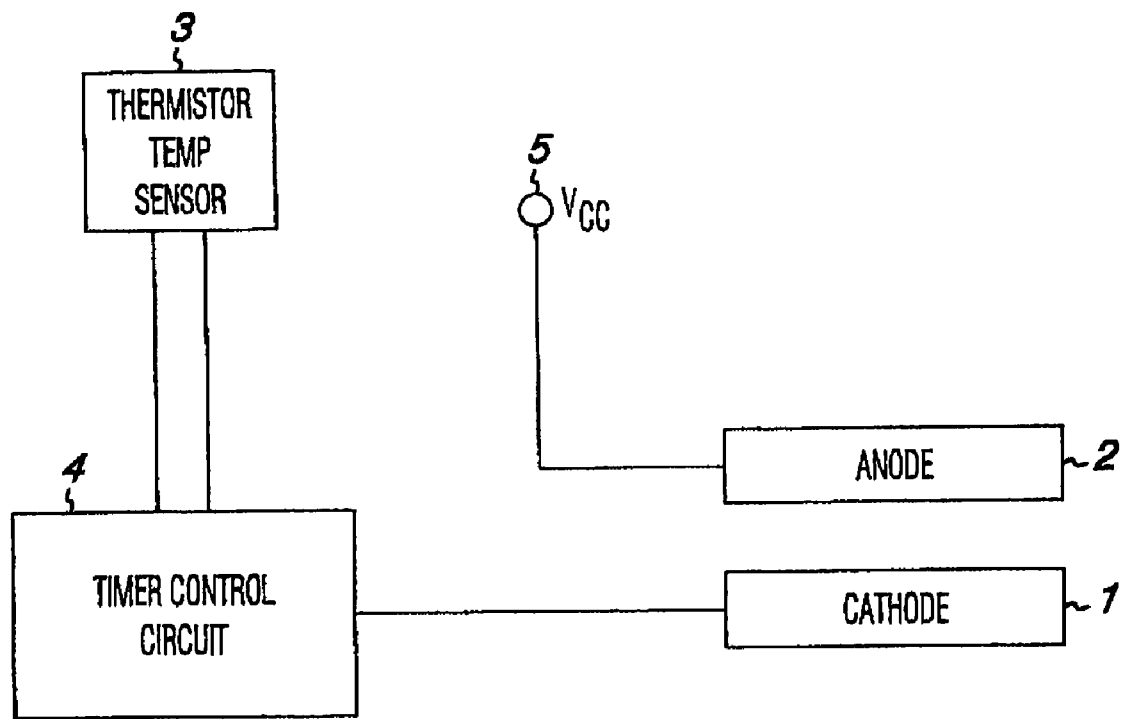


Fig. 3

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