Petitioner Tennant Company's Demonstratives for Oral Argument

May 20, 2022

TENNANT COMPANY v. OXYGENATOR WATER TECHNOLOGIES

Case No. IPR2021-00625

(Patent RE45,415)

Fredrikson & BYRON, P.A.

TENNANT COMPANY

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

Overview of Petitioner's Oral Argument

- Claim Construction
- Testing Burden
- Petitioner's Grounds 1-6
  - Ex. 1112 – US Pat. No. 3,891,535 to Wikey as primary reference (Mr. Johnson arguing)
- Petitioner's Grounds 7-24
  - Ex. 1105 – US Pat. No. 4,917,782 to Davies as primary reference (Mr. Steinert arguing)

Issues Not in Dispute

- **No dispute regarding qualifications of POSITA**

V. LEVEL OF ORDINARY SKILL IN THE ART

A person of ordinary skill in the art (POSITA) would have had a degree in chemistry, chemical engineering, or a similar discipline and at least two years of experience with electrolysis systems. Ex. 1103, ¶ 14. Alternatively, a POSITA could have equivalent experience in industry or research, such as designing, developing, testing, or implementing electrolysis systems. *Id*. Also, as noted in the '415 patent, a POSITA "can readily fabricate any of the emitters shown in FIG. 4 or 5 or can design other embodiments that will oxygenate flowing water." Ex. 1101, 9:20-22.

- **No dispute that Petitioner's references qualify as prior art**
- **No proposed claim amendments**

- Petition (Paper 1), 16
- PO Response (Paper 9), 7

Only Independent Claim at Issue

13. A method for producing an oxygenated aqueous composition comprising:

flowing water at a flow rate no greater than 12 gallons per minute through an electrolysis emitter comprising an electrical power source electrically connected to an anode electrode and a cathode electrode contained in a tubular housing,

causing electricity to flow from the power source to the electrodes, and,

producing the composition comprising a suspension comprising oxygen microbubbles and nanobubbles in the water, the microbubbles and nanobubbles having a bubble diameter of less than 50 microns, wherein:

the anode electrode is separated at a critical distance from the cathode such that the critical distance is from 0.005 inches to 0.140 inches;

the power source produces a voltage no greater than about 28.3 volts and an amperage no greater than about 13 amps,

the tubular housing has an inlet and an outlet and a tubular flow axis from the inlet to the outlet;

the water flows in the inlet, out the outlet, is in fluid connection with the electrodes, and the water flowing into the inlet has a conductivity produced by the presence of dissolved solids such that the water supports plant or animal life.

- Petition (Paper 1), 16
- Ex. 1101, 11:20-45

’415 File History

Examiner's Reasons for Allowance

Allowable Subject Matter

Claims 1 and 13-27 are allowed. The following is a statement of reasons for the indication of allowable subject matter: The prior art does not disclose nor fairly suggest the method for producing oxygenated aqueous composition comprising the combination of the critical distance between the cathode and anode of .0005-0.140, the voltage maximum of about 28.3 volts, and 13 or less amperage with a maximum of 12 gallons per minute such that it results in the formation of a suspension comprising oxygen microbubbles and nanobubbles in the water, the nanobubbles having a bubble diameter of less than 50 microns.

- Petition (Paper 1), 15
- Ex. 1102, 25

Examiner: Bubble Size Created by Electrode Gap

Regarding claims 77, 79, and 83, the claims do not further disclose additional structure that further limits it over its dependent claim. The claim states that the bubble size is a diameter less than 0.0006 inches. Since all of the claimed structure is present and independent claims state that the bubbles are due to the electrode gap, the device should create the bubble size for at least same reasons as applicant.

Regarding claims 76, 78, and 82, the Hough reference discloses that the saturation level is determined by the length of time the device is allowed to operate. Therefore the device is capable of saturation when given enough time.

- Petition (Paper 1), 15
- Ex. 1102, 108

Patent Confirms Bubble Size Results from the Size of Electrode Gap

(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.

- Petition (Paper 1), 9
- Ex. 1101, Abstract

In order to form microbubbles and nanobubbles, the anode and cathode are separated by a critical distance. The critical distance ranges from 0.005 inches to 0.140 inches. The preferred critical distance is from 0.045 to 0.060 inches.

- Petition (Paper 1), 9
- Ex. 1101, 3:13-16

"Critical distance" means the distance separating the anode and cathode at which evolved oxygen forms microbubbles and nanobubbles.

- Petition (Paper 1), 17
- Ex. 1101, 4:1-6

reacts to form molecular oxygen, O_2. In the special dimensions of the invention, as explained in more detail in the following examples, O_2 forms bubbles which are too small to break the surface tension of the fluid. These bubbles remain suspended indefinitely in the fluid and, when allowed to build up, make the fluid opalescent or milky. Only after several hours do the bubbles begin to coalesce on the sides of the container and the water clears. During that time, the water is supersaturated with oxygen. In contrast, the H_2 formed

- Petition (Paper 1), 10
- Ex. 1101, 4:30-38

Claim Construction

"Critical Distance"

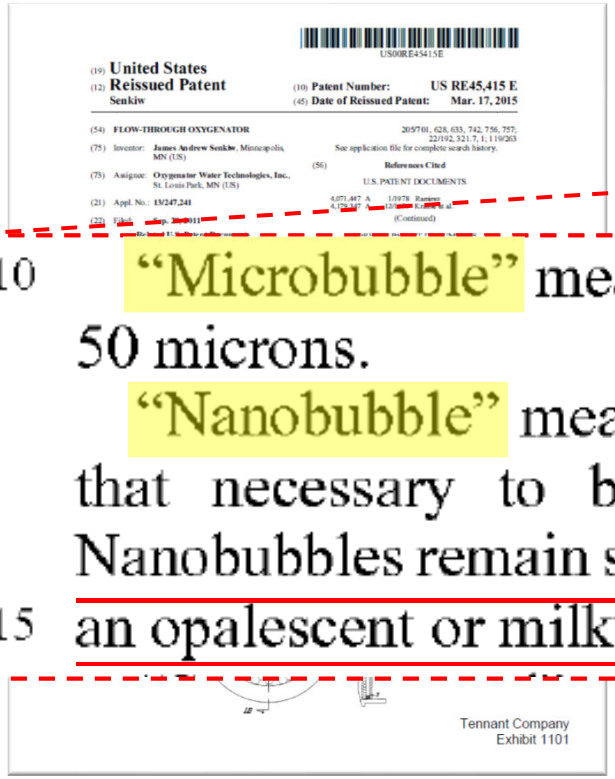
"Critical distance" means the distance separating the anode and cathode at which evolved oxygen forms microbubbles and nanobubbles.

- Petition (Paper 1), 17
- Ex. 1101, 4:1-6

In order to form microbubbles and nanobubbles, the anode and cathode are separated by a critical distance. The critical distance ranges from 0.005 inches to 0.140 inches. The preferred critical distance is from 0.045 to 0.060 inches.

- Petition (Paper 1), 9
- Ex. 1101, 3:13-16

“Microbubble” and “Nanobubble”



(19) United States
(12) Reissued Patent
Senkiw

(10) Patent Number: US RE45,415 E
(45) Date of Reissued Patent: Mar. 17, 2015

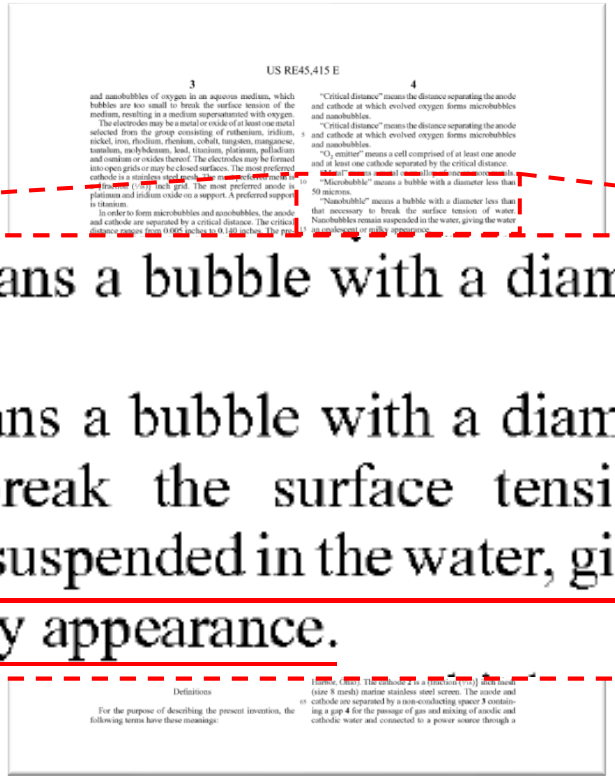
(54) FLOW-THROUGH OXYGENATOR

(75) Inventor: James Andrew Senkiw, Minneapolis, MN (US)

(73) Assignee: Oxygenator Water Technologies, Inc., St. Louis Park, MN (US)

(21) Appl. No.: 13/247,241

Tennant Company
Exhibit 1101



US RE45,415 E

3

and nanobubbles of oxygen in an aqueous medium, which bubbles are too small to break the surface tension of the medium, resulting in a medium supersaturated with oxygen.

The electrodes may be a metal or oxide of at least one metal selected from the group consisting of ruthenium, iridium, nickel, iron, rhodium, rhenium, cobalt, tungsten, manganese, tantalum, molybdenum, lead, titanium, platinum, palladium and osmium or oxides thereof. The electrodes may be formed into open grids or may be closed surfaces. The most preferred cathode is a stainless steel mesh, [illegible] inch grid. The most preferred anode is [illegible] inch grid. The most preferred anode is platinum and iridium oxide on a support. A preferred support is titanium.

In order to form microbubbles and nanobubbles, the anode and cathode are separated by a critical distance. The critical distance ranges from 0.005 inches to 0.140 inches. The most

Definitions

For the purpose of describing the present invention, the following terms have these meanings:

4

“Critical distance” means the distance separating the anode and cathode at which evolved oxygen forms microbubbles and nanobubbles.

“Critical distance” means the distance separating the anode and cathode at which evolved oxygen forms microbubbles and nanobubbles.

“O$_2$ emitter” means a cell comprised of at least one anode and at least one cathode separated by the critical distance.

[illegible]

“Microbubble” means a bubble with a diameter less than 50 microns.

“Nanobubble” means a bubble with a diameter less than that necessary to break the surface tension of water. Nanobubbles remain suspended in the water, giving the water

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“Nanobubble” means a bubble with a diameter less than that necessary to break the surface tension of water. Nanobubbles remain suspended in the water, giving the water an opalescent or milky appearance.

15

- Petition (Paper 1), 17-18
- Ex. 1101, 4:10-15
- Reply (Paper 42), 2

Patent Equates Milkiness, Dissolved Oxygen with Presence of Nanobubbles

"Nanobubble" means a bubble with a diameter less than that necessary to break the surface tension of water. Nanobubbles remain suspended in the water, giving the water an opalescent or milky appearance.

- Petition (Paper 1), 18
- Ex. 1101, 4:12-15

"Supersaturated" means oxygen at a higher concentration than normal calculated oxygen solubility at a particular temperature and pressure.

- Petition (Paper 1), 18
- Ex. 1101, 4:16-18

TABLE III

MODEL	ACTIVE ELECTRODE AREA, SQ. IN.	VOLTAGE	CURRENT, AMPS.	FLOW RATE GAL/MINUTE	DO OF* SAMPLE AT ONE MINUTE
2-Inch "T"	2	28.3	0.72	12	N/A
3-inch "T"	3	28.3	1.75	12	N/A
2-plate Tube	20	28.3	9.1	12	8.4
3-Plate tube	30	28.3	12.8	12	9.6

*As the apparatus runs longer, the flowing water becomes milky, indicating supersaturation. The one-minute time point shows the rapid increase in oxygenation.

- Reply (Paper 42), 9
- Ex. 1101, 9:39-49

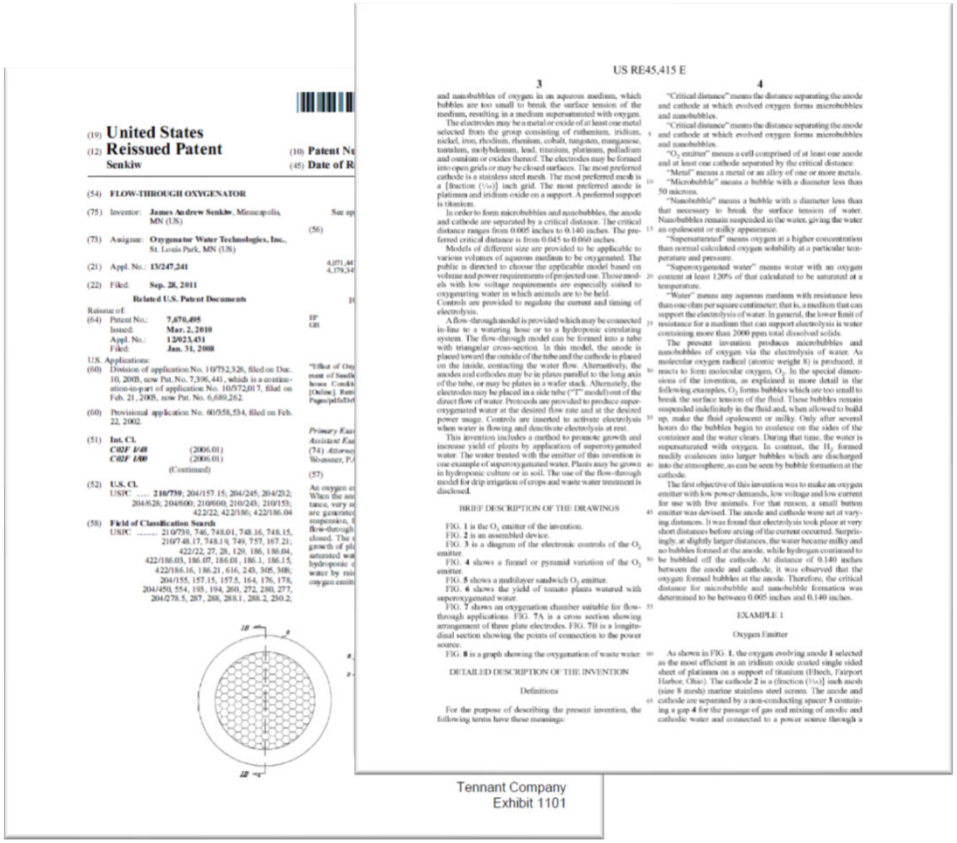
“Flowing Water . . . Through an Electrolysis Emitter”

1. ‘415 Patent provides no definition.

2. ‘415 Patent provides no limitation.

3. Nothing in the claims requires the water be flowing independent of electrolysis.

   - Petition (Paper 1), 19
   - Ex. 1101
   - Reply (Paper 42), 3-4



(19) United States
(12) Reissued Patent
Senkiw

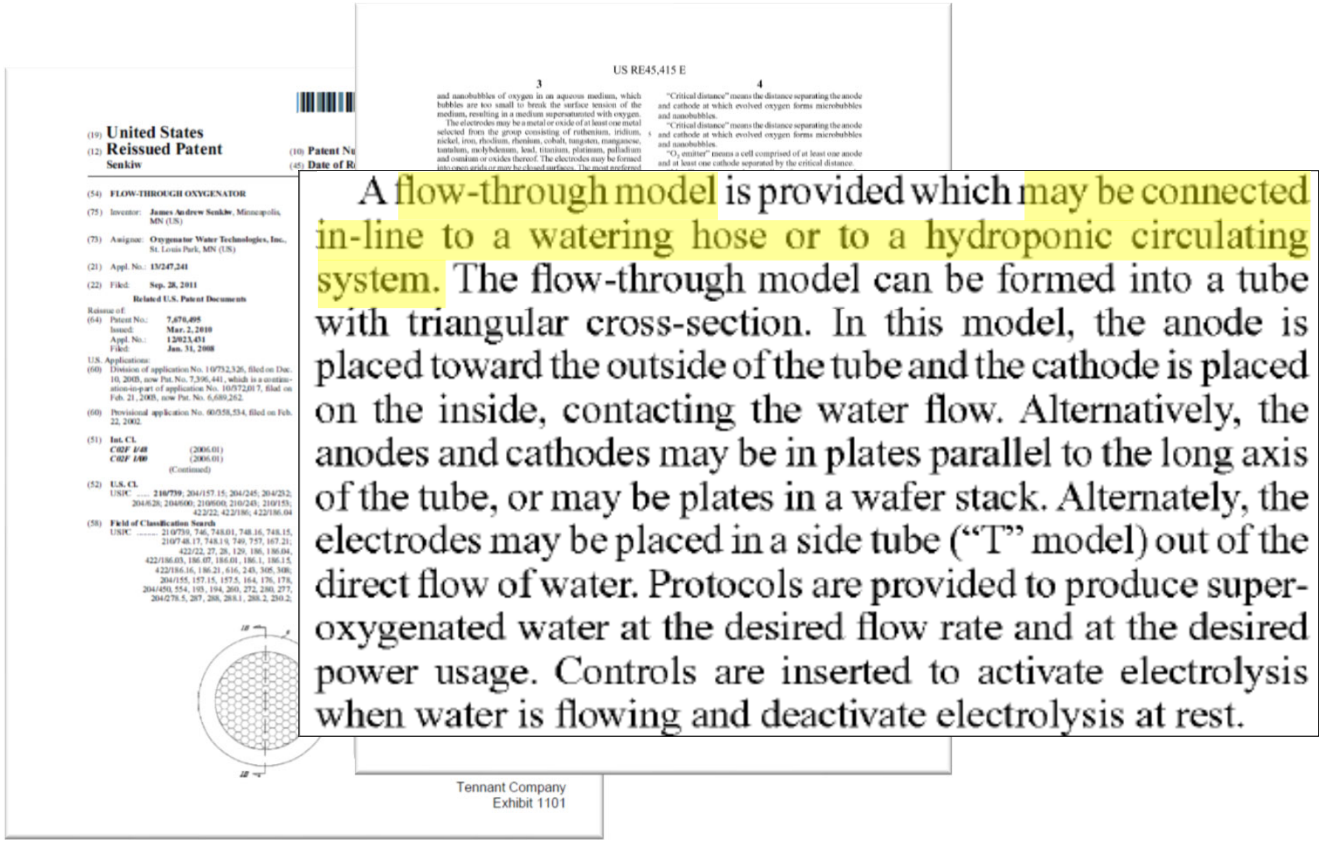
(54) FLOW-THROUGH OXYGENATOR

US RE45,415 E

Tennant Company
Exhibit 1101

Fredrikson & BYRON, P.A.

“Flowing Water . . . Through an Electrolysis Emitter”



US RE45,415 E

(19) United States
(12) Reissued Patent
Senkiw

(54) FLOW-THROUGH OXYGENATOR

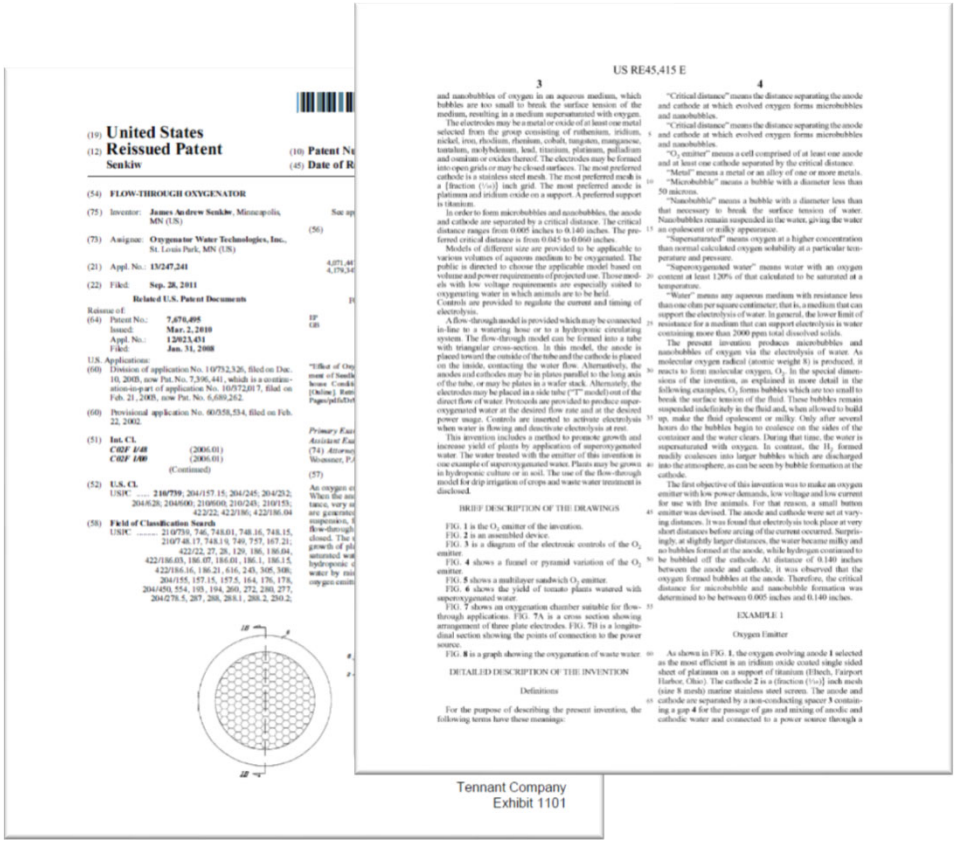
A flow-through model is provided which may be connected in-line to a watering hose or to a hydroponic circulating system. The flow-through model can be formed into a tube with triangular cross-section. In this model, the anode is placed toward the outside of the tube and the cathode is placed on the inside, contacting the water flow. Alternatively, the anodes and cathodes may be in plates parallel to the long axis of the tube, or may be plates in a wafer stack. Alternately, the electrodes may be placed in a side tube (“T” model) out of the direct flow of water. Protocols are provided to produce super-oxygenated water at the desired flow rate and at the desired power usage. Controls are inserted to activate electrolysis when water is flowing and deactivate electrolysis at rest.

Tennant Company
Exhibit 1101

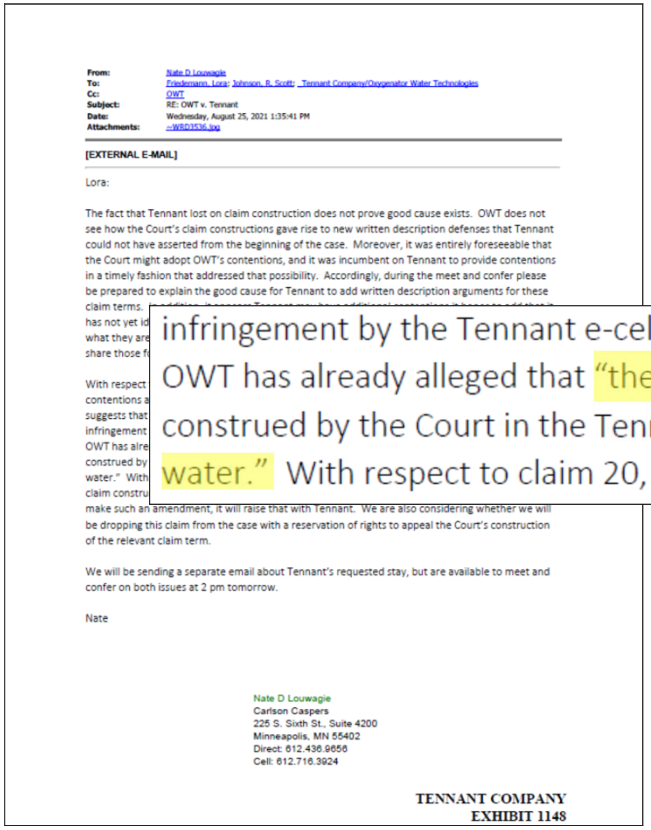
- Reply (Paper 42, 3
- Ex. 1101, 3:25-36

“Water Temperature is a Factor for Formation of the Suspension”

1. ‘415 Patent, claim 18 requires water temperature is a factor and that the temperature be no greater than about ambient temperature.
   - Petition (Paper 1), 34
   - Ex. 1101, 12:14-17
   - Reply (Paper 42), 11
2. For infringement, the Patent Owner asserts this does not require measuring or analyzing water temperature.
   - Reply (Paper 42), 5
   - Ex. 1148



"The Water has a Temperature No Greater than About Ambient… and the Water Temperature is a Factor for Formation of the Suspension" (Claim 18)



From: Nate D Louwagie
To: Friedemann, Lora; Johnson, R. Scott; _Tennant Company/Oxygenator Water Technologies
Cc: OWT
Subject: RE: OWT v. Tennant
Date: Wednesday, August 25, 2021 1:35:41 PM
Attachments: ~WRD3536.jpg

[EXTERNAL E-MAIL]

Lora:

The fact that Tennant lost on claim construction does not prove good cause exists. OWT does not see how the Court's claim constructions gave rise to new written description defenses that Tennant could not have asserted from the beginning of the case. Moreover, it was entirely foreseeable that the Court might adopt OWT's contentions, and it was incumbent on Tennant to provide contentions in a timely fashion that addressed that possibility. Accordingly, during the meet and confer please be prepared to explain the good cause for Tennant to add written description arguments for these claim terms.

With respect to claim 18, OWT has already alleged that "the water temperature is a factor for formation of the suspension" as construed by the Court in the Tennant process since Tennant instructs its user to use "clear ***cool*** water." With respect to claim 20, OWT is still in the process of analyzing the impact of the Court's claim construction. If we make such an amendment, it will raise that with Tennant. We are also considering whether we will be dropping this claim from the case with a reservation of rights to appeal the Court's construction of the relevant claim term.

We will be sending a separate email about Tennant's requested stay, but are available to meet and confer on both issues at 2 pm tomorrow.

Nate

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225 S. Sixth St., Suite 4200
Minneapolis, MN 55402
Direct: 612.436.9656
Cell: 612.716.3924

TENNANT COMPANY
EXHIBIT 1148

- Reply (Paper 42), 5
- Ex. 1148

Testing Burden

Petitioner's Testing

1. Petitioner reconstructed embodiments of three prior art reference and tested them during the pandemic
2. Board agreed Petitioner made a prima facie case for inherency (Paper No. 10, *24-25, and 35-36)
3. Burden then shifted to Patent Owner to prove the creation of "microbubbles" and "nanobubbles" was not inherent in the prior art. *Howmedica Osteonics Corp. v. Zimmer, Inc.*, 640 Fed. Appx. 951, 957 (Fed. Cir. 2016).
4. Patent Owner failed to do so.
    1. Patent Owner's Expert, Dr. White, testified:

BY MR. JOHNSON:

Q Have you yourself done any testing in this case?

A No.

Q Have you tried to recreate any prior art in this case?

A No.

- Reply (Paper 42), 1, 5-7, 10, 16, 17, 19
- Ex. 1147, 16:8-12.

Grounds 1-6
Primary Ref.:
Wikey – US Pat. No. 3,891,535

Fredrikson & BYRON, P.A.

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

Petitioner's Grounds 1-6

Ground	Challenged Claims	35 U.S.C. §	Prior Art
1	13, 18-23 and 25	102	Wikey
2	13, 18-23 and 25	103	Wikey and AFD
3	13, 18-23 and 25	103	Wikey and AFD in view of the general knowledge, experience and common sense of a POSITA as reflected in Wendt, Han, Glembotsky and Burns
4	26 and 27	103	Wikey and Clark
5	26 and 27	103	Wikey, Clark and AFD
6	26 and 27	103	Wikey, Clark and AFD in view of the general knowledge, experience and common sense of a POSITA, as reflected in Wendt, Han, Glembotsky and Burns

- Petition (Paper 1), 4

Ground 1- Wikey Anticipates Claims 13, 18-23, and 25

RE45,415

13. A method for producing an oxygenated aqueous composition comprising:

flowing water at a flow rate no greater than 12 gallons per minute through an electrolysis emitter comprising an electrical power source electrically connected to an anode electrode and a cathode electrode contained in a tubular housing,

causing electricity to flow from the power source to the electrodes, and,

producing the composition comprising a suspension comprising oxygen microbubbles and nanobubbles in the water, the microbubbles and nanobubbles having a bubble diameter of less than 50 microns, wherein:

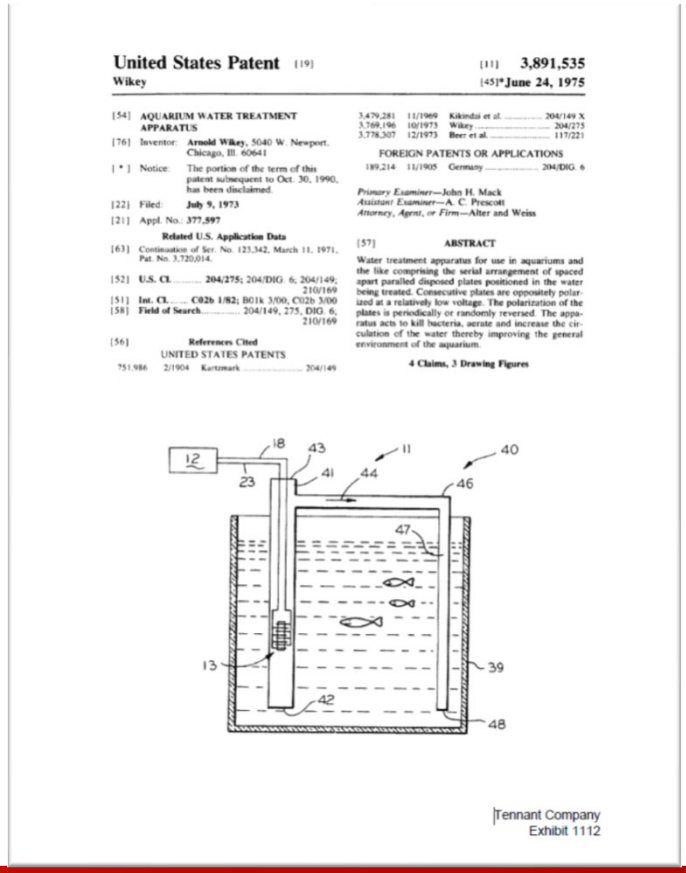
the anode electrode is separated at a critical distance from the cathode such that the critical distance is from 0.005 inches to 0.140 inches;

the power source produces a voltage no greater than about 28.3 volts and an amperage no greater than about 13 amps,

the tubular housing has an inlet and an outlet and a tubular flow axis from the inlet to the outlet;

the water flows in the inlet, out the outlet, is in fluid connection with the electrodes, and the water flowing into the inlet has a conductivity produced by the presence of dissolved solids such that the water supports plant or animal life.

- Petition (Paper 1), 30
- Ex. 1101, 11:20-12:4
- Ex. 1112



United States Patent [19]
Wikey

[11] 3,891,535
[45]* June 24, 1975

[54] AQUARIUM WATER TREATMENT APPARATUS

[76] Inventor: Arnold Wikey, 5040 W. Newport, Chicago, Ill. 60641

[*] Notice: The portion of the term of this patent subsequent to Oct. 30, 1990, has been disclaimed.

[22] Filed: July 9, 1973

[21] Appl. No.: 377,597

Related U.S. Application Data

[63] Continuation of Ser. No. 123,342, March 11, 1971, Pat. No. 3,720,014.

[52] U.S. Cl. 204/275; 204/DIG. 6; 204/149; 210/169

[51] Int. Cl. C02b 1/82; B01k 3/00, C02b 3/00

[58] Field of Search ..... 204/149, 275, DIG. 6, 210/169

[56] References Cited
UNITED STATES PATENTS

751,986	2/1904	Kartzmark	204/149
3,479,281	11/1969	Kikindai et al.	204/149 X
3,769,196	10/1973	Wikey	204/275
3,778,307	12/1973	Beer et al.	117/221

FOREIGN PATENTS OR APPLICATIONS

189,214	11/1905	Germany	204/DIG. 6

Primary Examiner—John H. Mack
Assistant Examiner—A. C. Prescott
Attorney, Agent, or Firm—Alter and Weiss

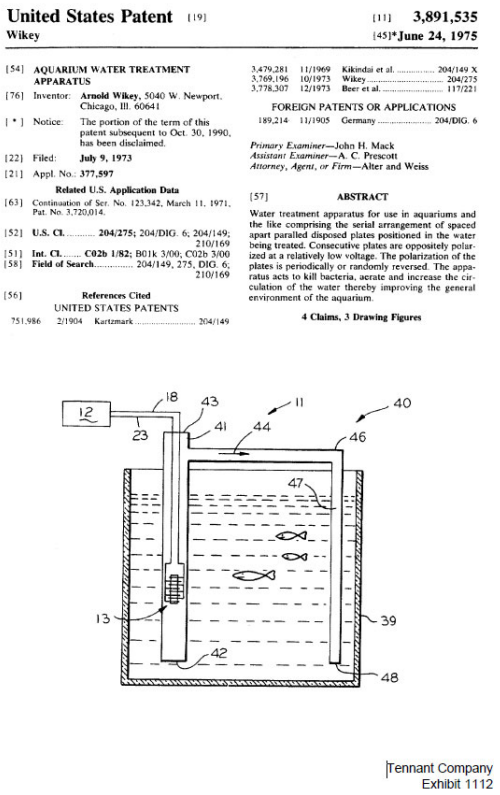
[57] ABSTRACT

Water treatment apparatus for use in aquariums and the like comprising the serial arrangement of spaced apart parallel disposed plates positioned in the water being treated. Consecutive plates are oppositely polarized at a relatively low voltage. The polarization of the plates is periodically or randomly reversed. The apparatus acts to kill bacteria, aerate and increase the circulation of the water thereby improving the general environment of the aquarium.

4 Claims, 3 Drawing Figures

Tennant Company
Exhibit 1112

Ground 1 – Wikey Teaches "Flowing Water at a Flow Rate No Greater than 12 Gallons per Minute"



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4 Claims, 3 Drawing Figures

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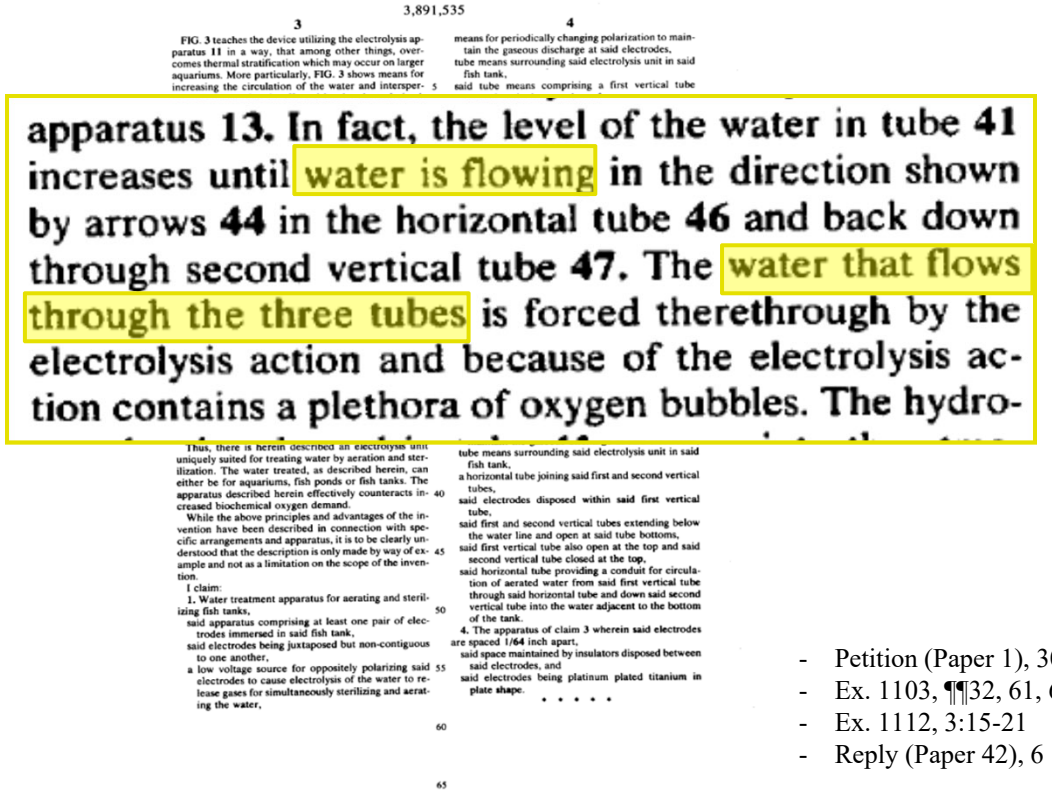


3,891,535

3 4

FIG. 3 teaches the device utilizing the electrolysis apparatus 11 in a way, that among other things, overcomes thermal stratification which may occur on larger aquariums. More particularly, FIG. 3 shows means for increasing the circulation of the water and intersper-

apparatus 13. In fact, the level of the water in tube 41 increases until water is flowing in the direction shown by arrows 44 in the horizontal tube 46 and back down through second vertical tube 47. The water that flows through the three tubes is forced therethrough by the electrolysis action and because of the electrolysis action contains a plethora of oxygen bubbles. The hydro-

Thus, there is herein described an electrolysis unit uniquely suited for treating water by aeration and sterilization. The water treated, as described herein, can either be for aquariums, fish ponds or fish tanks. The apparatus described herein effectively counteracts increased biochemical oxygen demand.

While the above principles and advantages of the invention have been described in connection with specific arrangements and apparatus, it is to be clearly understood that the description is only made by way of example and not as a limitation on the scope of the invention.

I claim:

1. Water treatment apparatus for aerating and sterilizing fish tanks,

said apparatus comprising at least one pair of electrodes immersed in said fish tank,

said electrodes being juxtaposed but non-contiguous to one another,

a low voltage source for oppositely polarizing said electrodes to cause electrolysis of the water to release gases for simultaneously sterilizing and aerating the water,

means for periodically changing polarization to maintain the gaseous discharge at said electrodes,

tube means surrounding said electrolysis unit in said fish tank,

said tube means comprising a first vertical tube

tube means surrounding said electrolysis unit in said fish tank,

a horizontal tube joining said first and second vertical tubes,

said electrodes disposed within said first vertical tube,

said first and second vertical tubes extending below the water line and open at said tube bottoms,

said first vertical tube also open at the top and said second vertical tube closed at the top,

said horizontal tube providing a conduit for circulation of aerated water from said first vertical tube through said horizontal tube and down said second vertical tube into the water adjacent to the bottom of the tank.

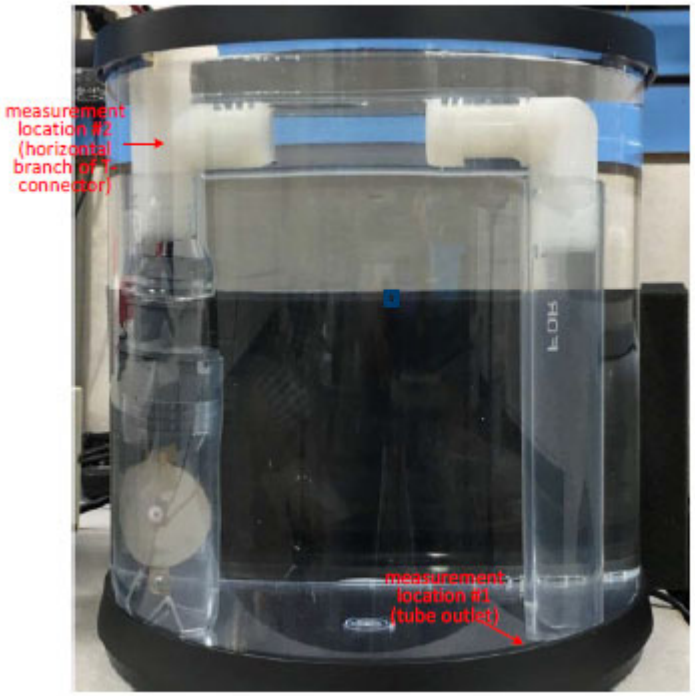
4. The apparatus of claim 3 wherein said electrodes are spaced 1/64 inch apart,

said space maintained by insulators disposed between said electrodes, and

said electrodes being platinum plated titanium in plate shape.

- Petition (Paper 1), 30
- Ex. 1103, ¶¶32, 61, 68, 69
- Ex. 1112, 3:15-21
- Reply (Paper 42), 6

Ground 1 – Wikey Teaches "Flowing Water at a Flow Rate No Greater than 12 Gallons per Minute"



- Petition (Paper 1), 22
- Ex. 1103, ¶ 54

56. Following are relevant parameters/measurements obtained from Operation #1:

Parameters/Measurements	Value
electrode spacing	0.016 inch
water type	well water
Voltage	6V
flow rate	0.96 gpm
current	6.2 amp
initial conductivity	358.2 ppm
initial dissolved oxygen content	69.8%
dissolved oxygen content while running cell	121.4%
3 hour dissolved oxygen content	126.6%

- Petition (Paper 1), 22
- Ex. 1103, ¶ 56

Ground 1- Wikey Anticipates Claims 13, 18-23, and 25

RE45,415

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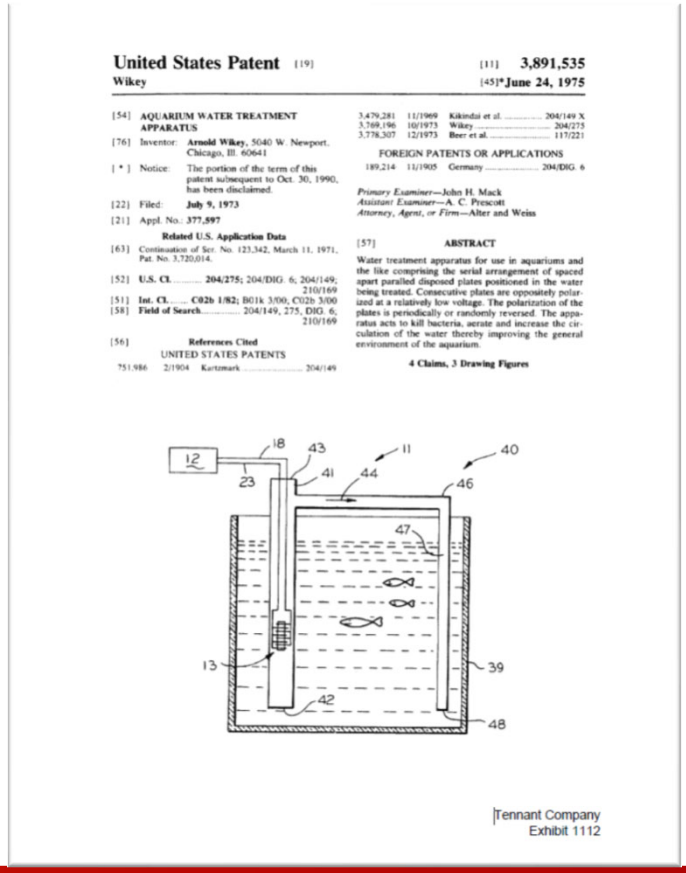
the anode electrode is separated at a critical distance from the cathode such that the critical distance is from 0.005 inches to 0.140 inches;

the power source produces a voltage no greater than about 28.3 volts and an amperage no greater than about 13 amps,

the tubular housing has an inlet and an outlet and a tubular flow axis from the inlet to the outlet;

the water flows in the inlet, out the outlet, is in fluid connection with the electrodes, and the water flowing into the inlet has a conductivity produced by the presence of dissolved solids such that the water supports plant or animal life.

- Petition (Paper 1), 30
- Ex. 1101, 11:20-12:4
- Ex. 1112



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[52] U.S. Cl. 204/275; 204/DIG. 6; 204/149; 210/169

[51] Int. Cl. C02b 1/82; B01k 3/00, C02b 3/00

[58] Field of Search ..... 204/149, 275, DIG. 6, 210/169

[56] References Cited
UNITED STATES PATENTS

751,986 2/1904 Kartzmark 204/149

3,479,281 11/1969 Kikindai et al. ..... 204/149 X
3,769,196 10/1973 Wikey 204/275
3,778,307 12/1973 Beer et al. 117/221

FOREIGN PATENTS OR APPLICATIONS

189,214 11/1905 Germany 204/DIG. 6

Primary Examiner—John H. Mack
Assistant Examiner—A. C. Prescott
Attorney, Agent, or Firm—Alter and Weiss

[57] ABSTRACT

Water treatment apparatus for use in aquariums and the like comprising the serial arrangement of spaced apart parallel disposed plates positioned in the water being treated. Consecutive plates are oppositely polarized at a relatively low voltage. The polarization of the plates is periodically or randomly reversed. The apparatus acts to kill bacteria, aerate and increase the circulation of the water thereby improving the general environment of the aquarium.

4 Claims, 3 Drawing Figures

Tennant Company
Exhibit 1112

Ground 1- Wikey Anticipates Claims 13, 18-23, and 25

RE45,415

13. A method for producing an oxygenated aqueous composition comprising:

flowing water at a flow rate no greater than 12 gallons per minute through an electrolysis emitter comprising an electrical power source electrically connected to an anode electrode and a cathode electrode contained in a tubular housing,

causing electricity to flow from the power source to the electrodes, and,

producing the composition comprising a suspension comprising oxygen microbubbles and nanobubbles in the water, the microbubbles and nanobubbles having a bubble diameter of less than 50 microns, wherein:

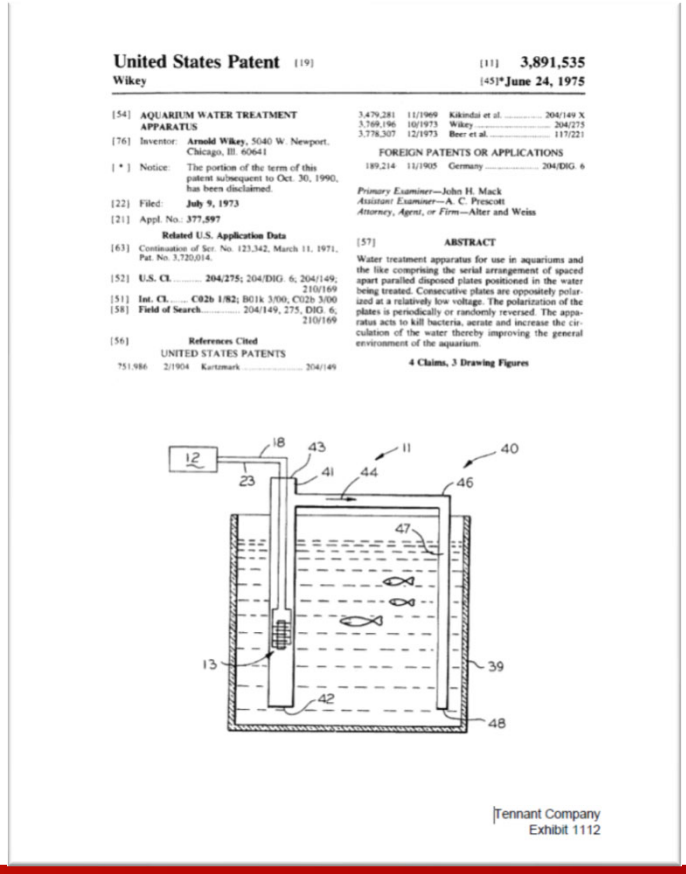
the anode electrode is separated at a critical distance from the cathode such that the critical distance is from 0.005 inches to 0.140 inches;

the power source produces a voltage no greater than about 28.3 volts and an amperage no greater than about 13 amps,

the tubular housing has an inlet and an outlet and a tubular flow axis from the inlet to the outlet;

the water flows in the inlet, out the outlet, is in fluid connection with the electrodes, and the water flowing into the inlet has a conductivity produced by the presence of dissolved solids such that the water supports plant or animal life.

- Petition (Paper 1), 30
- Ex. 1101, 11:20-12:4
- Ex. 1103, ¶¶ 29, 30
- Ex. 1112



United States Patent [19]
Wikey

[11] 3,891,535
[45]* June 24, 1975

[54] AQUARIUM WATER TREATMENT APPARATUS

[76] Inventor: Arnold Wikey, 5040 W. Newport, Chicago, Ill. 60641

[*] Notice: The portion of the term of this patent subsequent to Oct. 30, 1990, has been disclaimed.

[22] Filed: July 9, 1973

[21] Appl. No.: 377,597

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4 Claims, 3 Drawing Figures

Tennant Company
Exhibit 1112

Ground 1 – Wikey Teaches "causing electricity to flow"

United States Patent [19]
Wikey

[11] **3,891,535**
[45]* **June 24, 1975**

[54] **AQUARIUM WATER TREATMENT APPARATUS**

[76] Inventor: **Arnold Wikey**, 5040 W. Newport, Chicago, Ill. 60641

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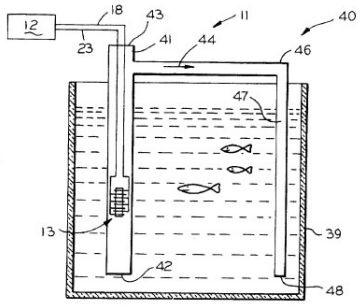

Tennant Company
Exhibit 1112

3,891,535

1

AQUARIUM WATER TREATMENT APPARATUS

This invention is a continuation in part of my prior application filed on Mar. 11, 1971, having Ser. No. 123,342, now U.S. Pat. No. 3,720,014 and entitled

2

in fish tanks, aquariums and the like. A reversing power supply generally designated as **12** feeds power to the electrodes units **13** diagrammatically shown under water **14**. The electrode unit comprises a plurality of juxtaposed plates or electrodes, such as electrodes **16** and **17**. In a preferred embodiment of the invention, the electrodes are plates made of platinum coated titanium.

lizes two or more plates spaced apart and insulated from each other. The plates are immersed in a fish tank or the like. A power source is provided for oppositely polarizing juxtaposed plates. A low voltage field is periodically reversed to prevent any buildup of impurities on the plates. Means may further be provided for carrying the released gases; i.e., the oxygen to the bottom of the bodies of waters to enhance the aerating effect along with the sterilization of the water.

The foregoing and other objects and advantages of this invention and the manner of obtaining them will be more apparent, and the invention itself will be best understood by reference to the following description of an embodiment of this invention taken in conjunction with the accompanying drawings, wherein:

FIG. **1** is a schematic view of the inventive water aerating treatment apparatus;

FIG. **2** shows the apparatus of FIG. **1** adapted for use in fish ponds or aquariums; and

FIG. **3** shows a further refinement of the apparatus of FIG. 1.

In FIG. **1** the number **11** generally shows the electrolysis apparatus utilized for aerating and treating water

the relative amperage of the preferred embodiment is in the order of ½ amp. With the low voltage across the alternate plates, the water tends to electrolyze and break into its constituent gases; i.e., two parts hydrogen and one part oxygen. With a platinum coated titanium plate, the bubbles of gas including oxygen are extremely small, and the plates themselves tend to resist any buildup of residue of impurities thereon. In addition, the reversing of the polarity also has tendencies to retain the plates in a clean condition so that they maximize the action of electrolysis obtained between the plates.

FIG. **2** shows utilization of the apparatus of FIG. **1** in a fish tank **39** where it is used for purifying and aerating the water. The size of the fish tank is of little consequence since more electrode units are added if required by the volume of water and number of fish in the aquarium.

The electrode unit **13** is shown connected to a power supply **12**. The showing, of course, is schematic, and the plates of the unit are in actuality more closely packed together to be within the dimensions set forth in the description of the plates of FIG. **1**.

- Petition (Paper 1), 30
- Ex. 1103, ¶¶ 32, 61, 68, 69
- Ex. 1112, 2:1-8
- Reply (Paper 42), 6

Ground 1 – Wikey Teaches "causing electricity to flow"

United States Patent [19]
Wikey

[11] **3,891,535**
[45]* **June 24, 1975**

[54] **AQUARIUM WATER TREATMENT APPARATUS**

[76] Inventor: **Arnold Wikey**, 5040 W. Newport, Chicago, Ill. 60641

[*] Notice: The portion of the term of this patent subsequent to Oct. 30, 1990, has been disclaimed.

[22] Filed: **July 9, 1973**

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[51] **Int. Cl.**..... **C02b 1/82**; B01k 3/00; C02b 3/00

[58] **Field of Search**..... 204/149, 275, DIG. 6; 210/169

3,479,281	11/1969	Kikindai et al.	204/149 X
3,769,196	10/1973	Wikey	204/275
3,778,307	12/1973	Beer et al.	117/221

FOREIGN PATENTS OR APPLICATIONS

189,214	11/1905	Germany	204/DIG. 6

Primary Examiner—John H. Mack
Assistant Examiner—A. C. Prescott
Attorney, Agent, or Firm—Alter and Weiss

[57] **ABSTRACT**

Water treatment apparatus for use in aquariums and the like comprising the serial arrangement of spaced apart paralled disposed plates positioned in the water being treated. Consecutive plates are oppositely polarized at a relatively low voltage. The polarization of the plates is periodically or randomly reversed. The apparatus acts to kill bacteria, aerate and increase the cir-

3,891,535

1 2

AQUARIUM WATER TREATMENT APPARATUS

This invention is a continuation in part of my prior application filed on Mar. 11, 1971, having Ser. No. 123,342, now U.S. Pat. No. 3,720,014 and entitled WATER TREATMENT APPARATUS AND METHOD. This invention relates to water treatment apparatus and more particularly to apparatus for improving the environment of the aquariums and the like.

Just as the death of natural bodies of water is caused by cultural and natural eutrophication, fish tanks and aquariums are also subject to the hazards of natural pollution. Among the most prominent characteristics of such nonusable polluted fish tank water are the high bacteria count and lack of oxygen. Of course, there are other characteristics, such as a putrid smell and/or algae, for example.

In the past, aeration of fish tanks and aquariums has been accomplished through the use of pumps and agitators. The pumps and agitators are relatively inefficient and noisy. Furthermore, they fail to reduce the bacteria in the tank.

Accordingly, an object of this present invention is to

in fish tanks, aquariums and the like. A reversing power supply generally designated as **12** feeds power to the electrodes units **13** diagrammatically shown under water **14**. The electrode unit comprises a plurality of juxtaposed plates or electrodes, such as electrodes **16** and **17**. In a preferred embodiment of the invention, the electrodes are plates made of platinum coated titanium.

The consecutive plates are oppositely polarized. For example, when plate **16** is positively polarized, then plate **17** is negatively polarized. The conductor **18** is connected to plate **16** and **19** and then passes around or through plate **17**. There is no electrical connection between plate **17** and conductor **18**. The plate **21** is also connected to the alternate plates, Similarly, conductor **23** is coupled to the alternate plate commencing with plate **17** at **24**.

The plates are all shown mounted on an insulated rod **26** and separated from each other with insulated washers, such as washer **27**. In a preferred embodiment of the invention, the washers are made from teflon.

The power supply **12** is shown schematically as comprising a D.C. source, such as battery **28**, which is connected to conductors **29** and **31**.

A preferred embodiment of the present invention utilizes two or more plates spaced apart and insulated from each other. The plates are immersed in a fish tank or the like. A power source is provided for oppositely polarizing juxtaposed plates. A low voltage field is periodically reversed to prevent any buildup of impurities on the plates. Means may further be provided for carrying the released gases; i.e., the oxygen to the bottom of the bodies of waters to enhance the aerating effect along with the sterilization of the water.

The foregoing and other objects and advantages of this invention and the manner of obtaining them will be more apparent, and the invention itself will be best understood by reference to the following description of an embodiment of this invention taken in conjunction with the accompanying drawings, wherein:

FIG. **1** is a schematic view of the inventive water aerating treatment apparatus;

FIG. **2** shows the apparatus of FIG. **1** adapted for use in fish ponds or aquariums; and

FIG. **3** shows a further refinement of the apparatus of FIG. **1**.

In FIG. **1** the number **11** generally shows the electrolysis apparatus utilized for aerating and treating water

the relative amperage of the preferred embodiment is in the order of ½ amp. With the low voltage across the alternate plates, the water tends to electrolyze and break into its constituent gases; i.e., two parts hydrogen and one part oxygen. With a platinum coated titanium plate, the bubbles of gas including oxygen are extremely small, and the plates themselves tend to resist any buildup of residue of impurities thereon. In addition, the reversing of the polarity also has tendencies to retain the plates in a clean condition so that they maximize the action of electrolysis obtained between the plates.

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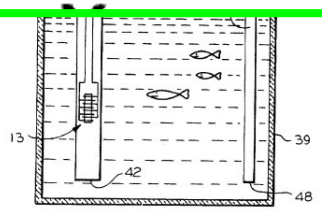
The electrode unit **13** is shown connected to a power supply **12**. The showing, of course, is schematic, and the plates of the unit are in actuality more closely packed together to be within the dimensions set forth in the description of the plates of FIG. **1**.

The power supply 12 is shown schematically as comprising a D.C. source, such as battery 28, which is connected to conductors 29 and 31.



Tennant Company
Exhibit 1112

- Petition (Paper 1), 30
- Reply (Paper 42), 6
- Ex. 1103, ¶¶ 29, 30
- Ex. 1112, 2:23-25

Ground 1- Wikey Anticipates Claims 13, 18-23, and 25

RE45,415

13. A method for producing an oxygenated aqueous composition comprising:

flowing water at a flow rate no greater than 12 gallons per minute through an electrolysis emitter comprising an electrical power source electrically connected to an anode electrode and a cathode electrode contained in a tubular housing,

causing electricity to flow from the power source to the electrodes, and,

producing the composition comprising a suspension comprising oxygen microbubbles and nanobubbles in the water, the microbubbles and nanobubbles having a bubble diameter of less than 50 microns, wherein:

the anode electrode is separated at a critical distance from the cathode such that the critical distance is from 0.005 inches to 0.140 inches;

the power source produces a voltage no greater than about 28.3 volts and an amperage no greater than about 13 amps,

the tubular housing has an inlet and an outlet and a tubular flow axis from the inlet to the outlet;

the water flows in the inlet, out the outlet, is in fluid connection with the electrodes, and the water flowing into the inlet has a conductivity produced by the presence of dissolved solids such that the water supports plant or animal life.

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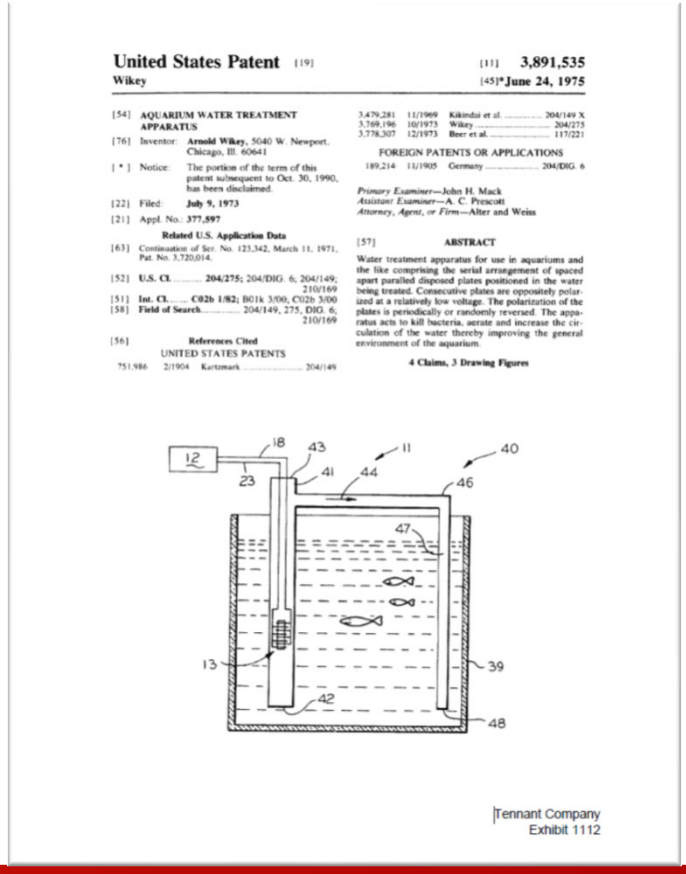
- Ex. 1101, 11:20-12:4
- Ex. 1103, ¶¶ 29, 30
- Ex. 1112



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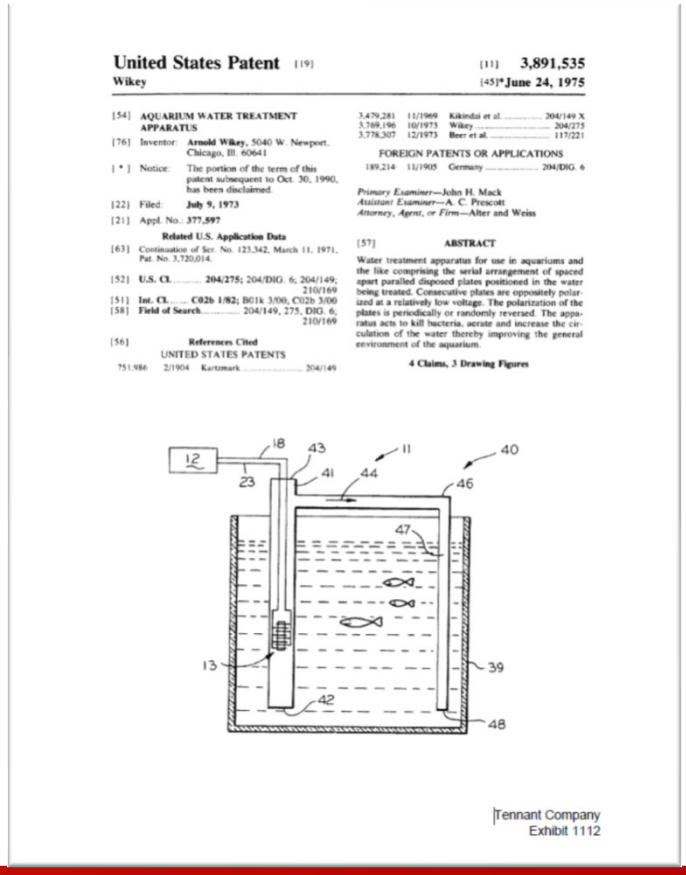
the water flows in the inlet, out the outlet, is in fluid connection with the electrodes, and the water flowing into the inlet has a conductivity produced by the presence of dissolved solids such that the water supports plant or animal life.

- Petition (Paper 1), 31
- Ex. 1101, 11:20-12:4
- Ex. 1103, ¶ 35
- Ex. 1112



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4 Claims, 3 Drawing Figures

Tennant Company
Exhibit 1112

Ground 1 – Wikey Teaches "producing the composition comprising a suspension comprising oxygen microbubbles and nanobubbles in the water, . . ."

United States Patent [19]
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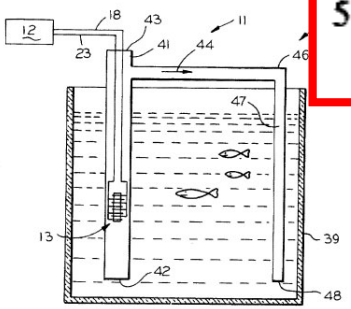

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In the past, aeration of fish tanks and aquariums has been accomplished through the use of pumps and agitators. The pumps and agitators are relatively inefficient and noisy. Furthermore, they fail to reduce the bacteria in the tank.

Accordingly, an object of this present invention is to provide economical and efficient equipment for aerating fish tanks and the like.

A related object of the present invention is to provide the apparatus for aerating water while sterilizing the water.

come pollution.

A preferred embodiment of the present invention utilizes two or more plates spaced apart and insulated from each other. The plates are immersed in a fish tank or the like. A power source is provided for oppositely polarizing juxtaposed plates. A low voltage field is periodically reversed to prevent any buildup of impurities on the plates. Means may further be provided for carrying the released gases; i.e., the oxygen to the bottom of the bodies of waters to enhance the aerating effect along with the sterilization of the water.

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FIG. **1** is a schematic view of the inventive water aerating treatment apparatus;

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FIG. **3** shows a further refinement of the apparatus of FIG. **1**.

In FIG. **1** the number **11** generally shows the electrolysis apparatus utilized for aerating and treating water

in fish tanks, aquariums and the like. A reversing power supply generally designated as **12** feeds power to the electrodes units **13** diagrammatically shown under water **14**. The electrode unit comprises a plurality of juxtaposed plates or electrodes, such as electrodes **16** and **17**. In a preferred embodiment of the invention, the electrodes are plates made of platinum coated titanium.

The consecutive plates are oppositely polarized. For example, when plate **16** is positively polarized, then plate **17** is negatively polarized. The conductor **18** is connected to plate **16** and **19** and then passes around or through plate **17**. There is no electrical connection between plate **17** and conductor **18**. The plate **21** is also connected to the alternate plates, Similarly, conductor **23** is coupled to the alternate plate commencing with plate **17** at **24**.

The plates are all shown mounted on an insulated rod **26** and separated from each other with insulated washers, such as washer **27**. In a preferred embodiment of the invention, the washers are made from teflon.

The power supply **12** is shown schematically as comprising a D.C. source, such as battery **28**, which is connected to conductors **29** and **31**.

Means are provided for periodically changing the polarity of the electrodes. As schematically shown in FIG. **1**, a small synchronous motor is coupled to a source of A.C. power. The motor **32** drives cam **33** through a

water in which the electrodes are placed. Nonetheless, the relative amperage of the preferred embodiment is in the order of ½ amp. With the low voltage across the alternate plates, the water tends to electrolyze and break into its constituent gases; i.e., two parts hydrogen and one part oxygen. With a platinum coated titanium plate, the bubbles of gas including oxygen are extremely small, and the plates themselves tend to resist any buildup of residue of impurities thereon. In addition, the reversing of the polarity also has tendencies to retain the plates in a clean condition so that they maximize the action of electrolysis obtained between the plates.

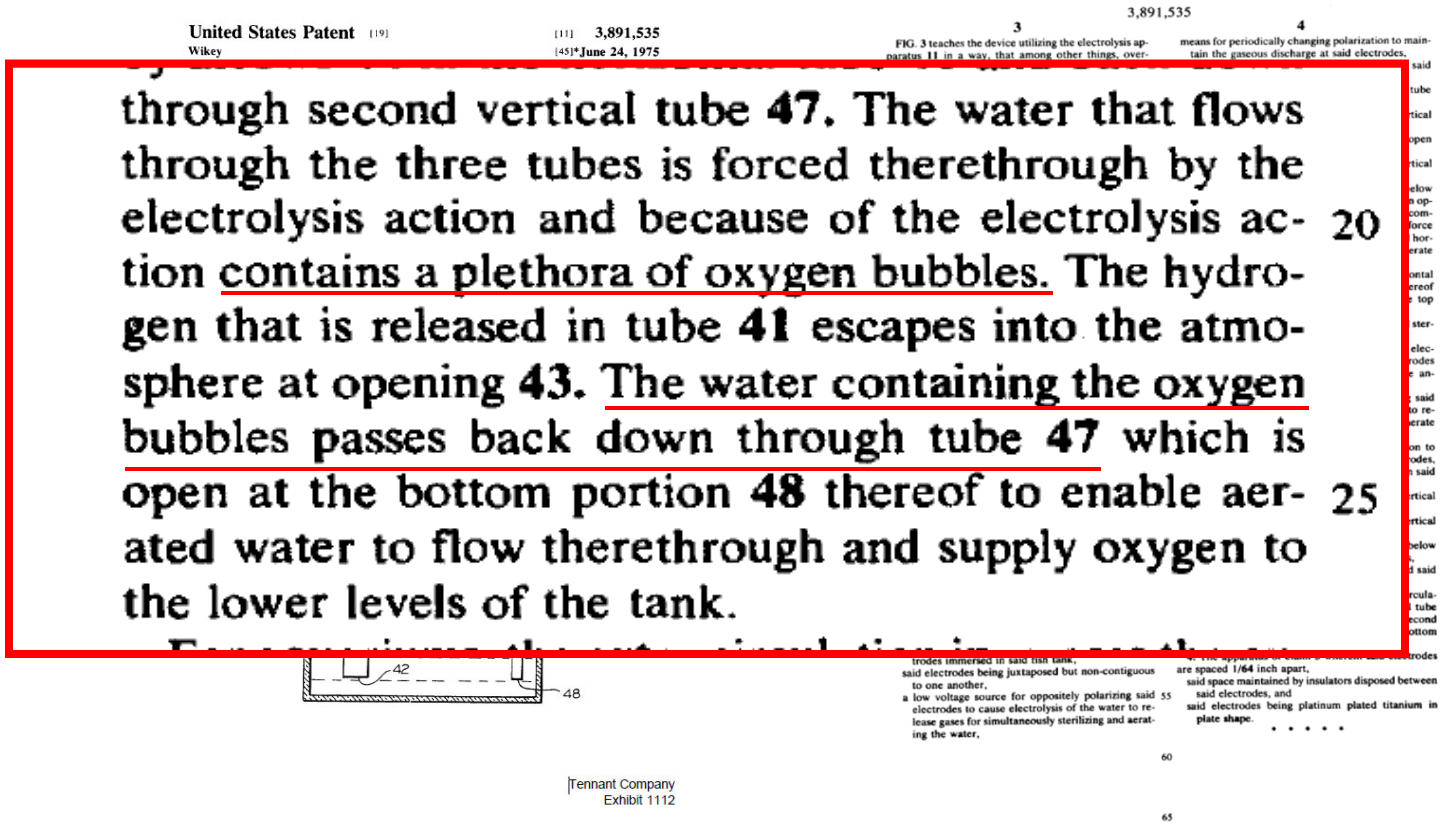
FIG. **2** shows utilization of the apparatus of FIG. **1** in a fish tank **39** where it is used for purifying and aerating the water. The size of the fish tank is of little consequence since more electrode units are added if required by the volume of water and number of fish in the aquarium.

The electrode unit **13** is shown connected to a power supply **12**. The showing, of course, is schematic, and the plates of the unit are in actuality more closely packed together to be within the dimensions set forth in the description of the plates of FIG. **1**.

50 and one part oxygen. With a platinum coated titanium plate, the bubbles of gas including oxygen are extremely small, and the plates themselves tend to resist

- Petition (Paper 1), 31
- Reply (Paper 42), 6
- Ex. 1112, 2:49-51

Ground 1 – Wikey Teaches "producing the composition comprising a suspension comprising oxygen microbubbles and nanobubbles in the water, . . ."



United States Patent [19]
Wikey

[11] 3,891,535
[45] June 24, 1975

3,891,535

3 FIG. 3 teaches the device utilizing the electrolysis apparatus 11 in a way, that among other things, over-

4 means for periodically changing polarization to maintain the gaseous discharge at said electrodes.

through second vertical tube **47**. The water that flows through the three tubes is forced therethrough by the electrolysis action and because of the electrolysis action contains a plethora of oxygen bubbles. The hydrogen that is released in tube **41** escapes into the atmosphere at opening **43**. The water containing the oxygen bubbles passes back down through tube **47** which is open at the bottom portion **48** thereof to enable aerated water to flow therethrough and supply oxygen to the lower levels of the tank.

42

48

said electrodes being juxtaposed but non-contiguous to one another,

a low voltage source for oppositely polarizing said electrodes to cause electrolysis of the water to release gases for simultaneously sterilizing and aerating the water,

are spaced 1/64 inch apart,

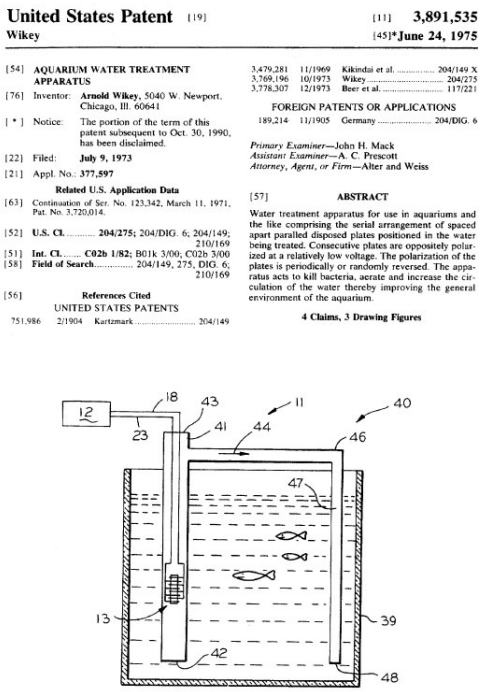
said space maintained by insulators disposed between said electrodes, and

said electrodes being platinum plated titanium in plate shape.

Tennant Company
Exhibit 1112

- Petition (Paper 1), 31
- Reply (Paper 42), 6
- Ex. 1112, 3:18-26

Ground 1 – Wikey Teaches "producing the composition comprising a suspension comprising oxygen microbubbles and nanobubbles in the water, . . ."



United States Patent [19]
Wikey

[11] 3,891,535
[45]* June 24, 1975

[54] AQUARIUM WATER TREATMENT APPARATUS

[76] Inventor: Arnold Wikey, 5040 W. Newport, Chicago, Ill. 60641

[*] Notice: The portion of the term of this patent subsequent to Oct. 30, 1990, has been disclaimed.

[22] Filed: July 9, 1973

[21] Appl. No.: 377,597

Related U.S. Application Data

[63] Continuation of Ser. No. 123,342, March 11, 1971, Pat. No. 3,720,014.

[52] U.S. Cl. 204/275; 204/DIG. 6; 204/149; 210/169

[51] Int. Cl. C02b 1/82; B01k 3/00; C02b 3/00

[58] Field of Search ..... 204/149, 275, DIG. 6; 210/169

[56] References Cited
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3,479,281 11/1969 Kikindai et al. ..... 204/149 X
3,769,196 10/1973 Wikey 204/275
3,778,307 12/1973 Beer et al. 117/221

FOREIGN PATENTS OR APPLICATIONS

189,214 11/1905 Germany 204/DIG. 6

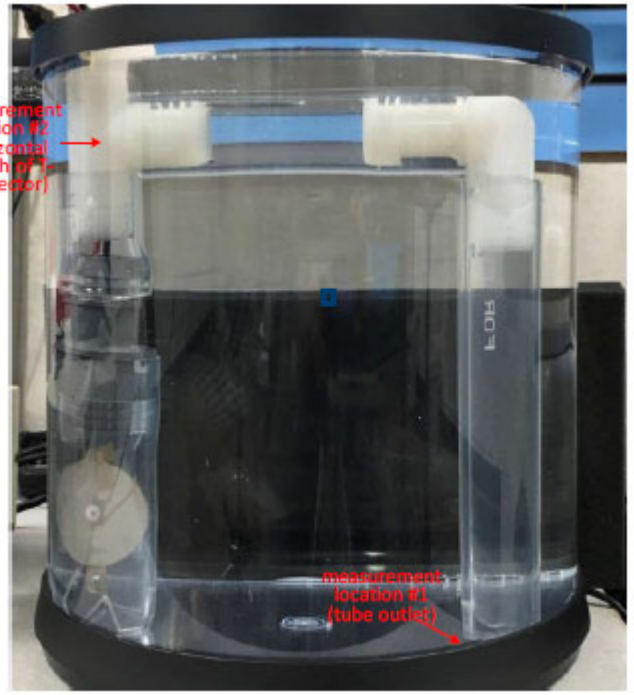
Primary Examiner—John H. Mack
Assistant Examiner—A. C. Prescott
Attorney, Agent, or Firm—Alter and Weiss

[57] ABSTRACT

Water treatment apparatus for use in aquariums and the like comprising the serial arrangement of spaced apart paralled disposed plates positioned in the water being treated. Consecutive plates are oppositely polarized at a relatively low voltage. The polarization of the plates is periodically or randomly reversed. The apparatus acts to kill bacteria, aerate and increase the circulation of the water thereby improving the general environment of the aquarium.

4 Claims, 3 Drawing Figures

Tennant Company
Exhibit 1112



- Petition (Paper 1), 22, 32
- Reply (Paper 42), 6
- Ex. 1103, ¶ 54
- Ex. 1112, 2:49-51

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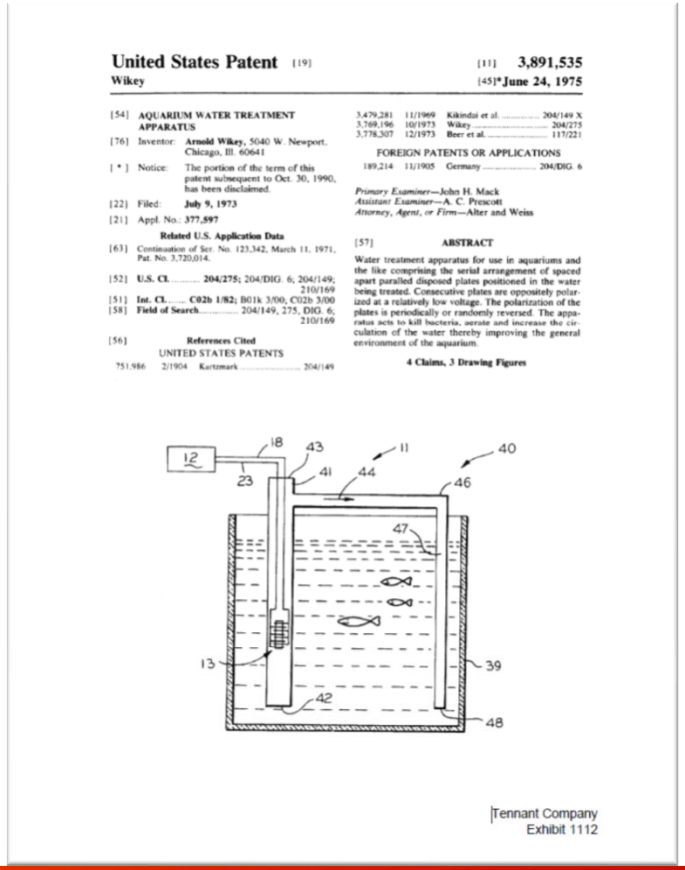

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3,778,307	12/1973	Beer et al.	117/221

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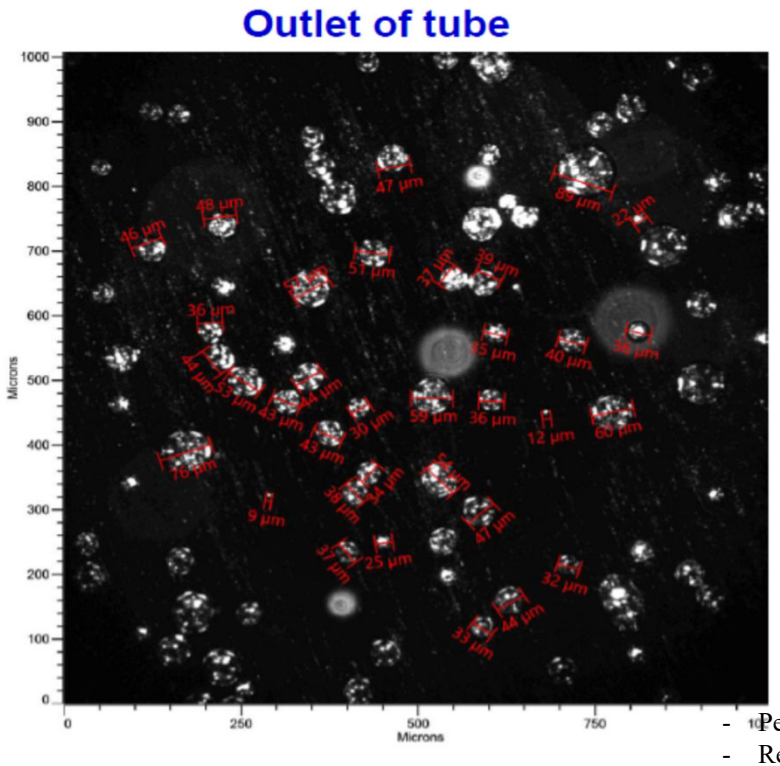
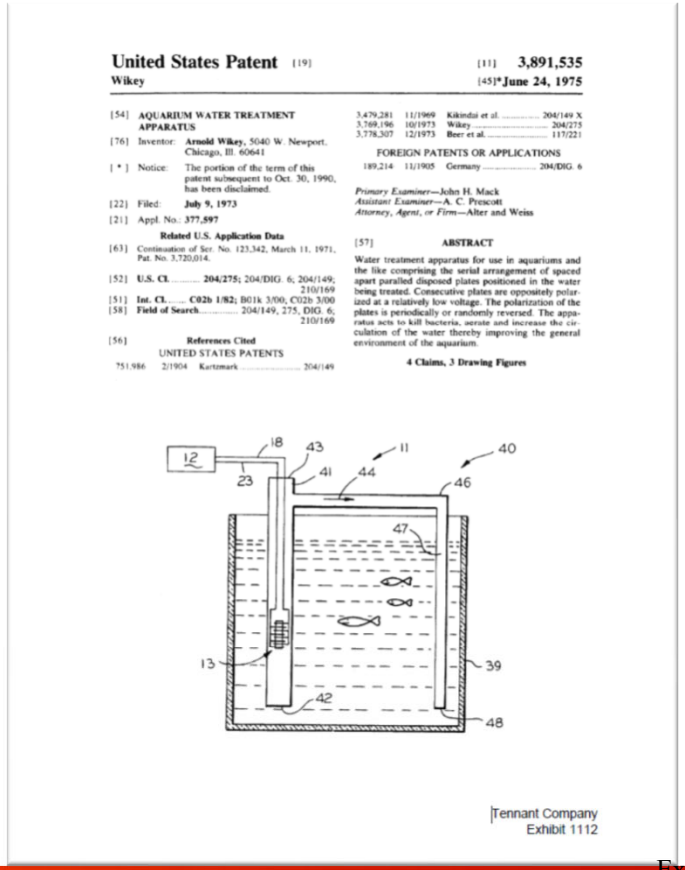
4 Claims, 3 Drawing Figures

Tennant Company
Exhibit 1112



- Petition (Paper 1), 22, 25
- Reply (Paper 42), 6
- Ex. 1103, ¶ 54
- Ex. 1112, 2:49-51
- Ex. 2179, 19

Ground 1 – Wikey Teaches "producing the composition comprising a suspension comprising oxygen microbubbles and nanobubbles in the water, . . ."



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[51] Int. Cl. C02b 1/82; B01k 3/00, C02b 3/00

[58] Field of Search ..... 204/149, 275, DIG. 6, 210/169

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3,479,281 11/1969 Kikindai et al. ..... 204/149 X
3,769,196 10/1973 Wikey 204/275
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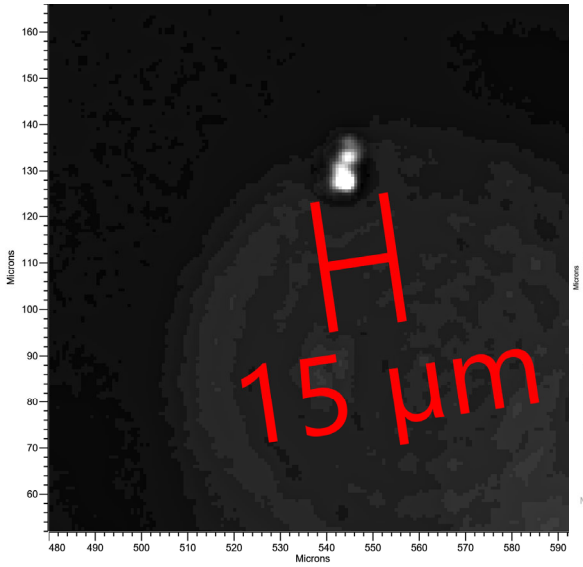
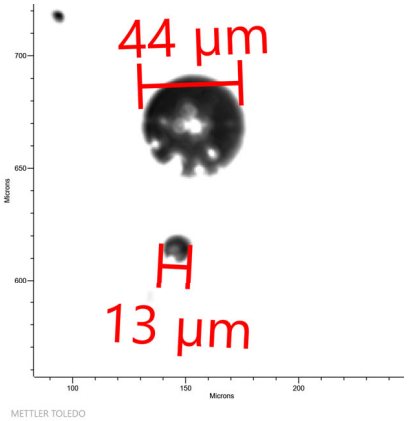
4 Claims, 3 Drawing Figures

Tennant Company
Exhibit 1112

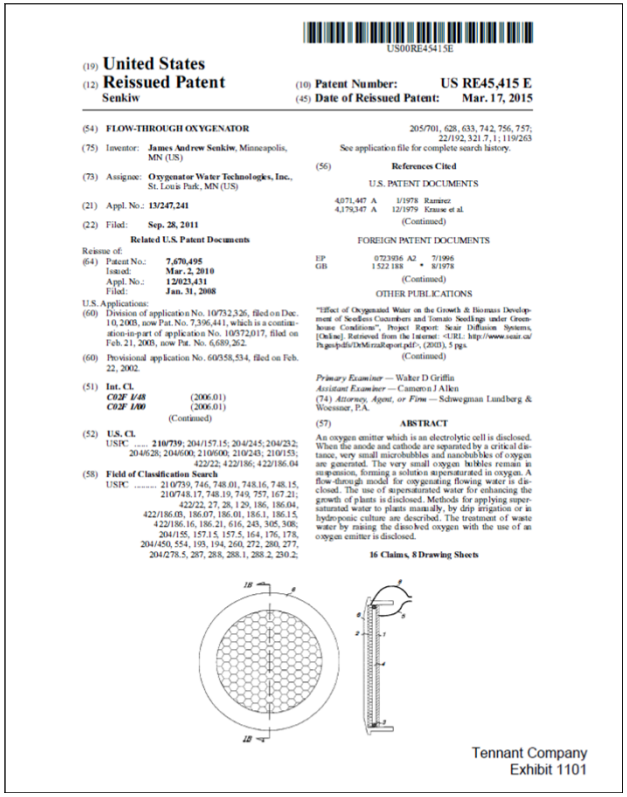




- Petition (Paper 1), 22, 25, 26
- Reply (Paper 42), 6
- Ex. 1103, ¶ 54
- Ex. 1112, 2:49-51
- Ex. 2179, 19

- Ex. 2179, 19

Ground 1 – Dr. Tremblay's Prior Art Testing Follows the '415 Patent Specification



US00RE45415E

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

(10) **Patent Number: US RE45,415 E**
(45) **Date of Reissued Patent: Mar. 17, 2015**

(54) **FLOW-THROUGH OXYGENATOR**

(75) Inventor: **James Andrew Senkiw**, Minneapolis, MN (US)

(73) Assignee: **Oxygenator Water Technologies, Inc.**, St. Louis Park, MN (US)

(21) Appl. No.: **13/247,241**

(22) Filed: **Sep. 28, 2011**

Related U.S. Patent Documents

Reissue of:
(64) Patent No.: **7,670,495**
Issued: **Mar. 2, 2010**
Appl. No.: **12/023,431**
Filed: **Jan. 31, 2008**

U.S. Applications:
(60) Division of application No. 10/732,326, filed on Dec. 10, 2003, now Pat. No. 7,396,441, which is a continuation-in-part of application No. 10/372,017, filed on Feb. 21, 2003, now Pat. No. 6,689,262.

(60) Provisional application No. 60/358,534, filed on Feb. 22, 2002.

(51) **Int. Cl.**
C02F 1/48 (2006.01)
C02F 1/00 (2006.01)
(Continued)

(52) **U.S. Cl.**
USPC **210/739**; 204/157.15; 204/245; 204/232; 204/628; 204/600; 210/600; 210/243; 210/153; 422/22; 422/186; 422/186.04

(58) **Field of Classification Search**
USPC 210/739, 746, 748.01, 748.16, 748.15, 210/748.17, 748.19, 749, 757, 167.21; 422/22, 27, 28, 129, 186, 186.04, 422/186.05, 186.07, 186.01, 186.1, 186.15, 422/186.16, 186.21, 616, 243, 305, 308; 204/155, 157.15, 157.5, 164, 176, 178, 204/450, 554, 193, 194, 260, 272, 280, 277, 204/278.5, 287, 288, 288.1, 288.2, 230.2; 205/701, 628, 633, 742, 756, 757; 22/192, 321.7.1; 119/263
See application file for complete search history.

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(Continued)

Primary Examiner — Walter D Griffin
Assistant Examiner — Cameron J Allen
(74) *Attorney, Agent, or Firm* — Schwegman Lundberg & Woessner, P.A.

(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 mixing the dissolved oxygen with the use of an oxygen emitter is disclosed.

16 Claims, 8 Drawing Sheets

Tennant Company
Exhibit 1101

Measurement of O_2 Bubbles

Attempts were made to measure the diameter of the O_2 bubbles emitted by the device of Example 1. In the case of particles other than gasses, measurements can easily be made by scanning electron microscopy, but gasses do not survive electron microscopy. Large bubble may be measured by pore exclusion, for example, which is also not feasible when measuring a gas bubble. A black and white digital, high contrast, backlit photograph of treated water with a millimeter scale reference was shot of water produced by the emitter of Example 1. About 125 bubbles were seen in the area selected for measurement. Seven bubbles ranging from the smallest clearly seen to the largest were measured. The area was enlarged, giving a scale multiplier of 0.029412.

Recorded bubble diameters at scale were 0.16, 0.22, 0.35, 0.51, 0.76, 0.88 and 1.09 millimeters. The last three were considered outliers by reverse analysis of variance and were assumed to be hydrogen bubbles. When multiplied by the scale multiplier, the assumed O_2 bubbles were found to range from 4.7 to 15 microns in diameter. This test was limited by the resolution of the camera and smaller bubbles in the nanometer range could not be resolved. It is known that white light cannot resolve features in the nanometer size range, so monochromatic laser light may give resolution sensitive enough to measure smaller bubbles. Efforts continue to

- Ex. 1101, 5:40-67
- Reply (Paper 42), 19, 21

Ground 1- Wikey Anticipates Claims 13, 18-23, and 25

RE45,415

13. A method for producing an oxygenated aqueous composition comprising:

flowing water at a flow rate no greater than 12 gallons per minute through an electrolysis emitter comprising an electrical power source electrically connected to an anode electrode and a cathode electrode contained in a tubular housing,

causing electricity to flow from the power source to the electrodes, and,

producing the composition comprising a suspension comprising oxygen microbubbles and nanobubbles in the water, the microbubbles and nanobubbles having a bubble diameter of less than 50 microns, wherein:

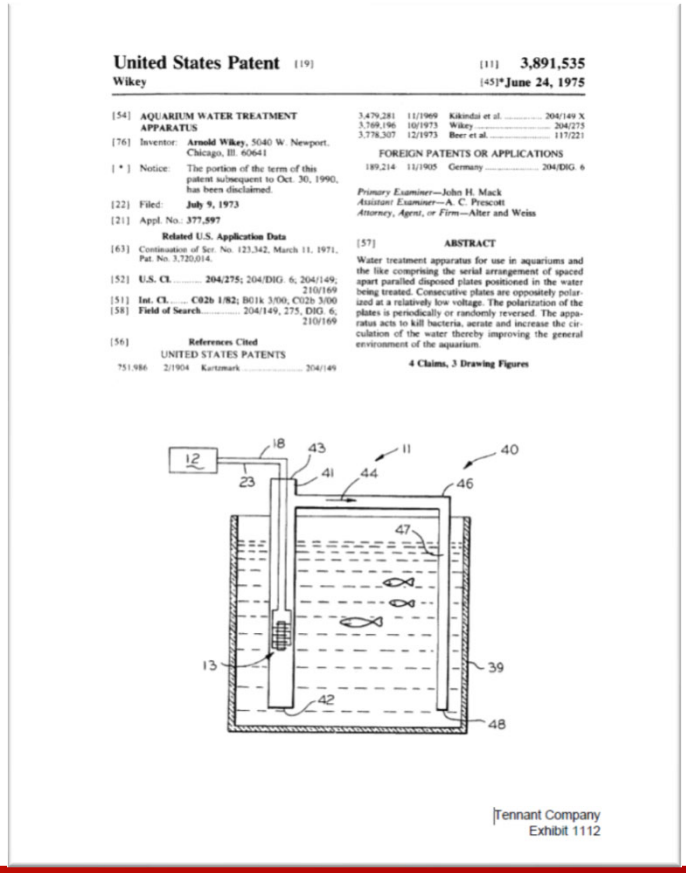
the anode electrode is separated at a critical distance from the cathode such that the critical distance is from 0.005 inches to 0.140 inches;

the power source produces a voltage no greater than about 28.3 volts and an amperage no greater than about 13 amps,

the tubular housing has an inlet and an outlet and a tubular flow axis from the inlet to the outlet;

the water flows in the inlet, out the outlet, is in fluid connection with the electrodes, and the water flowing into the inlet has a conductivity produced by the presence of dissolved solids such that the water supports plant or animal life.

- Petition (Paper 1), 31
- Ex. 1101, 11:20-12:4
- Ex. 1103, ¶ 35
- Ex. 1112



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[58] Field of Search ..... 204/149, 275, DIG. 6, 210/169

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4 Claims, 3 Drawing Figures

Tennant Company
Exhibit 1112

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RE45,415

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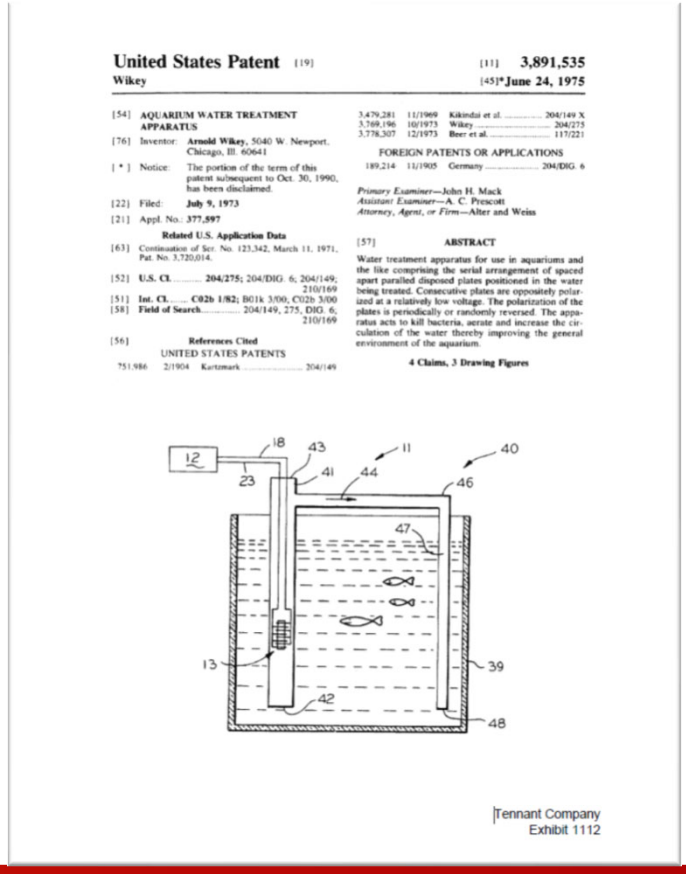
- Petition (Paper 1), 32
- Ex. 1101, 11:20-12:4
- Ex. 1103, ¶ 34
- Ex. 1112



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4 Claims, 3 Drawing Figures

Tennant Company
Exhibit 1112

Ground 1 – Wikey Teaches "the anode electrode is separated at a critical distance from the cathode such that the critical distance is from 0.005 inches to 0.140 inches"

United States Patent [19]
Wikey

[11] **3,891,535**
[45] ***June 24, 1975**

[54] **AQUARIUM WATER TREATMENT APPARATUS**

[76] Inventor: **Arnold Wikey**, 5040 W. Newport, Chicago, Ill. 60641

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FOREIGN PATENTS OR APPLICATIONS

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Assistant Examiner—A. C. Prescott
Attorney, Agent, or Firm—Alter and Weiss

3,891,535

1

AQUARIUM WATER TREATMENT APPARATUS

This invention is a continuation in part of my prior application filed on Mar. 11, 1971, having Ser. No. 123,342, now U.S. Pat. No. 3,720,014 and entitled WATER TREATMENT APPARATUS AND METHOD. This invention relates to water treatment apparatus and more particularly to apparatus for improving the environment of the aquariums and the like.

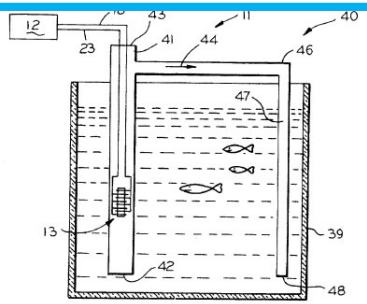
Just as the death of natural bodies of water is caused by cultural and natural eutrophication, fish tanks and aquariums are also subject to the hazards of natural pollution. Among the most prominent characteristics

2

in fish tanks, aquariums and the like. A reversing power supply generally designated as **12** feeds power to the electrodes units **13** diagrammatically shown under water **14**. The electrode unit comprises a plurality of juxtaposed plates or electrodes, such as electrodes **16** and **17**. In a preferred embodiment of the invention, the electrodes are plates made of platinum coated titanium.

The consecutive plates are oppositely polarized. For example, when plate **16** is positively polarized, then plate **17** is negatively polarized. The conductor **18** is connected to plate **16** and **19** and then passes around or through plate **17**. There is no electrical connection

In a preferred embodiment of the invention, the 40 plates are maintained at a distance of 1/64 inch apart by the insulators and a 6 volt D.C. source is utilized.



utilizes a change of polarity to prevent residual insulation.

Yet another object of this invention is to provide an aerating and circulating pump with no moving parts for use on fish ponds or aquariums.

Yet a further object of the invention is to provide low voltage, low current flow electrolysis equipment that can be used to both aerate and sterilize water to overcome pollution.

A preferred embodiment of the present invention utilizes two or more plates spaced apart and insulated from each other. The plates are immersed in a fish tank or the like. A power source is provided for oppositely polarizing juxtaposed plates. A low voltage field is periodically reversed to prevent any buildup of impurities on the plates. Means may further be provided for carrying the released gases; i.e., the oxygen to the bottom of the bodies of waters to enhance the aerating effect along with the sterilization of the water.

The foregoing and other objects and advantages of this invention and the manner of obtaining them will be more apparent, and the invention itself will be best understood by reference to the following description of an embodiment of this invention taken in conjunction with the accompanying drawings, wherein:

FIG. **1** is a schematic view of the inventive water aerating treatment apparatus;

FIG. **2** shows the apparatus of FIG. **1** adapted for use in fish ponds or aquariums; and

FIG. **3** shows a further refinement of the apparatus of FIG. **1**.

In FIG. **1** the number **11** generally shows the electrolysis apparatus utilized for aerating and treating water

Known means for periodically or randomly changing the polarity of the alternate plates, such as plates **16** and **17**, for example, can be used within the scope of this invention.

In a preferred embodiment of the invention, the plates are maintained at a distance of **1/64** inch apart by the insulators and a 6 volt D.C. source is utilized. The amperage between the plates, of course, depends on the size of the plates and the conductivity of the water in which the electrodes are placed. Nonetheless, the relative amperage of the preferred embodiment is in the order of ½ amp. With the low voltage across the alternate plates, the water tends to electrolyze and break into its constituent gases; i.e., two parts hydrogen and one part oxygen. With a platinum coated titanium plate, the bubbles of gas including oxygen are extremely small, and the plates themselves tend to resist any buildup of residue of impurities thereon. In addition, the reversing of the polarity also has tendencies to retain the plates in a clean condition so that they maximize the action of electrolysis obtained between the plates.

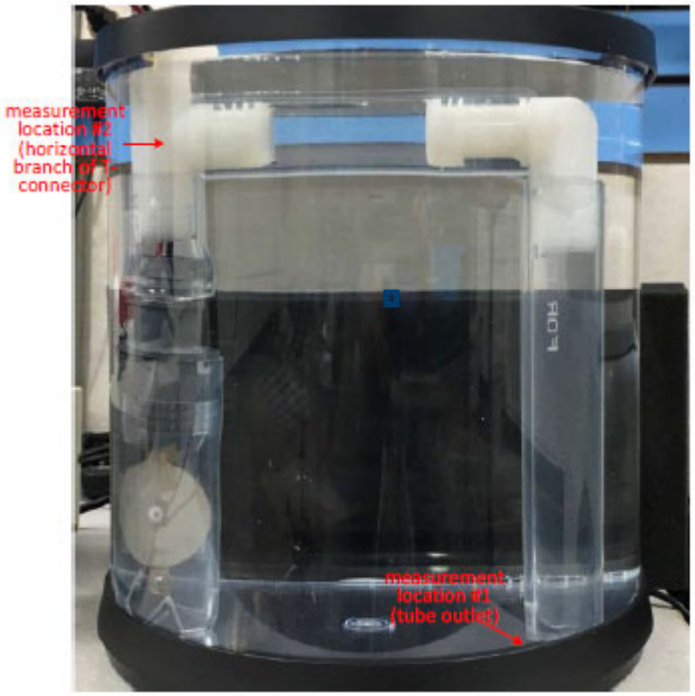
FIG. **2** shows utilization of the apparatus of FIG. **1** in a fish tank **39** where it is used for purifying and aerating the water. The size of the fish tank is of little consequence since more electrode units are added if required by the volume of water and number of fish in the aquarium.

The electrode unit **13** is shown connected to a power supply **12**. The showing, of course, is schematic, and the plates of the unit are in actuality more closely packed together to be within the dimensions set forth in the description of the plates of FIG. **1**.

Tennant Company
Exhibit 1112

- Petition (Paper 1), 32
- Ex. 1103, ¶ 34
- Ex. 1112, 2:39-41

Ground 1 – Wikey Teaches "the anode electrode is separated at a critical distance from the cathode such that the critical distance is from 0.005 inches to 0.140 inches"



- Petition (Paper 1), 21-22
- Ex. 1103, 28, ¶ 54

56. Following are relevant parameters/measurements obtained from Operation #1:

Parameters/Measurements	Value
electrode spacing	0.016 inch
water type	well water
Voltage	6V
flow rate	0.96 gpm
current	6.2 amp
initial conductivity	358.2 ppm
initial dissolved oxygen content	69.8%
dissolved oxygen content while running cell	121.4%
3 hour dissolved oxygen content	126.6%

- Petition (Paper 1), 21-22
- Ex. 1103, 28, ¶ 56

Ground 1- Wikey Anticipates Claims 13, 18-23, and 25

RE45,415

13. A method for producing an oxygenated aqueous composition comprising:

flowing water at a flow rate no greater than 12 gallons per minute through an electrolysis emitter comprising an electrical power source electrically connected to an anode electrode and a cathode electrode contained in a tubular housing,

causing electricity to flow from the power source to the electrodes, and,

producing the composition comprising a suspension comprising oxygen microbubbles and nanobubbles in the water, the microbubbles and nanobubbles having a bubble diameter of less than 50 microns, wherein:

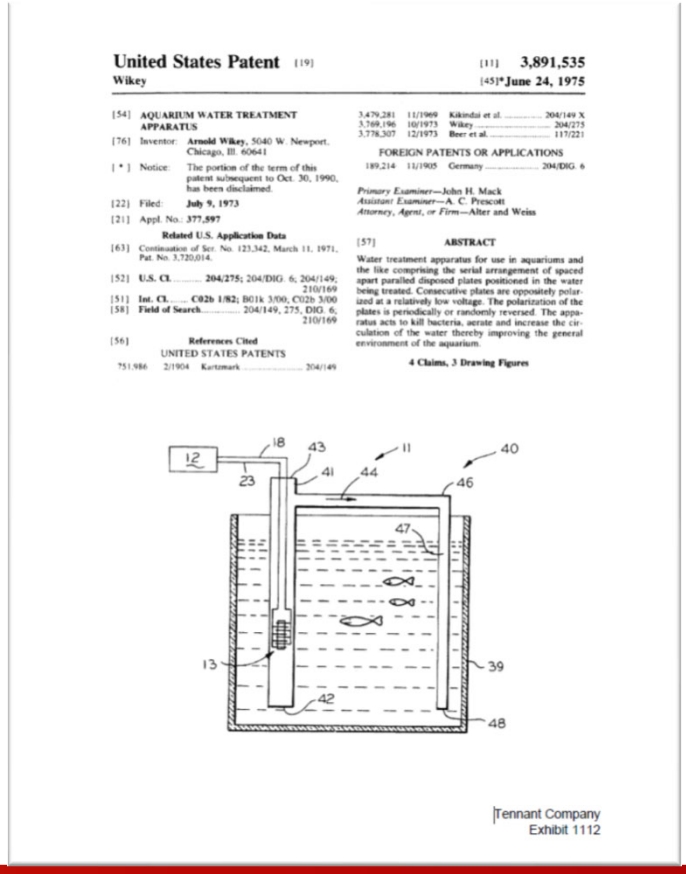
the anode electrode is separated at a critical distance from the cathode such that the critical distance is from 0.005 inches to 0.140 inches;

the power source produces a voltage no greater than about 28.3 volts and an amperage no greater than about 13 amps,

the tubular housing has an inlet and an outlet and a tubular flow axis from the inlet to the outlet;

the water flows in the inlet, out the outlet, is in fluid connection with the electrodes, and the water flowing into the inlet has a conductivity produced by the presence of dissolved solids such that the water supports plant or animal life.

- Petition (Paper 1), 32
- Ex. 1101, 11:20-12:4
- Ex. 1103, ¶ 34
- Ex. 1112



United States Patent [19]
Wikey

[11] 3,891,535
[45]* June 24, 1975

[54] AQUARIUM WATER TREATMENT APPARATUS

[76] Inventor: Arnold Wikey, 5040 W. Newport, Chicago, Ill. 60641

[*] Notice: The portion of the term of this patent subsequent to Oct. 30, 1990, has been disclaimed.

[22] Filed: July 9, 1973

[21] Appl. No.: 377,597

Related U.S. Application Data

[63] Continuation of Ser. No. 123,342, March 11, 1971, Pat. No. 3,720,014.

[52] U.S. Cl. 204/275; 204/DIG. 6; 204/149; 210/169

[51] Int. Cl. C02b 1/82; B01k 3/00, C02b 3/00

[58] Field of Search ..... 204/149, 275, DIG. 6, 210/169

[56] References Cited
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FOREIGN PATENTS OR APPLICATIONS

189,214 11/1905 Germany 204/DIG. 6

Primary Examiner—John H. Mack
Assistant Examiner—A. C. Prescott
Attorney, Agent, or Firm—Alter and Weiss

[57] ABSTRACT

Water treatment apparatus for use in aquariums and the like comprising the serial arrangement of spaced apart paralled disposed plates positioned in the water being treated. Consecutive plates are oppositely polarized at a relatively low voltage. The polarization of the plates is periodically or randomly reversed. The apparatus acts to kill bacteria, aerate and increase the circulation of the water thereby improving the general environment of the aquarium.

4 Claims, 3 Drawing Figures

Tennant Company
Exhibit 1112

Ground 1- Wikey Anticipates Claims 13, 18-23, and 25

RE45,415

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producing the composition comprising a suspension comprising oxygen microbubbles and nanobubbles in the water, the microbubbles and nanobubbles having a bubble diameter of less than 50 microns, wherein:

the anode electrode is separated at a critical distance from the cathode such that the critical distance is from 0.005 inches to 0.140 inches;

the power source produces a voltage no greater than about 28.3 volts and an amperage no greater than about 13 amps,

the tubular housing has an inlet and an outlet and a tubular flow axis from the inlet to the outlet;

the water flows in the inlet, out the outlet, is in fluid connection with the electrodes, and the water flowing into the inlet has a conductivity produced by the presence of dissolved solids such that the water supports plant or animal life.

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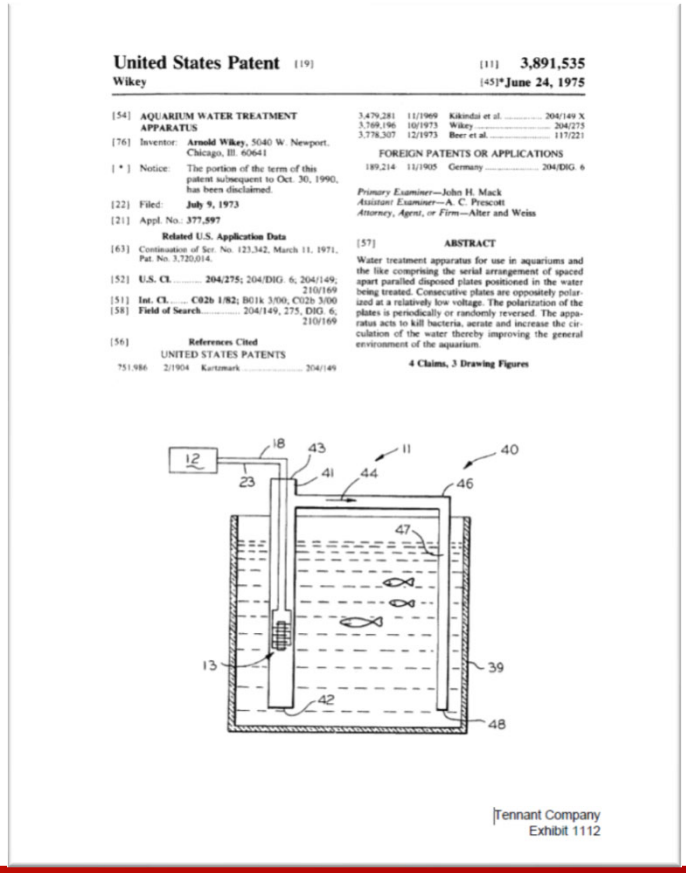

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4 Claims, 3 Drawing Figures

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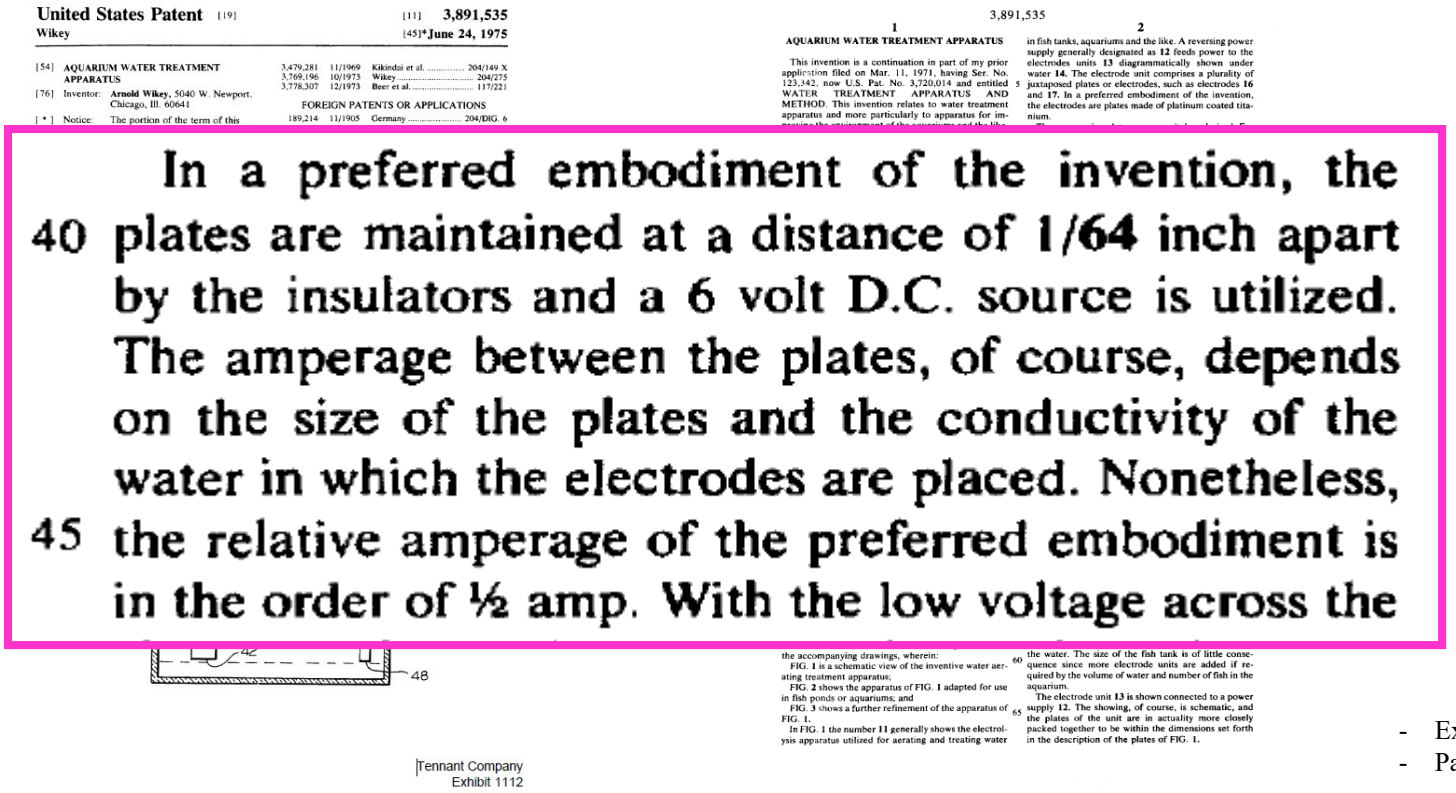

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3,891,535

1

AQUARIUM WATER TREATMENT APPARATUS

This invention is a continuation in part of my prior application filed on Mar. 11, 1971, having Ser. No. 123,342, now U.S. Pat. No. 3,720,014 and entitled WATER TREATMENT APPARATUS AND METHOD. This invention relates to water treatment apparatus and more particularly to apparatus for im-

2

in fish tanks, aquariums and the like. A reversing power supply generally designated as 12 feeds power to the electrodes units 13 diagrammatically shown under water 14. The electrode unit comprises a plurality of juxtaposed plates or electrodes, such as electrodes 16 and 17. In a preferred embodiment of the invention, the electrodes are plates made of platinum coated titanium.

In a preferred embodiment of the invention, the plates are maintained at a distance of 1/64 inch apart by the insulators and a 6 volt D.C. source is utilized. The amperage between the plates, of course, depends on the size of the plates and the conductivity of the water in which the electrodes are placed. Nonetheless, the relative amperage of the preferred embodiment is in the order of ½ amp. With the low voltage across the

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the accompanying drawings, wherein:

FIG. 1 is a schematic view of the inventive water aerating treatment apparatus;

FIG. 2 shows the apparatus of FIG. 1 adapted for use in fish ponds or aquariums; and

FIG. 3 shows a further refinement of the apparatus of FIG. 1.

In FIG. 1 the number 11 generally shows the electrolysis apparatus utilized for aerating and treating water

the water. The size of the fish tank is of little consequence since more electrode units are added if required by the volume of water and number of fish in the aquarium.

The electrode unit 13 is shown connected to a power supply 12. The showing, of course, is schematic, and the plates of the unit are in actuality more closely packed together to be within the dimensions set forth in the description of the plates of FIG. 1.

Tennant Company
Exhibit 1112

- Ex. 1112, 2:49-51
- Paper 42, 6

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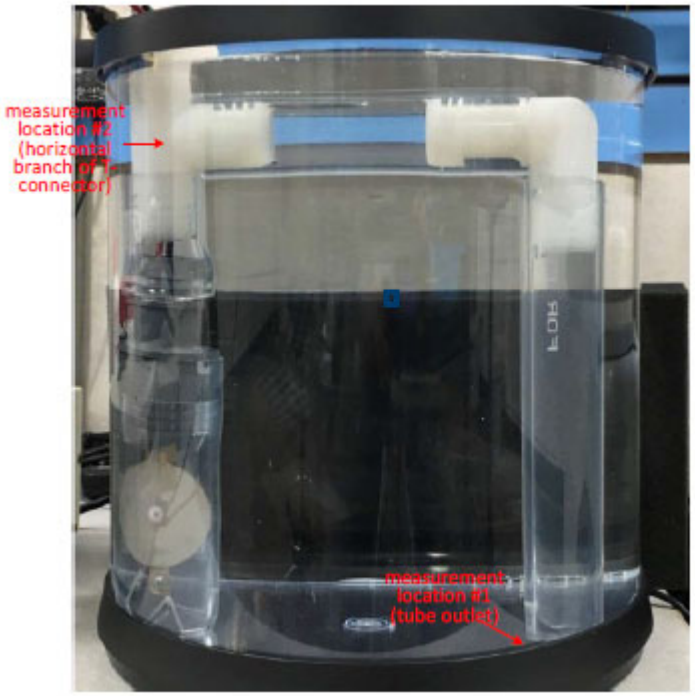

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the anode electrode is separated at a critical distance from the cathode such that the critical distance is from 0.005 inches to 0.140 inches;

the power source produces a voltage no greater than about 28.3 volts and an amperage no greater than about 13 amps,

the tubular housing has an inlet and an outlet and a tubular flow axis from the inlet to the outlet;

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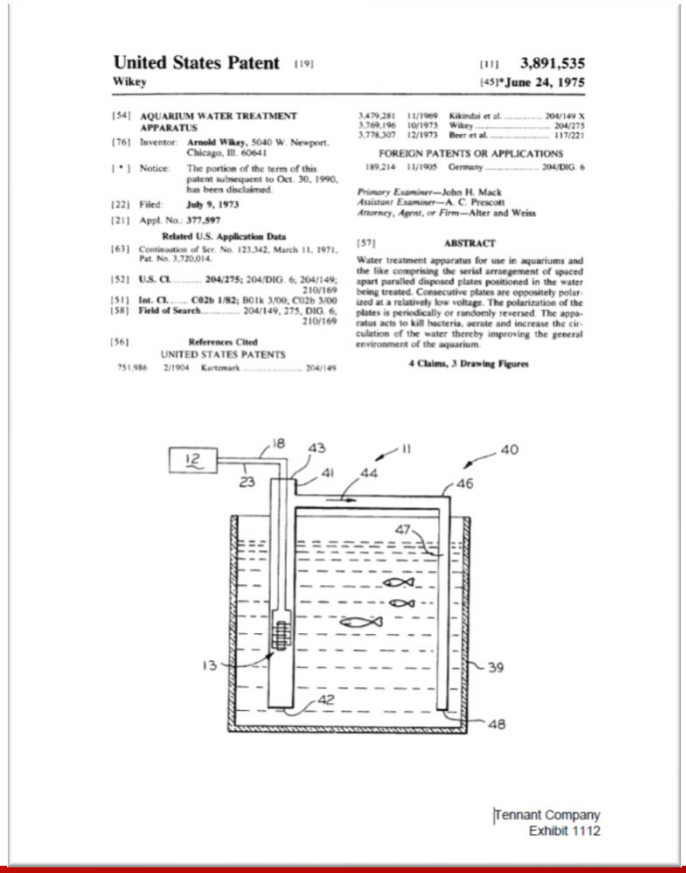

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4 Claims, 3 Drawing Figures

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Ground 1- Wikey Anticipates Claims 13, 18-23, and 25

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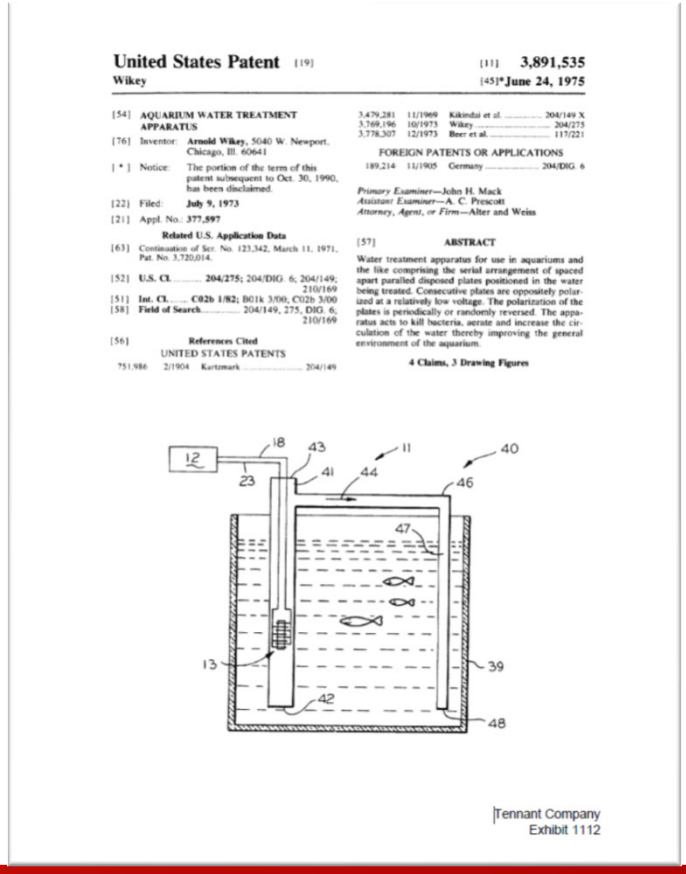

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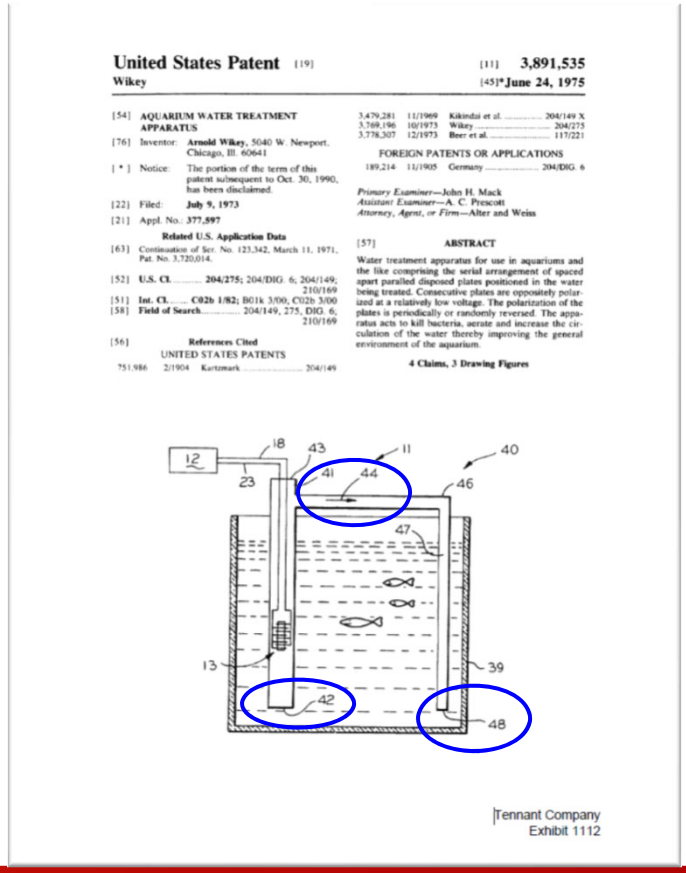

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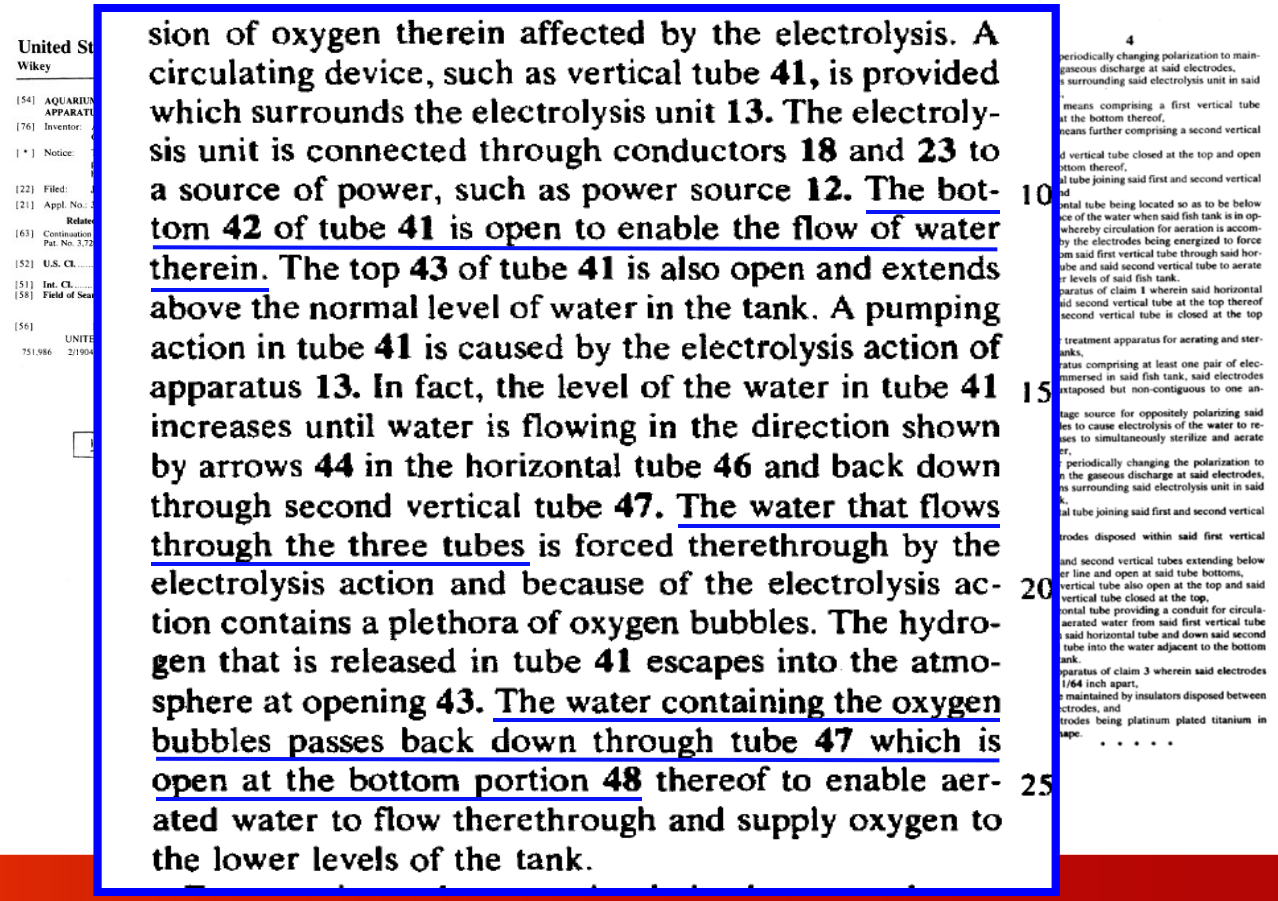

sion of oxygen therein affected by the electrolysis. A circulating device, such as vertical tube **41**, is provided which surrounds the electrolysis unit **13**. The electrolysis unit is connected through conductors **18** and **23** to a source of power, such as power source **12**. The bottom **42** of tube **41** is open to enable the flow of water therein. The top **43** of tube **41** is also open and extends above the normal level of water in the tank. A pumping action in tube **41** is caused by the electrolysis action of apparatus **13**. In fact, the level of the water in tube **41** increases until water is flowing in the direction shown by arrows **44** in the horizontal tube **46** and back down through second vertical tube **47**. The water that flows through the three tubes is forced therethrough by the electrolysis action and because of the electrolysis action contains a plethora of oxygen bubbles. The hydrogen that is released in tube **41** escapes into the atmosphere at opening **43**. The water containing the oxygen bubbles passes back down through tube **47** which is open at the bottom portion **48** thereof to enable aerated water to flow therethrough and supply oxygen to the lower levels of the tank.

- Petition (Paper 1), 33
- Ex. 1112, 3:6-26
- Reply (Paper 42), 6

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RE45,415

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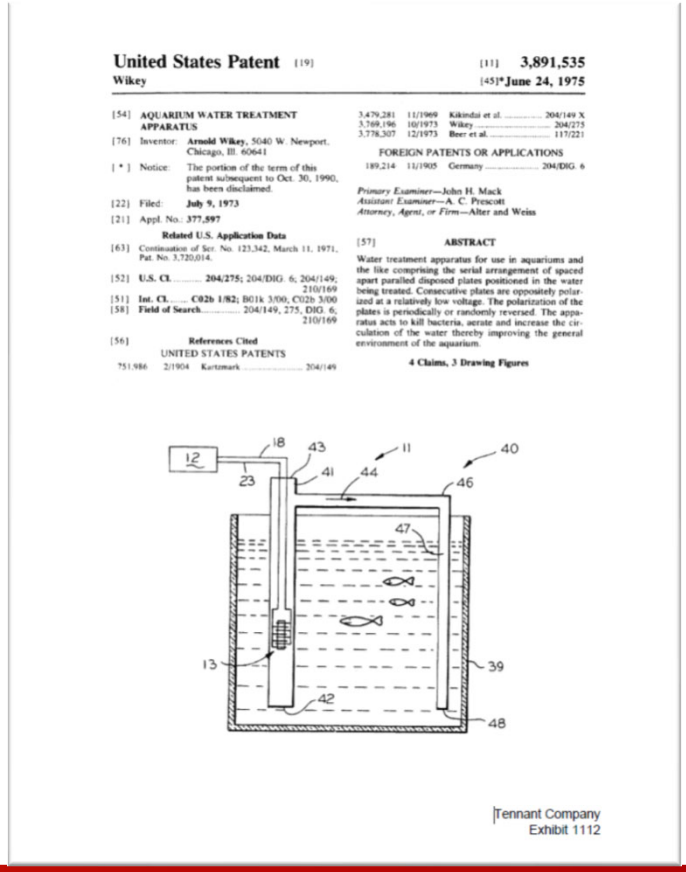

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RE45,415

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flowing water at a flow rate no greater than 12 gallons per minute through an electrolysis emitter comprising an electrical power source electrically connected to an anode electrode and a cathode electrode contained in a tubular housing,

causing electricity to flow from the power source to the electrodes, and,

producing the composition comprising a suspension comprising oxygen microbubbles and nanobubbles in the water, the microbubbles and nanobubbles having a bubble diameter of less than 50 microns, wherein:

the anode electrode is separated at a critical distance from the cathode such that the critical distance is from 0.005 inches to 0.140 inches;

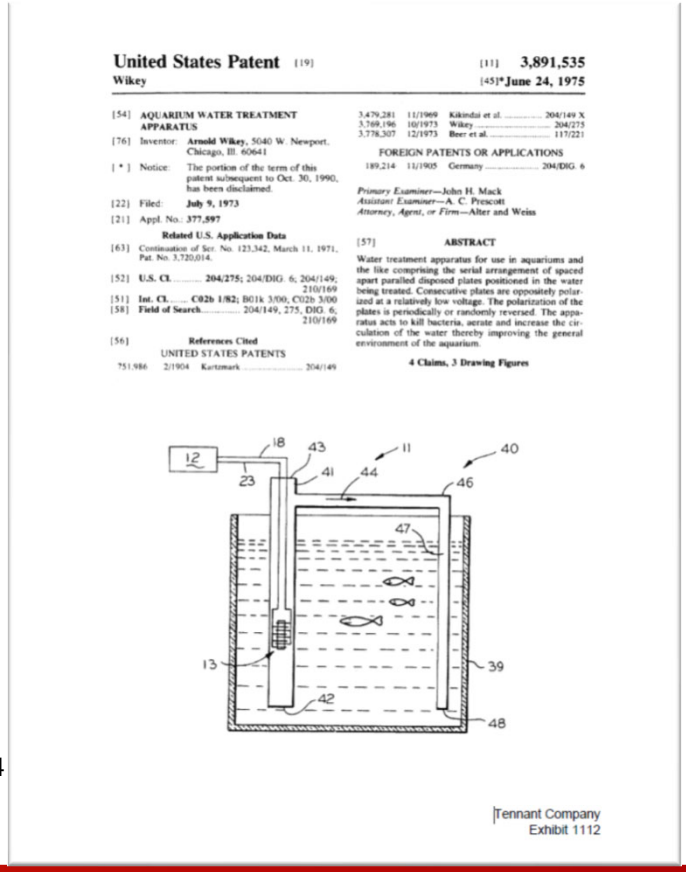
the power source produces a voltage no greater than about 28.3 volts and an amperage no greater than about 13 amps,

the tubular housing has an inlet and an outlet and a tubular flow axis from the inlet to the outlet;

the water flows in the inlet, out the outlet, is in fluid connection with the electrodes, and the water flowing into the inlet has a conductivity produced by the presence of dissolved solids such that the water supports plant or animal life.

- Ex. 1101, 11:20-12:4.

- Petition (Paper 1), 33-34
- Ex. 1101, 11:20-12:4
- Ex. 1103, ¶ 36
- Ex. 1112



United States Patent [19]
Wikey

[11] 3,891,535
[45]* June 24, 1975

[54] AQUARIUM WATER TREATMENT APPARATUS

[76] Inventor: Arnold Wikey, 5040 W. Newport, Chicago, Ill. 60641

[*] Notice: The portion of the term of this patent subsequent to Oct. 30, 1990, has been disclaimed.

[22] Filed: July 9, 1973

[21] Appl. No.: 377,597

Related U.S. Application Data

[63] Continuation of Ser. No. 123,342, March 11, 1971, Pat. No. 3,720,014.

[52] U.S. Cl. 204/275; 204/DIG. 6; 204/149; 210/169

[51] Int. Cl. C02b 1/82; B01k 3/00, C02b 3/00

[58] Field of Search ..... 204/149, 275, DIG. 6, 210/169

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FOREIGN PATENTS OR APPLICATIONS

189,214 11/1905 Germany 204/DIG. 6

Primary Examiner—John H. Mack
Assistant Examiner—A. C. Prescott
Attorney, Agent, or Firm—Alter and Weiss

[57] ABSTRACT

Water treatment apparatus for use in aquariums and the like comprising the serial arrangement of spaced apart parallel disposed plates positioned in the water being treated. Consecutive plates are oppositely polarized at a relatively low voltage. The polarization of the plates is periodically or randomly reversed. The apparatus acts to kill bacteria, aerate and increase the circulation of the water thereby improving the general environment of the aquarium.

4 Claims, 3 Drawing Figures

Tennant Company
Exhibit 1112

Ground 1 – Wikey Teaches "the water flows in the inlet, out the outlet, is in fluid connection with the electrodes, and the water flowing into the inlet has a conductivity produced by the presence of dissolved solids such that the water supports plant or animal life"

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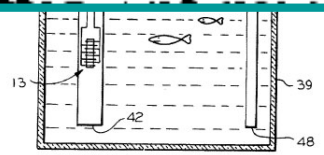
FIG. 3 teaches the device utilizing the electrolysis apparatus **11** in a way, that among other things, overcomes thermal stratification which may occur on larger aquariums. More particularly, FIG. 3 shows means for increasing the circulation of the water and interspersion of oxygen therein affected by the electrolysis. A circulating device, such as vertical tube **41**, is provided which surrounds the electrolysis unit **13**. The electrolysis unit is connected through conductors **18** and **23** to a source of power, such as power source **12**. The bottom **42** of tube **41** is open to enable the flow of water therein. The top **43** of tube **41** is also open and extends above the normal level of water in the tank. A pumping action in tube **41** is caused by the electrolysis action of apparatus **13**. In fact, the level of the water in tube **41** increases until water is flowing in the direction shown by arrows **44** in the horizontal tube **46** and back down through second vertical tube **47**. The water that flows through the three tubes is forced therethrough by the electrolysis action and because of the electrolysis ac-

For aquariums, the extra circulation increases the oxygen in all levels of the tank and contributes to the health of the fish life in the aquariums. 30



derstood that the description is only made by way of example and not as a limitation on the scope of the invention.

I claim:

1. Water treatment apparatus for aerating and sterilizing fish tanks,
said apparatus comprising at least one pair of electrodes immersed in said fish tank,
said electrodes being juxtaposed but non-contiguous to one another,
a low voltage source for oppositely polarizing said electrodes to cause electrolysis of the water to release gases for simultaneously sterilizing and aerating the water,
means for periodically changing polarization to maintain the gaseous discharge at said electrodes,
tube means surrounding said electrolysis unit in said fish tank,
said tube means comprising a first vertical tube opened at the bottom thereof,
said tube means further comprising a second vertical tube,
said second vertical tube closed at the top and open at the bottom thereof,
a horizontal tube joining said first and second vertical tubes, and
said horizontal tube being located so as to be below the surface of the water when said fish tank is in operation, whereby circulation for aeration is accomplished by the electrodes being energized to force water from said first vertical tube through said horizontal tube and said second vertical tube to aerate the lower levels of said fish tank.

2. The apparatus of claim **1** wherein said horizontal

said first vertical tube also open at the top and said second vertical tube closed at the top,
said horizontal tube providing a conduit for circulation of aerated water from said first vertical tube through said horizontal tube and down said second vertical tube into the water adjacent to the bottom of the tank.

4. The apparatus of claim **3** wherein said electrodes are spaced **1/64** inch apart,
said space maintained by insulators disposed between said electrodes, and
said electrodes being platinum plated titanium in plate shape.

Tennant Company
Exhibit 1112

- Petition (Paper 1), 33-34
- Ex. 1103, ¶ 36
- Ex. 1112, 3:28-30

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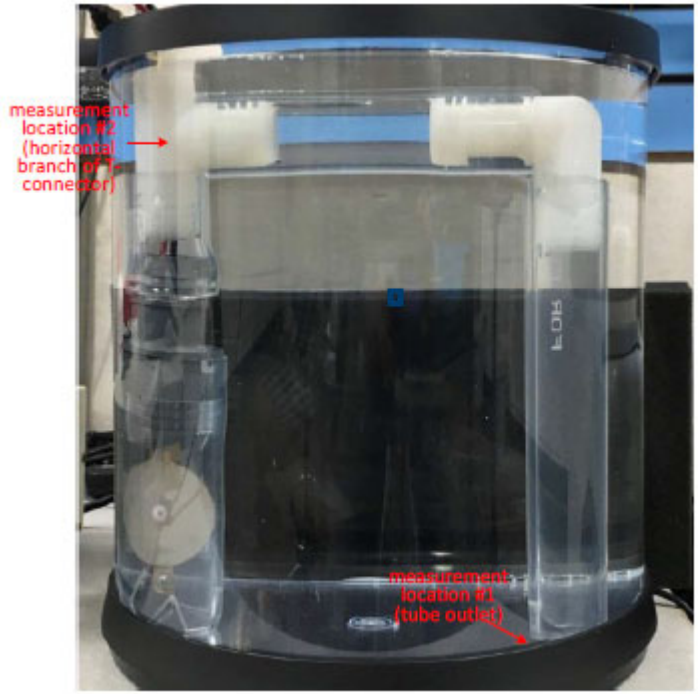

- Petition (Paper 1), 21-22
- Ex. 1103, 28, ¶ 54

56. Following are relevant parameters/measurements obtained from

Operation #1:

Parameters/Measurements	Value
electrode spacing	0.016 inch
water type	well water
Voltage	6V
flow rate	0.96 gpm
current	6.2 amp
initial conductivity	358.2 ppm
initial dissolved oxygen content	69.8%
dissolved oxygen content while running cell	121.4%
3 hour dissolved oxygen content	126.6%

- Petition (Paper 1), 21-22, 33-34
- Ex. 1103, ¶¶ 36, 56

Ground 1- Wikey Anticipates Claims 13, 18-23, and 25

RE45,415

13. A method for producing an oxygenated aqueous composition comprising:

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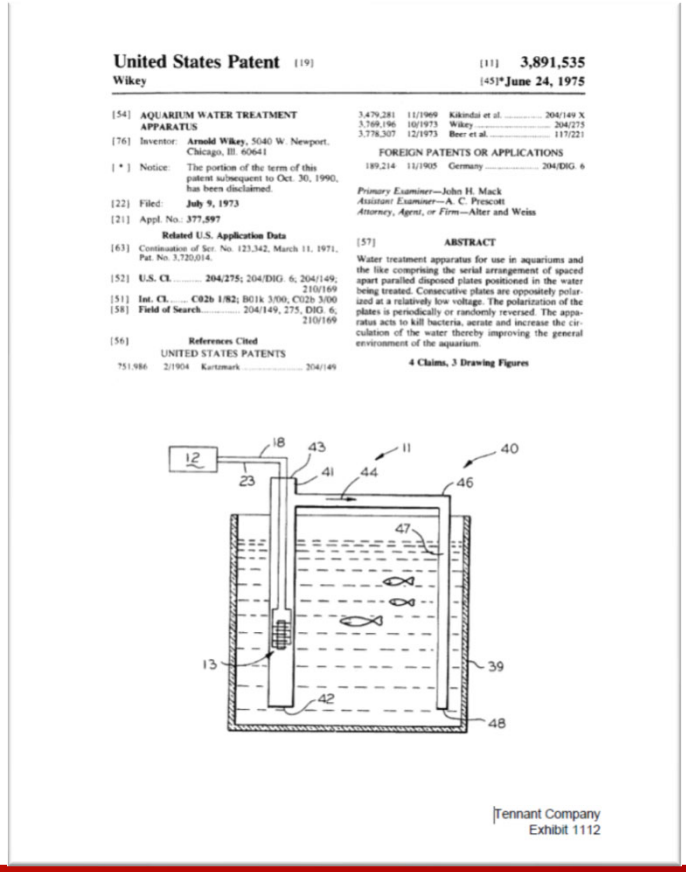
- Ex. 1101, 11:20-12:4.



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[57] ABSTRACT

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4 Claims, 3 Drawing Figures

Tennant Company
Exhibit 1112

Ground 1- Wikey Anticipates Claims 13, 18-23, and 25

RE45,415

18. A method according to claim 13 wherein the water has a temperature no greater than about ambient temperature at the inlet and the water temperature is a factor for formation of the suspension.

19. A method according to claim 13 wherein the microbubbles and nanobubbles remain in the water at least in part for a period up to several hours.

20. A method according to claim 19 wherein the period for which the microbubbles and nanobubbles at least in part remain in the water is determined by containing the water with microbubbles and nanobubbles in a two and one half gallon aquarium reservoir container.

21. A method according to claim 13 wherein the microbubbles and nanobubbles supersaturate the water.

22. A method according to claim 13 wherein the bubble diameter of the microbubbles and nanobubbles is less than 0.0006 inches.

23. A method according to claim 13 wherein the separation of electrodes is maintained by a nonconductive spacer.

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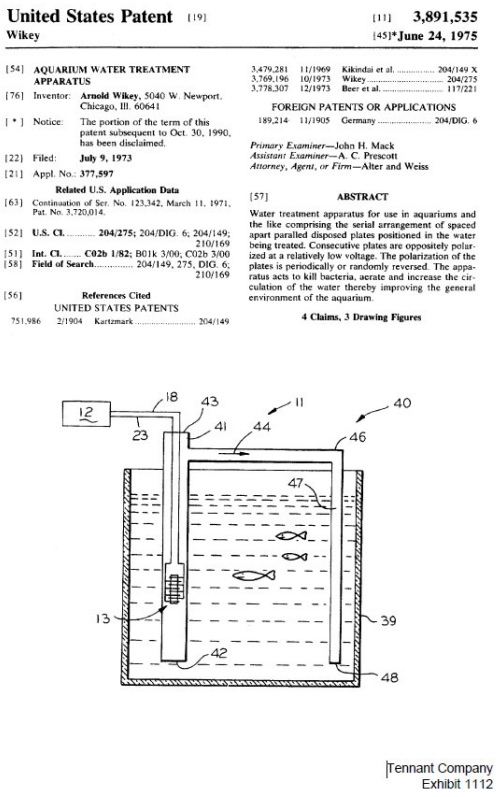
25. A method according to claim 13 wherein the microbubbles and nanobubbles are substantially incapable of breaking the surface tension of the water.

- Ex. 1101, 12:14-37.



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4 Claims, 3 Drawing Figures

Tennant Company
Exhibit 1112

- Petition (Paper 1), 34
- Ex. 1103, ¶ 36
- Ex. 1112

Ground 1- Wikey Anticipates Claims 13, 18-23, and 25

RE45,415

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…

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- Ex. 1101, 12:14-37.

reacts to form molecular oxygen, O_2. In the special dimensions of the invention, as explained in more detail in the following examples, O_2 forms bubbles which are too small to break the surface tension of the fluid. These bubbles remain suspended indefinitely in the fluid and, when allowed to build up, make the fluid opalescent or milky. Only after several hours do the bubbles begin to coalesce on the sides of the container and the water clears. During that time, the water is supersaturated with oxygen. In contrast, the H_2 formed

- Petition (Paper 1), 34-35
- Ex. 1101, 4:30-38

Ground 1- Wikey Anticipates Claims 13, 18-23, and 25

RE45,415

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dissolved oxygen content while running cell	121.4%
3 hour dissolved oxygen content	126.6%

- Ex. 1112, 3:13-15, Fig. 3
- Ex. 1103 ¶¶ 35, 56
- Petition (Paper 1), 22, 34-36

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- Ex. 1101, 12:14-37.

claims). The suspension of oxygen microbubbles and nanobubbles in water displays the characteristic that these bubbles are substantially incapable of breaking the surface tension of the water (2:63-67, 4:30-33). This phenomenon is described as making an opalescent or milky fluid

(the nanobubbles in water, 4:27-54). This phenomenon is capable of remaining for several hours when the suspension is contained in an appropriate container (4:34-37, 7:45-55). A container such as a two and one-half gallon aquarium reservoir is appropriate (7:45-55). A volume of the water having some depth is needed to maintain this suspension for such a period. If the suspension is spread as a film or layer of water on a flat surface such as a floor or other flat surface, the microbubbles and nanobubbles can escape in a short time from such films or layers of water.

- Ex. 1102, 149-150
- Petition (Paper 1), 35-36

Ground 1- Wikey Anticipates Claims 13, 18-23, and 25

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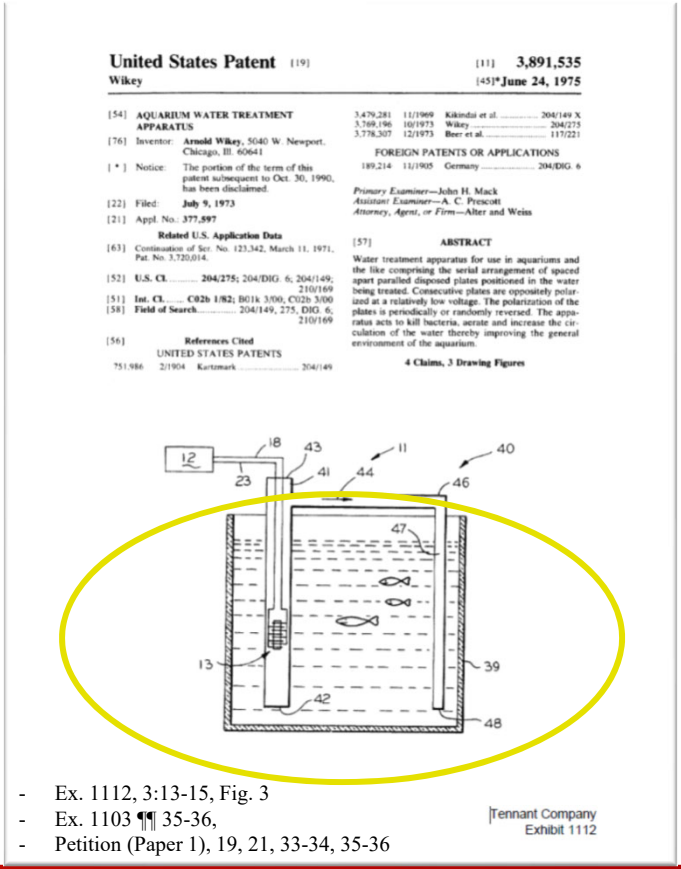

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4 Claims, 3 Drawing Figures

- Ex. 1112, 3:13-15, Fig. 3
- Ex. 1103 ¶¶ 35-36,
- Petition (Paper 1), 19, 21, 33-34, 35-36

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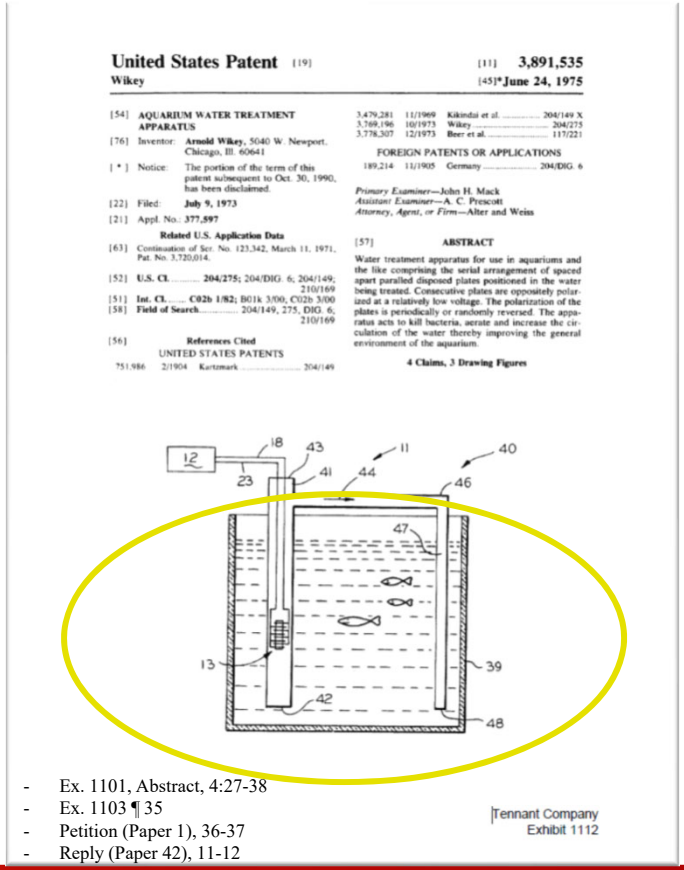

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- Ex. 1101, Abstract, 4:27-38
- Ex. 1103 ¶ 35
- Petition (Paper 1), 36-37
- Reply (Paper 42), 11-12

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25. A method according to claim 13 wherein the microbubbles and nanobubbles are substantially incapable of breaking the surface tension of the water.

- Ex. 1101, 12:14-37.

56. Following are relevant parameters/measurements obtained from Operation #1:

Parameters/Measurements	Value
electrode spacing	0.016 inch
water type	well water
Voltage	6V
flow rate	0.96 gpm
current	6.2 amp
initial conductivity	358.2 ppm
initial dissolved oxygen content	69.8%
dissolved oxygen content while running cell	121.4%
3 hour dissolved oxygen content	126.6%

- Ex. 1101, Abstract, 4:27-38
- Ex. 1103 ¶ ¶ 35, 56, 61, 68
- Petition (Paper 1), 36-37, 21-29
- Reply (Paper 42), 11-12

Ground 1- Wikey Anticipates Claims 13, 18-23, and 25

RE45,415

18. A method according to claim 13 wherein the water has a temperature no greater than about ambient temperature at the inlet and the water temperature is a factor for formation of the suspension.

19. A method according to claim 13 wherein the microbubbles and nanobubbles remain in the water at least in part for a period up to several hours.

20. A method according to claim 19 wherein the period for which the microbubbles and nanobubbles at least in part remain in the water is determined by containing the water with microbubbles and nanobubbles in a two and one half gallon aquarium reservoir container.

21. A method according to claim 13 wherein the microbubbles and nanobubbles supersaturate the water.

22. A method according to claim 13 wherein the bubble diameter of the microbubbles and nanobubbles is less than 0.0006 inches.

23. A method according to claim 13 wherein the separation of electrodes is maintained by a nonconductive spacer.

…

25. A method according to claim 13 wherein the microbubbles and nanobubbles are substantially incapable of breaking the surface tension of the water.

- Ex. 1101, 12:14-37.

Regarding claims 77, 79, and 83, the claims do not further disclose additional structure that further limits it over its dependent claim. The claim states that the bubble size is a diameter less than 0.0006 inches. Since all of the claimed structure is present and independent claims state that the bubbles are due to the electrode gap, the device should create the bubble size for at least same reasons as applicant.

- Ex. 1102, 108
- Ex. 1103 ¶ ¶ 35, 61, 68
- Petition (Paper 1), 37, 21-29

Ground 1- Wikey Anticipates Claims 13, 18-23, and 25

RE45,415

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…

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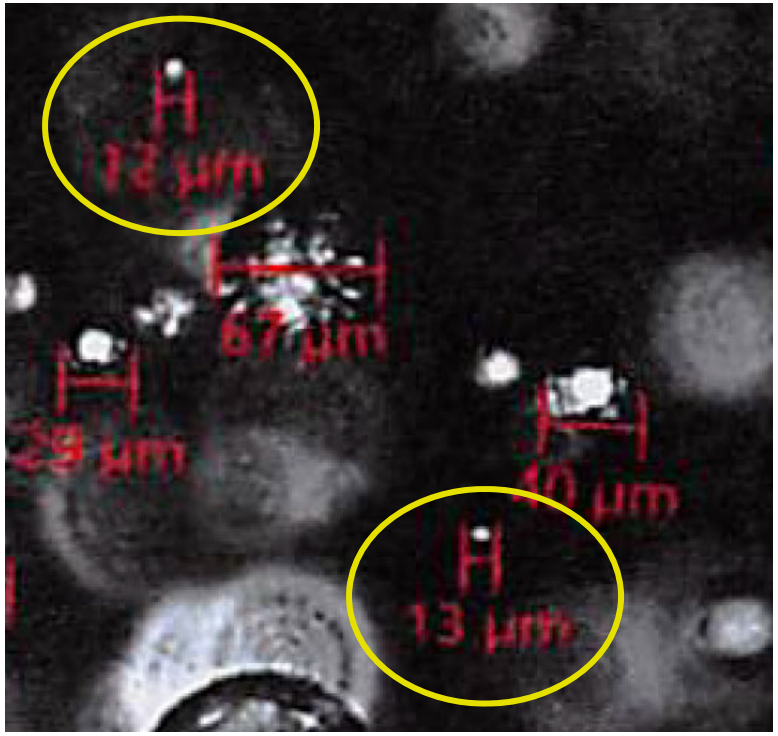
- Ex. 1101, 12:14-37.

- .0006 inches = 15.24 microns



- Ex. 2179, 19
- Ex. 1103 ¶¶ 35, 58-61, 65-68
- Petition (Paper 1), 36-37, 21-29

Ground 1- Wikey Anticipates Claims 13, 18-23, and 25

RE45,415

18. A method according to claim 13 wherein the water has a temperature no greater than about ambient temperature at the inlet and the water temperature is a factor for formation of the suspension.

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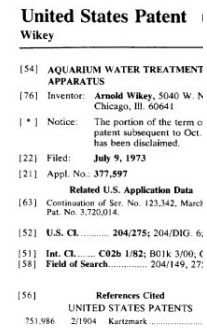
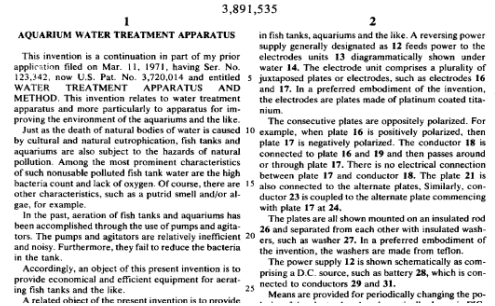
- Ex. 1101, 12:14-37.



United States Patent
Wikey

[54] AQUARIUM WATER TREATMENT APPARATUS
[76] Inventor: Arnold Wikey, 5040 W. N Chicago, Ill. 60641
[*] Notice: The portion of the term o patent subsequent to Oct. has been disclaimed.
[22] Filed: July 9, 1973
[21] Appl. No.: 377,597
Related U.S. Application Data
[63] Continuation of Ser. No. 123,342, March Pat. No. 3,720,014.
[52] U.S. Cl. 204/275; 204/DIG. 6;
[51] Int. Cl. ..... C02b 1/82; B01k 3/00; C
[58] Field of Search 204/149, 27
[56] References Cited
UNITED STATES PATENTS
751,986 2/1904 Kartzmark .....



3,891,535

1
AQUARIUM WATER TREATMENT APPARATUS

This invention is a continuation in part of my prior application filed on Mar. 11, 1971, having Ser. No. 123,342, now U.S. Pat. No. 3,720,014 and entitled WATER TREATMENT APPARATUS AND METHOD. This invention relates to water treatment apparatus and more particularly to apparatus for improving the environment of the aquariums and the like.

Just as the death of natural bodies of water is caused by cultural and natural eutrophication, fish tanks and aquariums are also subject to the hazards of natural pollution. Among the most prominent characteristics of such nonusable polluted fish tank water are the high bacteria count and lack of oxygen. Of course, there are other characteristics, such as a putrid smell and/or algae, for example.

In the past, aeration of fish tanks and aquariums has been accomplished through the use of pumps and agitators. The pumps and agitators are relatively inefficient and noisy. Furthermore, they fail to reduce the bacteria in the tank.

Accordingly, an object of this present invention is to provide economical and efficient equipment for aerating fish tanks and the like.

A related object of the present invention is to provide

2
in fish tanks, aquariums and the like. A reversing power supply generally designated as **12** feeds power to the electrodes units **13** diagrammatically shown under water **14**. The electrode unit comprises a plurality of juxtaposed plates or electrodes, such as electrodes **16** and **17**. In a preferred embodiment of the invention, the electrodes are plates made of platinum coated titanium.

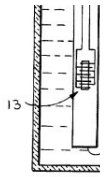
The consecutive plates are oppositely polarized. For example, when plate **16** is positively polarized, then plate **17** is negatively polarized. The conductor **18** is connected to plate **16** and **19** and then passes around or through plate **17**. There is no electrical connection between plate **17** and conductor **18**. The plate **21** is also connected to the alternate plates. Similarly, conductor **23** is coupled to the alternate plate commencing with plate **17** at **24**.

The plates are all shown mounted on an insulated rod **26** and separated from each other with insulated washers, such as washer **27**. In a preferred embodiment of the invention, the washers are made from teflon.

The power supply **12** is shown schematically as comprising a D.C. source, such as battery **28**, which is connected to conductors **29** and **31**.

Means are provided for periodically changing the po-

20 **The plates are all shown mounted on an insulated rod 26 and separated from each other with insulated washers, such as washer 27. In a preferred embodiment of the invention, the washers are made from teflon.**



A preferred embodiment of the present invention utilizes two or more plates spaced apart and insulated from each other. The plates are immersed in a fish tank or the like. A power source is provided for oppositely polarizing juxtaposed plates. A low voltage field is periodically reversed to prevent any buildup of impurities on the plates. Means may further be provided for carrying the released gases; i.e., the oxygen to the bottom of the bodies of waters to enhance the aerating effect along with the sterilization of the water.

The foregoing and other objects and advantages of this invention and the manner of obtaining them will be more apparent, and the invention itself will be best understood by reference to the following description of an embodiment of this invention taken in conjunction with the accompanying drawings, wherein:

FIG. **1** is a schematic view of the inventive water aerating treatment apparatus;

FIG. **2** shows the apparatus of FIG. **1** adapted for use in fish ponds or aquariums; and

FIG. **3** shows a further refinement of the apparatus of FIG. **1**.

In FIG. **1** the number **11** generally shows the electrolysis apparatus utilized for aerating and treating water

water in which the electrodes are placed. Nonetheless, the relative amperage of the preferred embodiment is in the order of ½ amp. With the low voltage across the alternate plates, the water tends to electrolyze and break into its constituent gases; i.e., two parts hydrogen and one part oxygen. With a platinum coated titanium plate, the bubbles of gas including oxygen are extremely small, and the plates themselves tend to resist any buildup of residue of impurities thereon. In addition, the reversing of the polarity also has tendencies to retain the plates in a clean condition so that they maximize the action of electrolysis obtained between the plates.

FIG. **2** shows utilization of the apparatus of FIG. **1** in a fish tank **39** where it is used for purifying and aerating the water. The size of the fish tank is of little consequence since more electrode units are added if required by the volume of water and number of fish in the aquarium.

The electrode unit **13** is shown connected to a power supply **12**. The showing, of course, is schematic, and the plates of the unit are in actuality more closely packed together to be within the dimensions set forth in the description of the plates of FIG. **1**.

- Ex. 1112, 2:18-21
- Ex. 1101, 5:14-15
- Petition (Paper 1), 37-38

Ground 1- Wikey Anticipates Claims 13, 18-23, and 25

RE45,415

18. A method according to claim 13 wherein the water has a temperature no greater than about ambient temperature at the inlet and the water temperature is a factor for formation of the suspension.

19. A method according to claim 13 wherein the microbubbles and nanobubbles remain in the water at least in part for a period up to several hours.

20. A method according to claim 19 wherein the period for which the microbubbles and nanobubbles at least in part remain in the water is determined by containing the water with microbubbles and nanobubbles in a two and one half gallon aquarium reservoir container.

21. A method according to claim 13 wherein the microbubbles and nanobubbles supersaturate the water.

22. A method according to claim 13 wherein the bubble diameter of the microbubbles and nanobubbles is less than 0.0006 inches.

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…

25. A method according to claim 13 wherein the microbubbles and nanobubbles are substantially incapable of breaking the surface tension of the water.

- Ex. 1101, 12:14-37.

20 The plates are all shown mounted on an insulated rod **26** and separated from each other with insulated washers, such as washer **27.** In a preferred embodiment of the invention, the washers are made from teflon.

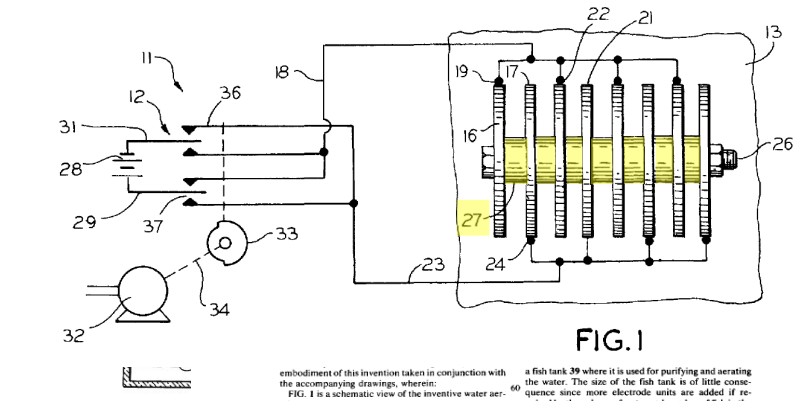

FIG. 1

- Ex. 1112, 2:18-21, Fig. 1
- Ex. 1101, 5:14-15
- Petition (Paper 1), 37-38

Ground 1- Wikey Anticipates Claims 13, 18-23, and 25

RE45,415

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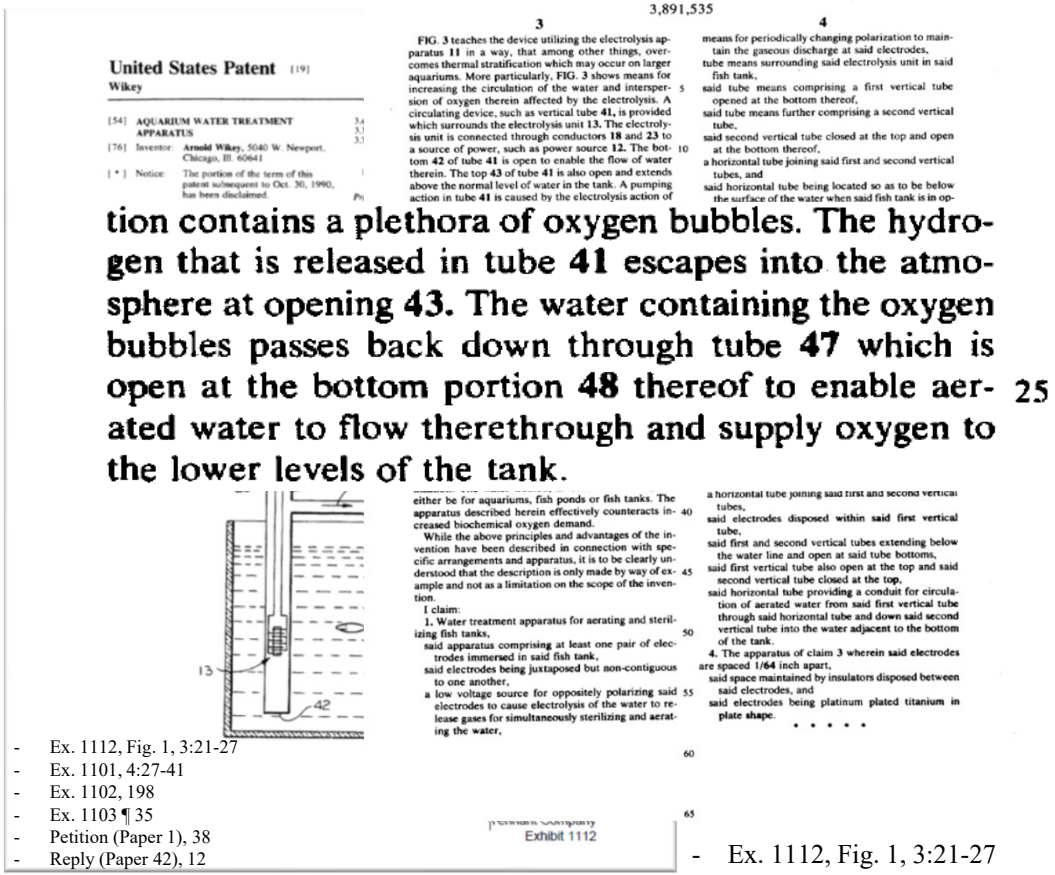
- Ex. 1101, 12:14-37.



3,891,535

United States Patent [19]
Wikey

[54] AQUARIUM WATER TREATMENT APPARATUS
[76] Inventor: Arnold Wikey, 5040 W. Newport, Chicago, Ill. 60641
[*] Notice: The portion of the term of this patent subsequent to Oct. 30, 1990, has been disclaimed.

FIG. 3 teaches the device utilizing the electrolysis apparatus 11 in a way, that among other things, overcomes thermal stratification which may occur on larger aquariums. More particularly, FIG. 3 shows means for increasing the circulation of the water and interspersion of oxygen therein affected by the electrolysis. A circulating device, such as vertical tube 41, is provided which surrounds the electrolysis unit 13. The electrolysis unit is connected through conductors 18 and 23 to a source of power, such as power source 12. The bottom 42 of tube 41 is open to enable the flow of water therein. The top 43 of tube 41 is also open and extends above the normal level of water in the tank. A pumping action in tube 41 is caused by the electrolysis action of

means for periodically changing polarization to maintain the gaseous discharge at said electrodes,
tube means surrounding said electrolysis unit in said fish tank,
said tube means comprising a first vertical tube opened at the bottom thereof,
said tube means further comprising a second vertical tube,
said second vertical tube closed at the top and open at the bottom thereof,
a horizontal tube joining said first and second vertical tubes, and
said horizontal tube being located so as to be below the surface of the water when said fish tank is in op-

tion contains a plethora of oxygen bubbles. The hydrogen that is released in tube 41 escapes into the atmosphere at opening 43. The water containing the oxygen bubbles passes back down through tube 47 which is open at the bottom portion 48 thereof to enable aerated water to flow therethrough and supply oxygen to the lower levels of the tank.

either be for aquariums, fish ponds or fish tanks. The apparatus described herein effectively counteracts increased biochemical oxygen demand.
While the above principles and advantages of the invention have been described in connection with specific arrangements and apparatus, it is to be clearly understood that the description is only made by way of example and not as a limitation on the scope of the invention.
I claim:
1. Water treatment apparatus for aerating and sterilizing fish tanks,
said apparatus comprising at least one pair of electrodes immersed in said fish tank,
said electrodes being juxtaposed but non-contiguous to one another,
a low voltage source for oppositely polarizing said electrodes to cause electrolysis of the water to release gases for simultaneously sterilizing and aerating the water,

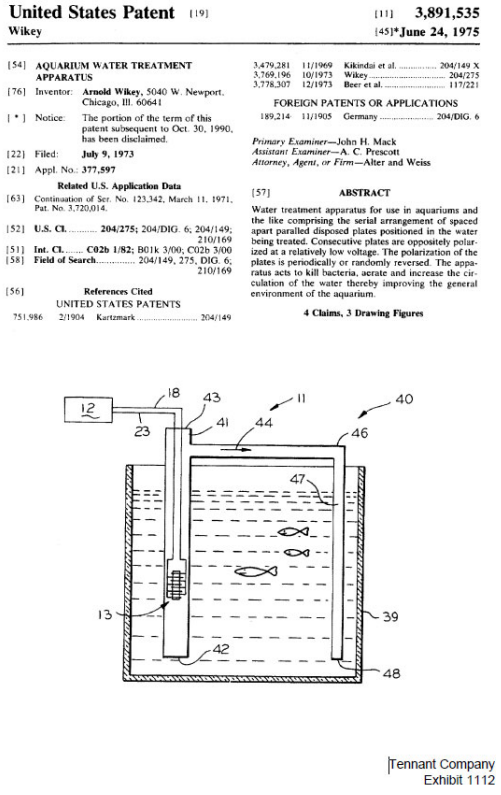
a horizontal tube joining said first and second vertical tubes,
said electrodes disposed within said first vertical tube,
said first and second vertical tubes extending below the water line and open at said tube bottoms,
said first vertical tube also open at the top and said second vertical tube closed at the top,
said horizontal tube providing a conduit for circulation of aerated water from said first vertical tube through said horizontal tube and down said second vertical tube into the water adjacent to the bottom of the tank.
4. The apparatus of claim 3 wherein said electrodes are spaced 1/64 inch apart,
said space maintained by insulators disposed between said electrodes, and
said electrodes being platinum plated titanium in plate shape.

Exhibit 1112

- Ex. 1112, Fig. 1, 3:21-27
- Ex. 1101, 4:27-41
- Ex. 1102, 198
- Ex. 1103 ¶ 35
- Petition (Paper 1), 38
- Reply (Paper 42), 12

- Ex. 1112, Fig. 1, 3:21-27

Ground 2 – Wikey and AFD Render Claims 13, 18-23, and 25 Obvious



United States Patent [19] [11] **3,891,535**
Wikey [45]* **June 24, 1975**

[54] **AQUARIUM WATER TREATMENT APPARATUS**

[76] Inventor: **Arnold Wikey**, 5040 W. Newport, Chicago, Ill. 60641

[*] Notice: The portion of the term of this patent subsequent to Oct. 30, 1990, has been disclaimed.

[22] Filed: **July 9, 1973**

[21] Appl. No.: **377,597**

Related U.S. Application Data

[63] Continuation of Ser. No. 123,342, March 11, 1971, Pat. No. 3,720,014.

[52] **U.S. Cl.** **204/275**; 204/DIG. 6; 204/149; 210/169

[51] **Int. Cl.** **C02b 1/82**; B01k 3/00; C02b 3/00

[58] **Field of Search** ..... 204/149, 275, DIG. 6; 210/169

[56] **References Cited**
UNITED STATES PATENTS

751,986	2/1904	Kartzmark	204/149
3,479,281	11/1969	Kikindai et al.	204/149 X
3,769,196	10/1973	Wikey	204/275
3,778,307	12/1973	Beer et al.	117/221

FOREIGN PATENTS OR APPLICATIONS

189,214	11/1905	Germany	204/DIG. 6

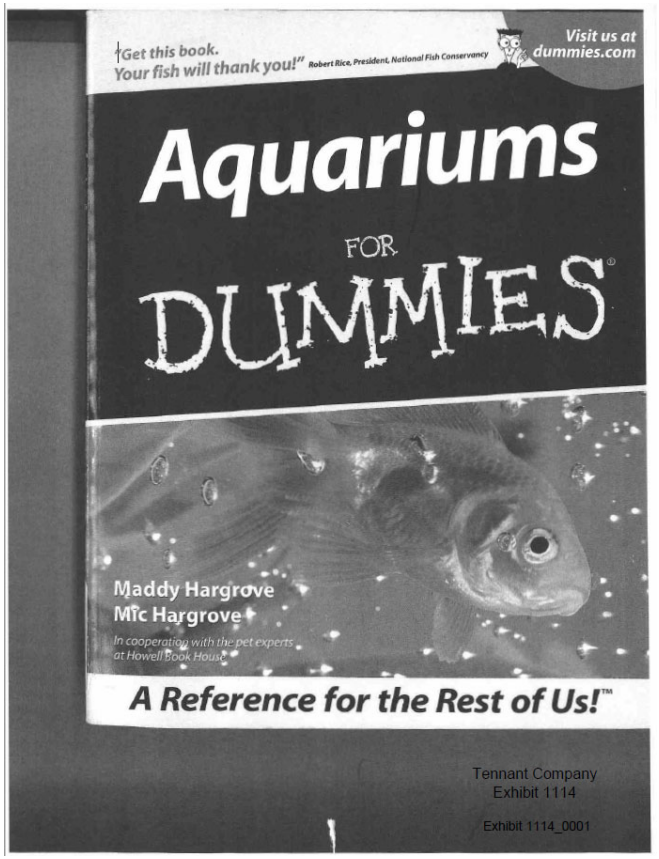
Primary Examiner—John H. Mack
Assistant Examiner—A. C. Prescott
Attorney, Agent, or Firm—Alter and Weiss

[57] **ABSTRACT**

Water treatment apparatus for use in aquariums and the like comprising the serial arrangement of spaced apart parallel disposed plates positioned in the water being treated. Consecutive plates are oppositely polarized at a relatively low voltage. The polarization of the plates is periodically or randomly reversed. The apparatus acts to kill bacteria, aerate and increase the circulation of the water thereby improving the general environment of the aquarium.

4 Claims, 3 Drawing Figures

Tennant Company
Exhibit 1112



- Ex. 1114, 9-11, 20-22, 24, 31, 54, 71-77
- Ex. 1103 ¶¶ 70-72, 182
- Petition (Paper 1), 39-40
- Reply (Paper 42), 13-14

Ground 2 – Wikey and AFD Render Claims 13, 18-23, and 25 Obvious

Motivation to combine: Dr. Tremblay, a PhD in Chemistry with a vast amount of experience in electrolysis cell design notes:

- A POSITA would have been motivated to combine Wikey and AFD because they address the same field, and because AFD "teaches the use of a filtration system to help aerate the water by producing flow and bubbles. - Ex. 1103 ¶182. Paper No. 42.

- AFD teaches: filtration "produces water flow and bubbles.

- AFD teaches use of an air pump. –Ex. 1114, 21

- Wikey teaches that electrolysis results in a "pumping action" – Ex. 1112, 3:13-15.

- Both Wikey and AFD relate to aerating or increasing the oxygen content of water in an aquarium to support plant and animal life.

- AFD teaches a flow rate of 1.33 gallons per minute.
- -Ex. 1103, ¶ 71

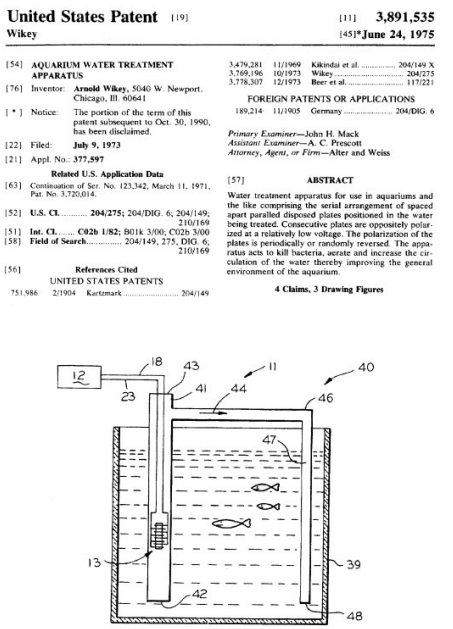
- AFD discloses various container sizes and water no greater than ambient temperature
- -Ex. 1103, ¶ ¶ 70, 72

- Ex. 1114, 9-11, 21-22, 24, 31, 54, 71-77
- Ex. 1112, 3:13-15
- Ex. 1103 ¶¶ 70-72, 182
- Petition (Paper 1), 39-40
- Reply (Paper 42), 13-14

Petitioner's Grounds 1-6

Ground	Challenged Claims	35 U.S.C. §	Prior Art
1	13, 18-23 and 25	102	Wikey
2	13, 18-23 and 25	103	Wikey and AFD
3	13, 18-23 and 25	103	Wikey and AFD in view of the general knowledge, experience and common sense of a POSITA as reflected in Wendt, Han, Glembotsky and Burns
4	26 and 27	103	Wikey and Clark
5	26 and 27	103	Wikey, Clark and AFD
6	26 and 27	103	Wikey, Clark and AFD in view of the general knowledge, experience and common sense of a POSITA, as reflected in Wendt, Han, Glembotsky and Burns

Ground 3 – Wikey and AFD in view of the general knowledge, experience and common sense of a POSITA as reflected in Wendt, Han, Glembotsky and Burns



United States Patent [19]
Wikey
[11] 3,891,535
[45]* June 24, 1975

[54] AQUARIUM WATER TREATMENT APPARATUS

[76] Inventor: Arnold Wikey, 5040 W. Newport, Chicago, Ill. 60641

[*] Notice: The portion of the term of this patent subsequent to Oct. 30, 1990, has been disclaimed.

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[51] Int. Cl. C02b 1/82; B01k 3/00; C02b 3/00

[58] Field of Search ..... 204/149, 275, DIG. 6; 210/169

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3,778,307	12/1973	Beer et al.	117/221

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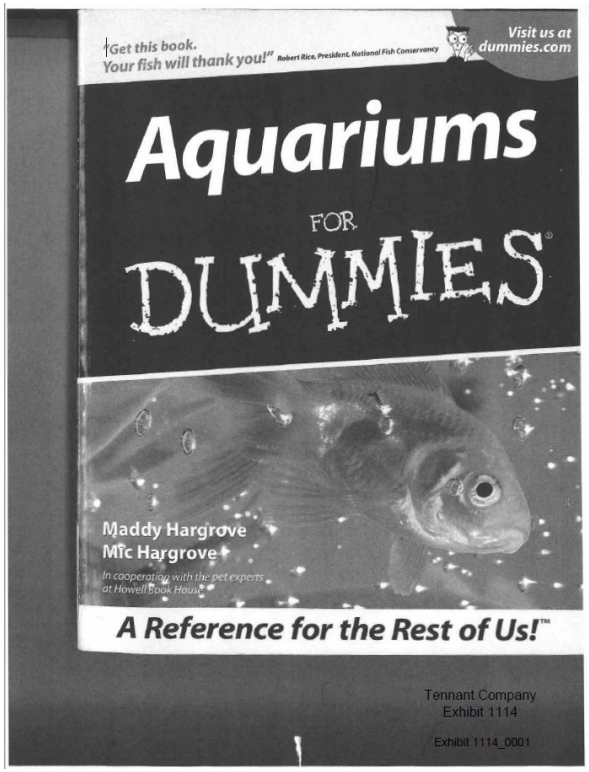
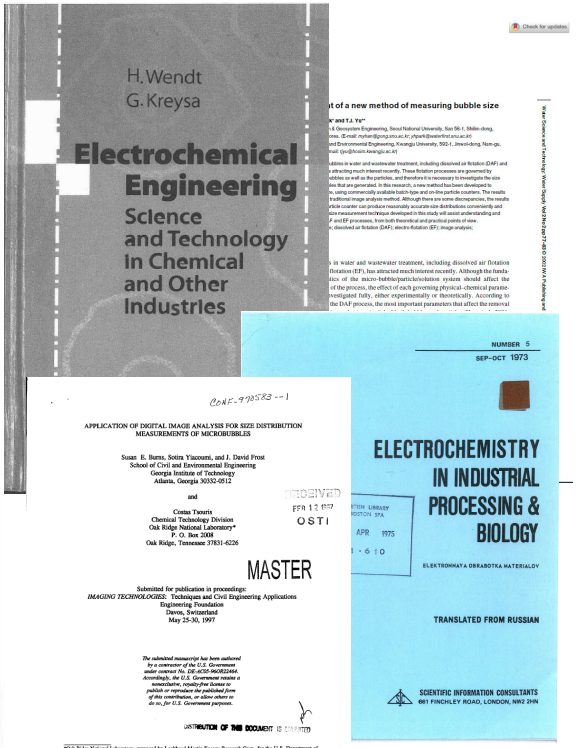
4 Claims, 3 Drawing Figures

- Ex. 1112; Ex. 1114; Ex. 1117, 103; Ex. 1137, 77; Ex. 1124, Fig. 1; Ex. 1131, 2, 4, and Fig. 1
- Ex. 1103 ¶¶ 16, 182-183, 26-69 (Wikey), 70-72 (AFD), 170-181,
- Petition (Paper 1), 40-44
- Reply (Paper 42), 13-14, 15-16, 25

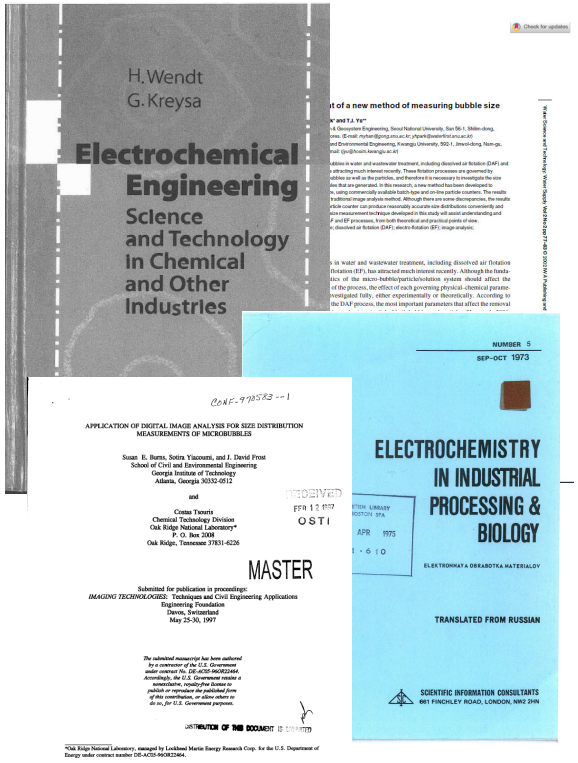
Tennant Company
Exhibit 1112





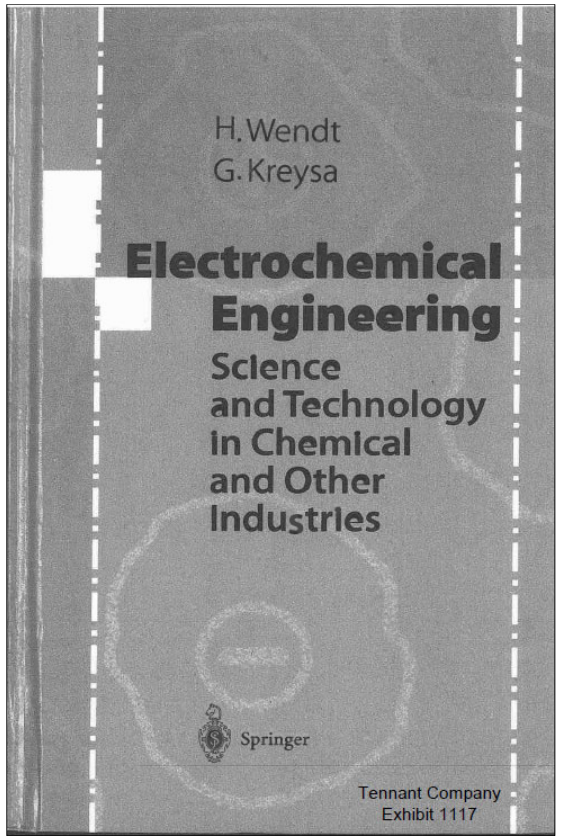
Ground 3 – Wikey and AFD in view of the general knowledge, experience and common sense of a POSITA as reflected in Wendt, Han, Glembotsky and Burns

- These textbooks merely reflect the general knowledge and understanding of a POSITA.
- Show how a POSITA would understand Wikey
- A POSITA would have understood water electrolysis systems were known to produce bubbles smaller than 50 microns. – Pet. 40-43; Ex. 1103, ¶¶170-183, 191, 206.



- Ex. 1117, 103; Ex. 1137, 77; Ex. 1124, Title, Fig. 1; Ex. 1131, Abstract, 2, 4, and Fig. 1;
- Ex. 1103 ¶¶ 16, 170-183.
- Petition (Paper 1), 40-43, 43-44
- Reply (Paper 42), 13-14, 15-16, 25

Ground 3 – Producing Oxygen Bubbles Smaller than 50 Microns was Well Known



5.4.7
Mass Transfer at Gas Evolving Electrodes

Mass transfer at gas evolving electrodes can be remarkably enhanced, provided gas evolution is intense enough to influence the flow of the electrolyte along the electrode. As radii of electrochemically evolved gas bubbles are usually relative small (5–50 μm), bubbles can perturb concentration boundary layers very effectively thereby enhancing mass transfer and compressing Nernst-diffusion layers.

- Ex. 1117, 103
- Ex. 1103 ¶¶ 16, 170, 181, 183
- Petition (Paper 1), 40-41, 43-44
- Reply (Paper 42), 15-16, 25

Ground 3 – Producing Oxygen Bubbles Smaller than 50 Microns was Well Known

Development of a new method of measuring bubble size

M.Y. Han*, Y.H. Park* and T.J. Yu**

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Abstract The use of bubbles in water and wastewater treatment, including dissolved air flotation (DAF) and electro-flotation (EF), is attracting much interest recently. These flotation processes are governed by characteristics of the bubbles as well as the particles, and therefore it is necessary to investigate the size distribution of the bubbles that are generated. In this research, a new method has been developed to measure the bubble size, using commercially available batch-type and on-line particle counters. The results are compared with the traditional image analysis method. Although there are some discrepancies, the results show that an on-line particle counter can produce reasonably accurate size distributions conveniently and efficiently. The bubble size measurement technique developed in this study will assist understanding and improvement of the DAF and EF processes, from both theoretical and practical points of view.

Keywords Bubble size; dissolved air flotation (DAF); electro-flotation (EF); image analysis; particle counter

Introduction

The use of bubbles in water and wastewater treatment, including dissolved air flotation (DAF) and electro-flotation (EF), has attracted much interest recently. Although the fundamental characteristics of the micro-bubble/particle/solution system should affect the removal efficiency of the process, the effect of each governing physical–chemical parameter has not been investigated fully, either experimentally or theoretically. According to recent modeling of the DAF process, the most important parameters that affect the removal efficiency are the size and zeta potential of both bubbles and particles (Han *et al.*, 2001; Han, 2002).

In DAF, bubbles are generated when air-saturated water is released into atmospheric pressure. The size of bubbles is mostly affected by pressure difference across the injection system and type of nozzle (AWWA, 1999). The size range is generally reported to be 10–100 μm, with the average being approximately 40 μm, under a pressure of 4–6 atmospheres (Edzwald, 1995). In EF, hydrogen and oxygen bubbles are generated when current is applied to the solution through metal electrodes. The average size range is reported to be around 20–40 μm, which is a smaller range than that of DAF (Burns *et al.*, 1997).

Several methods have been developed to measure the size of bubbles. The most straightforward method is image analysis. Because this method requires a complicated experimental setup and is time-consuming, it is not easy to produce enough data to generate size distributions under different conditions. Another method is to measure the rising velocity of the bubbles and to calculate the sizes by Stokes' Law. However, because the sizes of bubbles are not uniform, and because the rising velocity of many bubbles is different from that of a single bubble, no general equations are available to predict the size distribution of bubbles from the rising velocities.

In this study, a new method to measure the size of bubbles, using particle counters, was developed. The bubble counting results obtained from both image analysis and particle

Tennant Company Exhibit 1137

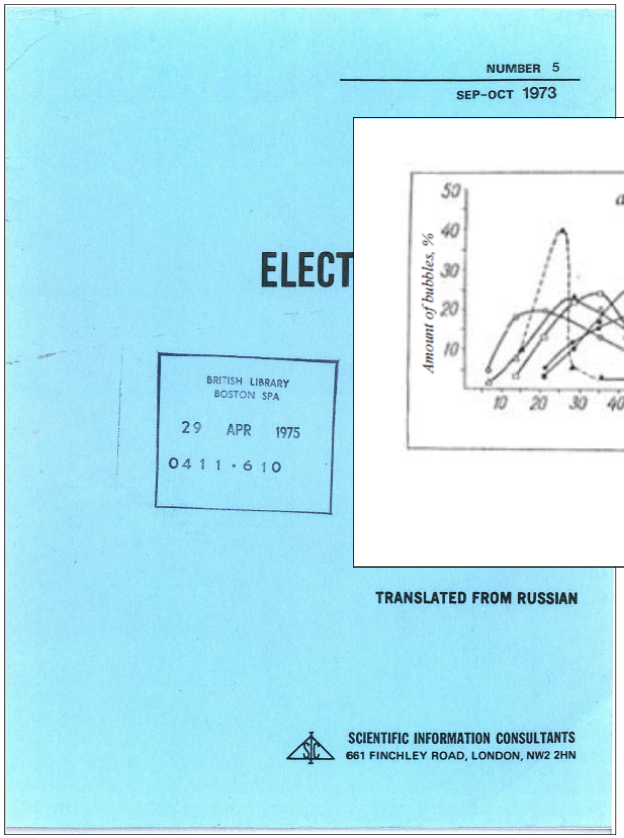
Introduction

The use of bubbles in water and wastewater treatment, including dissolved air flotation (DAF) and electro-flotation (EF), has attracted much interest recently. Although the fundamental characteristics of the micro-bubble/particle/solution system should affect the removal efficiency of the process, the effect of each governing physical–chemical parameter has not been investigated fully, either experimentally or theoretically. According to recent modeling of the DAF process, the most important parameters that affect the removal efficiency are the size and zeta potential of both bubbles and particles (Han *et al.*, 2001; Han, 2002).

In DAF, bubbles are generated when air-saturated water is released into atmospheric pressure. The size of bubbles is mostly affected by pressure difference across the injection system and type of nozzle (AWWA, 1999). The size range is generally reported to be 10–100 μm, with the average being approximately 40 μm, under a pressure of 4–6 atmospheres (Edzwald, 1995). In EF, hydrogen and oxygen bubbles are generated when current is applied to the solution through metal electrodes. The average size range is reported to be around 20–40 μm, which is a smaller range than that of DAF (Burns *et al.*, 1997).

- Ex. 1137, 77
- Ex. 1103 ¶¶ 16, 171, 181, 183
- Petition (Paper 1), 41, 43-44
- Reply (Paper 42), 15-16, 25

Ground 3 – Producing Oxygen Bubbles Smaller than 50 Microns was Well Known



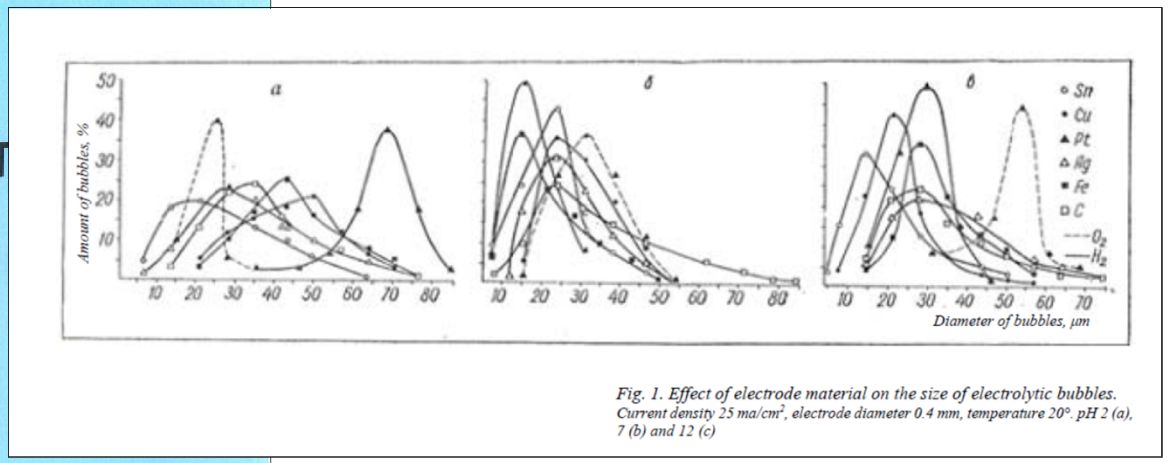


Fig. 1. Effect of electrode material on the size of electrolytic bubbles. Current density 25 ma/cm², electrode diameter 0.4 mm, temperature 20°. pH 2 (a), 7 (b) and 12 (c)

- Ex. 1124, Fig. 1
- Ex. 1103 ¶¶ 16, 172-175, 181, 183
- Petition (Paper 1), 41-44
- Reply (Paper 42), 15-16, 25

Ground 3 – Producing Oxygen Bubbles Smaller than 50 Microns was Well Known

CONF-970583--1

APPLICATION OF DIGITAL IMAGE ANALYSIS FOR SIZE DISTRIBUTION MEASUREMENTS OF MICROBUBBLES

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and

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Engineering Foundation
Davos, Switzerland
May 25-30, 1997

*Oak Ridge National Laboratory, managed by Lockheed Martin Energy Research Corp. for the U.S. Department of Energy under contract number DE-AC05-96OR22464.

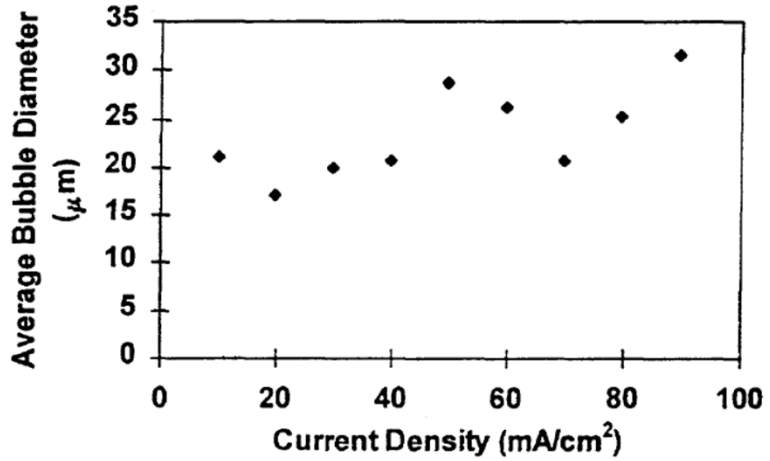


Figure 1. Oxygen bubble diameter as a function of current density: I = 0.1 M.

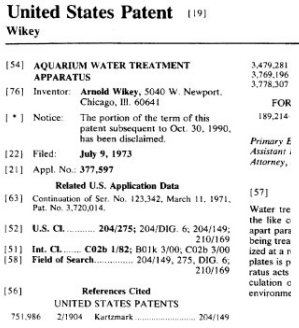
- Ex. 1131, Fig. 1
- Ex. 1103 ¶¶ 16, 176-181, 183
- Petition (Paper 1), 42-44
- Reply (Paper 42), 15-16, 25

Ground 4 – Wikey and Clark Render Claims 26 and 27 Obvious

RE45,415

26. A method according to claim 13 wherein each anode and cathode electrode of the emitter is positioned so that substantially all points midway between opposing anode and cathode electrodes are closer to a surface of the tubular housing than to a center point within the tubular housing.

27. A method according to claim 26 wherein each anode and cathode electrode of the emitter are positioned so that the electrodes do not obstruct a water flow passage along the center of the tubular housing.



United States Patent [19]
Wikey

[11] 3,891,535
[45]* June 24, 1975

[54] AQUARIUM WATER TREATMENT APPARATUS

[76] Inventor: Arnold Wikey, 5040 W. Newport, Chicago, Ill. 60641

[*] Notice: The portion of the term of this patent subsequent to Oct. 30, 1990, has been disclaimed.

[22] Filed: July 9, 1973

[21] Appl. No.: 377,597

Related U.S. Application Data

[63] Continuation of Ser. No. 123,342, March 11, 1971, Pat. No. 3,720,014.

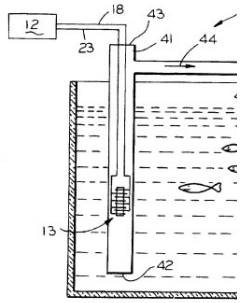
[52] U.S. Cl. 204/275; 204/DIG. 6; 204/149; 210/169

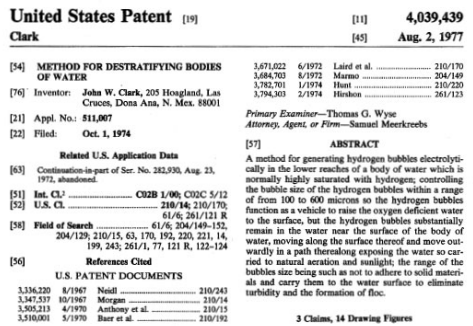
[51] Int. Cl. C02b 1/82; B01k 3/00; C02b 3/00

[58] Field of Search ..... 204/149, 275, DIG. 6; 210/169

[56] References Cited
UNITED STATES PATENTS

751,986 2/1904 Kartzmark 204/149





United States Patent [19]
Clark

[11] 4,039,439
[45] Aug. 2, 1977

[54] METHOD FOR DESTRATIFYING BODIES OF WATER

[76] Inventor: John W. Clark, 205 Hoagland, Las Cruces, Dona Ana, N. Mex. 88001

[21] Appl. No.: 511,007

[22] Filed: Oct. 1, 1974

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 282,930, Aug. 23, 1972, abandoned.

[51] Int. Cl.² C02B 1/00; C02C 5/12

[52] U.S. Cl. ..... 210/14; 210/170; 61/6; 261/121 R

[58] Field of Search ..... 61/6; 204/149–152, 204/129, 210/15, 63, 170, 192, 220, 221, 14, 199, 243; 261/1, 77, 121 R, 122–124

[56] References Cited
U.S. PATENT DOCUMENTS

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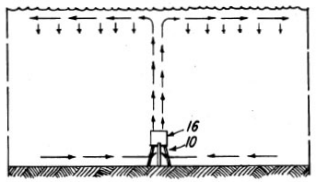
3,505,213 4/1970 Anthony et al. 210/15
3,510,001 5/1970 Baer et al. 210/192
3,671,022 6/1972 Laird et al. 210/170
3,684,703 8/1972 Marmo 204/149
3,782,701 1/1974 Hunt 210/220
3,794,303 2/1974 Hirshon 261/123

Primary Examiner—Thomas G. Wyse
Attorney, Agent, or Firm—Samuel Meerkreebs

[57] ABSTRACT

A method for generating hydrogen bubbles electrolytically in the lower reaches of a body of water which is normally highly saturated with hydrogen; controlling the bubble size of the hydrogen bubbles within a range of from 100 to 600 microns so the hydrogen bubbles function as a vehicle to raise the oxygen deficient water to the surface, but the hydrogen bubbles substantially remain in the water near the surface of the body of water, moving along the surface thereof and move outwardly in a path therealong exposing the water so carried to natural aeration and sunlight; the range of the bubbles size being such as not to adhere to solid materials and carry them to the water surface to eliminate turbidity and the formation of floc.

3 Claims, 14 Drawing Figures



- Ex. 1106, Fig. 5, 9:8-20
- Ex. 1112.
- Ex. 1103 ¶¶ 184, 26-69 (Wikey), 73-77 (Clark)
- Petition (Paper 1), 44-46
- Reply (Paper 42), 14-15

Tennant Company
Exhibit 1106

Ground 4 – Wikey and Clark Render Claims 26 and 27 Obvious

RE45,415

26. A method according to claim 13 wherein each anode and cathode electrode of the emitter is positioned so that substantially all points midway between opposing anode and cathode electrodes are closer to a surface of the tubular housing than to a center point within the tubular housing.

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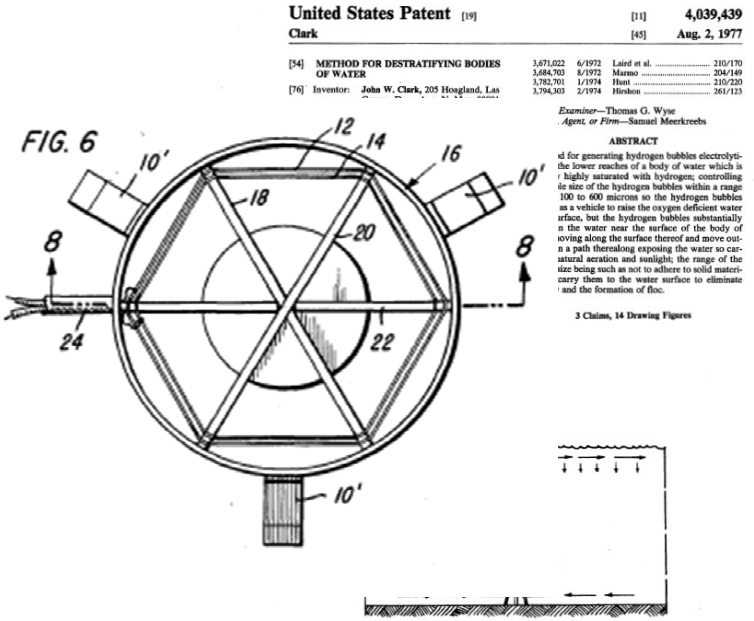
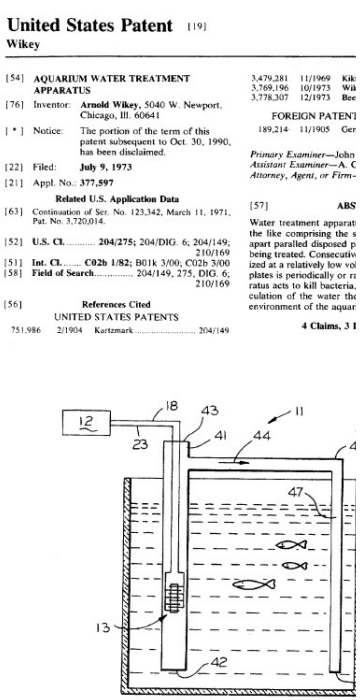


- Ex. 1106, Fig. 6, 9:8-20, 8:58-63
- Ex. 1112.
- Ex. 1103 ¶¶ 184, 26-69 (Wikey), 73-77 (Clark)
- Petition (Paper 1), 44-46
- Reply (Paper 42), 14-15

Tennant Company
Exhibit 1106

Ground 5 – Wikey and Clark and AFD Render Claims 26 and 27 Obvious



United States Patent [19]
Wikey

[54] **AQUARIUM WATER TREATMENT APPARATUS**

[76] Inventor: **Arnold Wikey**, 5040 W. Newport, Chicago, Ill. 60641

[*] Notice: The portion of the term of this patent subsequent to Oct. 30, 1990, has been disclaimed.

[22] Filed: **July 9, 1973**

[21] Appl. No.: **377,597**

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[52] **U.S. Cl.** **204/275**; 204/DIG. 6; 204/149; 210/169

[51] **Int. Cl.** **C02b 1/82**; B01k 3/00; C02b 3/00

[58] **Field of Search** ..... 204/149, 275, DIG. 6; 210/169

[56] **References Cited**
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3,769,196 10/1973 Wa
3,778,307 12/1973 Bee

FOREIGN PATENT
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Primary Examiner—John
Assistant Examiner—A. C
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[57] ABS

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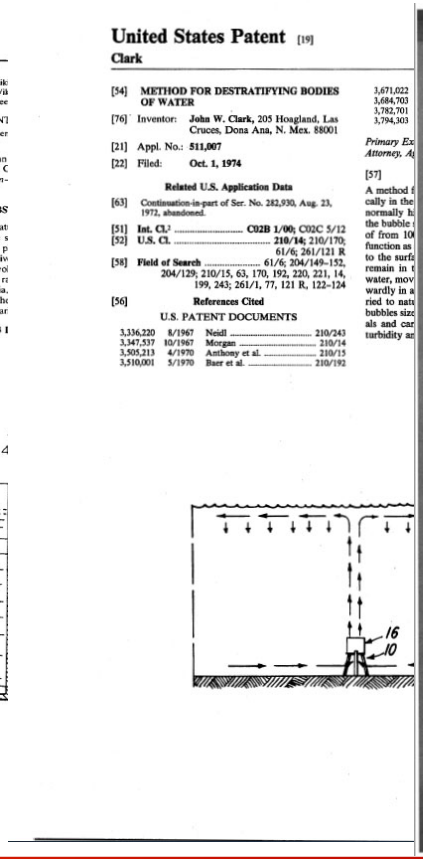
4 Claims, 3 I



United States Patent [19]
Clark

[54] **METHOD FOR DESTRATIFYING BODIES OF WATER**

[76] Inventor: **John W. Clark**, 205 Hoagland, Las Cruces, Dona Ana, N. Mex. 88001

[21] Appl. No.: **511,007**

[22] Filed: **Oct. 1, 1974**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 282,930, Aug. 23, 1972, abandoned.

[51] **Int. Cl.**[2] **C02B 1/00**; C02C 5/12

[52] **U.S. Cl.** ..... **210/14**; 210/170; 61/6; 261/121 R

[58] **Field of Search** ..... 61/6; 204/149–152, 204/129; 210/15, 63, 170, 192, 220, 221, 14, 199, 243; 261/1, 77, 121 R, 122–124

[56] **References Cited**
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3,336,220	8/1967	Neidl	210/243
3,347,537	10/1967	Morgan	210/14
3,505,213	4/1970	Anthony et al.	210/15
3,510,001	5/1970	Baer et al.	210/192
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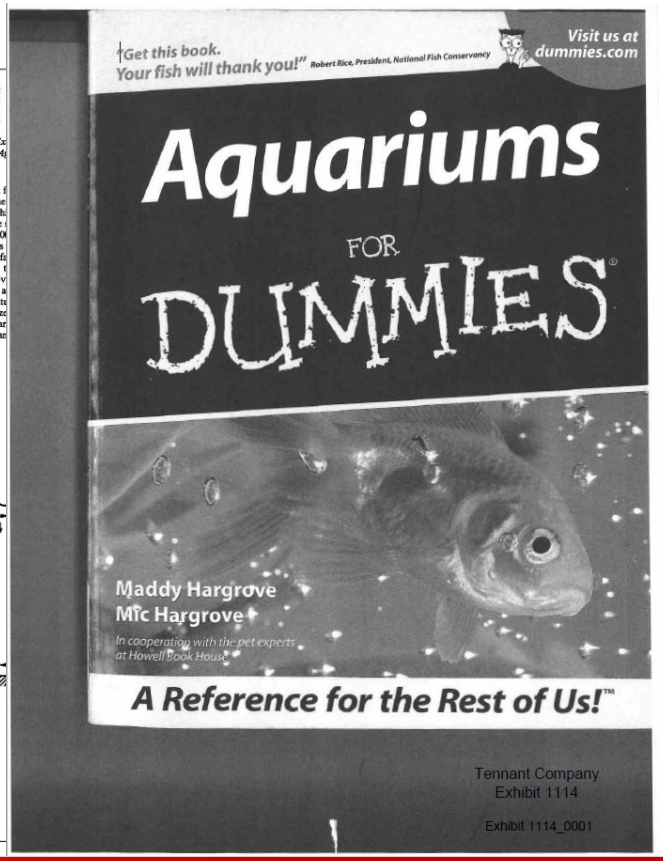
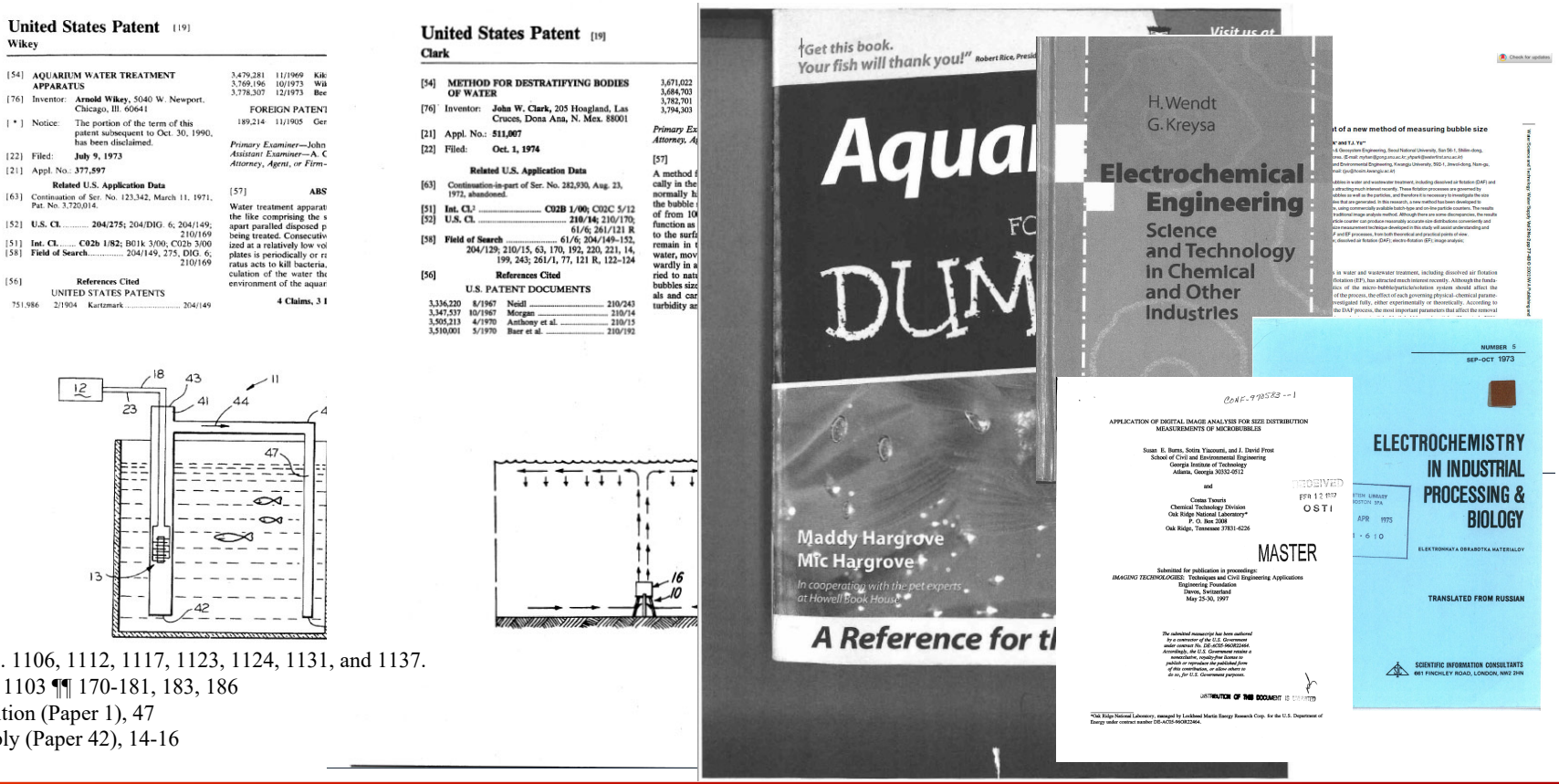


- Exs. 1106, 1112, 1117.
- Ex. 1103 ¶¶ 70-77, 182, 184-185
- Petition (Paper 1), 47
- Reply (Paper 42), 13-15

Ground 6 – Wikey, Clark, AFD, Wendt, Han, Glembotsky and Burns Render Claims 26 and 27 Obvious



- Exs. 1106, 1112, 1117, 1123, 1124, 1131, and 1137.
- Ex. 1103 ¶¶ 170-181, 183, 186
- Petition (Paper 1), 47
- Reply (Paper 42), 14-16

Grounds 7-24
Primary Ref.:
Davies – US Pat. No. 4,917,782

Petitioner's Grounds 7-12

Ground	Challenged Claims	35 U.S.C. §	Prior Art
7	13, 14, 17-23 and 25	102	Davies
8	13, 14, 17-23 and 25	103	Davies and Hough
9	13, 14, 17-23 and 25	103	Davies and Erickson
10	13, 14, 17-23 and 25	103	Davies, Erickson and Hough
11	13, 14, 17-23 and 25	103	Davies and Erickson in view of the general knowledge, experience and common sense of a POSITA, as reflected in Wendt, Han, Glembotsky and Burns
12	13, 14, 17-23 and 25	103	Davies, Erickson and Hough in view of the general knowledge, experience and common sense of a POSITA, as reflected in Wendt, Han, Glembotsky and Burns

Petitioner's Grounds 13-18

Ground	Challenged Claims	35 U.S.C. §	Prior Art
13	24	103	Davies and Schoeberl
14	24	103	Davies, Schoeberl and Hough
15	24	103	Davies, Erickson and Schoeberl
16	24	103	Davies, Erickson, Schoeberl and Hough
17	24	103	Davies, Erickson and Schoeberl in view of the general knowledge, experience and common sense of a POSITA, as reflected in Wendt, Han, Glembotsky and Burns
18	24	103	Davies, Erickson, Schoeberl and Hough in view of the general knowledge, experience and common sense of a POSITA, as reflected in Wendt, Han, Glembotsky and Burns

Petitioner's Grounds 19-24

Ground	Challenged Claims	35 U.S.C. §	Prior Art
19	26 and 27	103	Davies and Peters
20	26 and 27	103	Davies, Peters and Hough
21	26 and 27	103	Davies, Peters and Erickson
22	26 and 27	103	Davies, Peters, Erickson and Hough
23	26 and 27	103	Davies, Peters and Erickson in view of the general knowledge, experience and common sense of a POSITA, as reflected in Wendt, Han, Glembotsky and Burns
24	26 and 27	103	Davies, Peters, Erickson and Hough in view of the general knowledge, experience and common sense of a POSITA, as reflected in Wendt, Han, Glembotsky and Burns

Ground 7 – Davies Anticipates Claims 13, 14, 17-23, and 25

RE45,415

13. A method for producing an oxygenated aqueous composition comprising:

flowing water at a flow rate no greater than 12 gallons per minute through an electrolysis emitter comprising an electrical power source electrically connected to an anode electrode and a cathode electrode contained in a tubular housing,

causing electricity to flow from the power source to the electrodes, and,

producing the composition comprising a suspension comprising oxygen microbubbles and nanobubbles in the water, the microbubbles and nanobubbles having a bubble diameter of less than 50 microns, wherein:

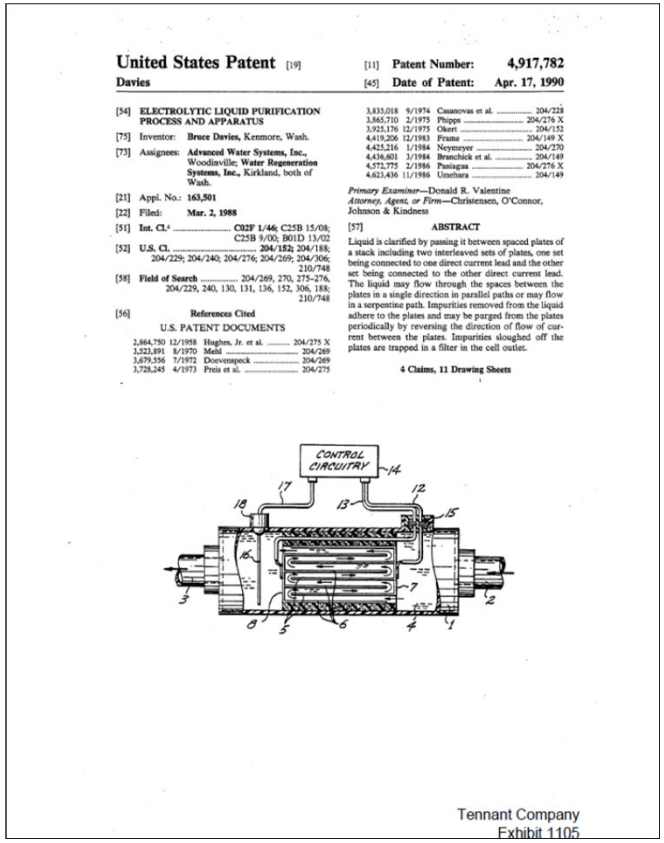
the anode electrode is separated at a critical distance from the cathode such that the critical distance is from 0.005 inches to 0.140 inches;

the power source produces a voltage no greater than about 28.3 volts and an amperage no greater than about 13 amps,

the tubular housing has an inlet and an outlet and a tubular flow axis from the inlet to the outlet;

the water flows in the inlet, out the outlet, is in fluid connection with the electrodes, and the water flowing into the inlet has a conductivity produced by the presence of dissolved solids such that the water supports plant or animal life.

- Ex. 1101, 11:20-12:4.



United States Patent [19]
Davies

[11] Patent Number: 4,917,782
[45] Date of Patent: Apr. 17, 1990

[54] ELECTROLYTIC LIQUID PURIFICATION PROCESS AND APPARATUS

[75] Inventor: Bruce Davies, Kenmore, Wash.

[73] Assignees: Advanced Water Systems, Inc., Woodinville; Water Regeneration Systems, Inc., Kirkland, both of Wash.

[21] Appl. No.: 163,501

[22] Filed: Mar. 2, 1988

[51] Int. Cl.[4] C02F 1/46; C25B 15/08; C25B 9/00; B01D 13/02

[52] U.S. Cl. 204/152; 204/188; 204/229; 204/240; 204/276; 204/269; 204/306; 210/748

[58] Field of Search 204/269, 270, 275-276, 204/229, 240, 130, 131, 136, 152, 306, 188; 210/748

[56] References Cited
U.S. PATENT DOCUMENTS

2,864,750	12/1958	Hughes, Jr. et al.	204/275 X
3,523,891	8/1970	Mehl	204/269
3,679,556	7/1972	Doevenspeck	204/269
3,728,245	4/1973	Preis et al.	204/275
3,835,018	9/1974	Casanovas et al.	204/228
3,865,710	2/1975	Phipps	204/276 X
3,925,176	12/1975	Okert	204/152
4,419,206	12/1983	Frame	204/149 X
4,425,216	1/1984	Neymeyer	204/270
4,436,601	3/1984	Branchick et al.	204/149
4,572,775	2/1986	Paniagua	204/276 X
4,623,436	11/1986	Umehara	204/149

Primary Examiner—Donald R. Valentine
Attorney, Agent, or Firm—Christensen, O'Connor, Johnson & Kindness

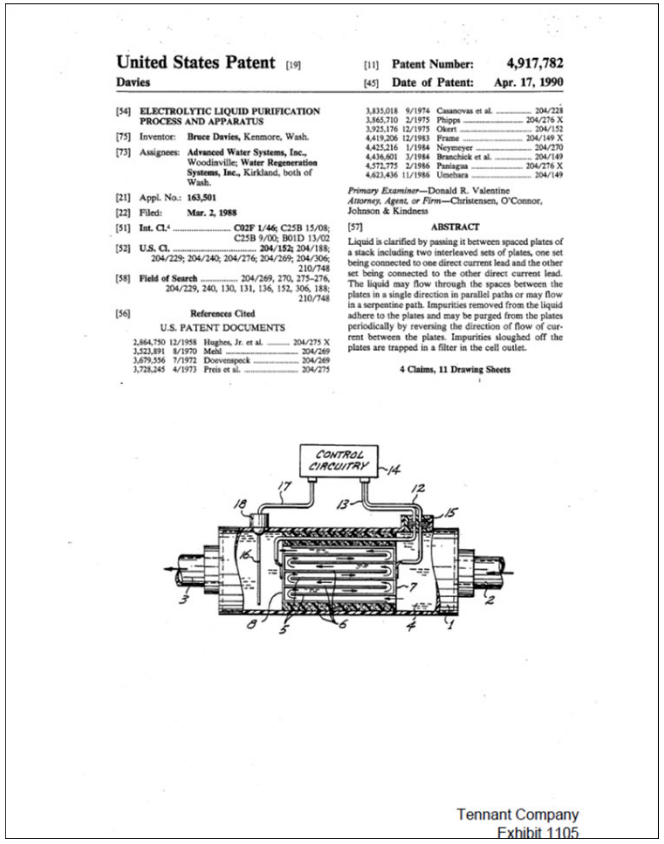
[57] ABSTRACT

Liquid is clarified by passing it between spaced plates of a stack including two interleaved sets of plates, one set being connected to one direct current lead and the other set being connected to the other direct current lead. The liquid may flow through the spaces between the plates in a single direction in parallel paths or may flow in a serpentine path. Impurities removed from the liquid adhere to the plates and may be purged from the plates periodically by reversing the direction of flow of current between the plates. Impurities sloughed off the plates are trapped in a filter in the cell outlet.

4 Claims, 11 Drawing Sheets

Tennant Company
Exhibit 1105

Ground 7 – Davies Configurations



United States Patent [19]
Davies

[11] Patent Number: 4,917,782
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[52] U.S. Cl. 204/152; 204/188; 204/229; 204/240; 204/276; 204/269; 204/306; 210/748

[58] Field of Search 204/269, 270, 275-276, 204/229, 240, 130, 131, 136, 152, 306, 188; 210/748

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Primary Examiner—Donald R. Valentine
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[57] ABSTRACT

Liquid is clarified by passing it between spaced plates of a stack including two interleaved sets of plates, one set being connected to one direct current lead and the other set being connected to the other direct current lead. The liquid may flow through the spaces between the plates in a single direction in parallel paths or may flow in a serpentine path. Impurities removed from the liquid adhere to the plates and may be purged from the plates periodically by reversing the direction of flow of current between the plates. Impurities sloughed off the plates are trapped in a filter in the cell outlet.

4 Claims, 11 Drawing Sheets

Tennant Company
Exhibit 1105

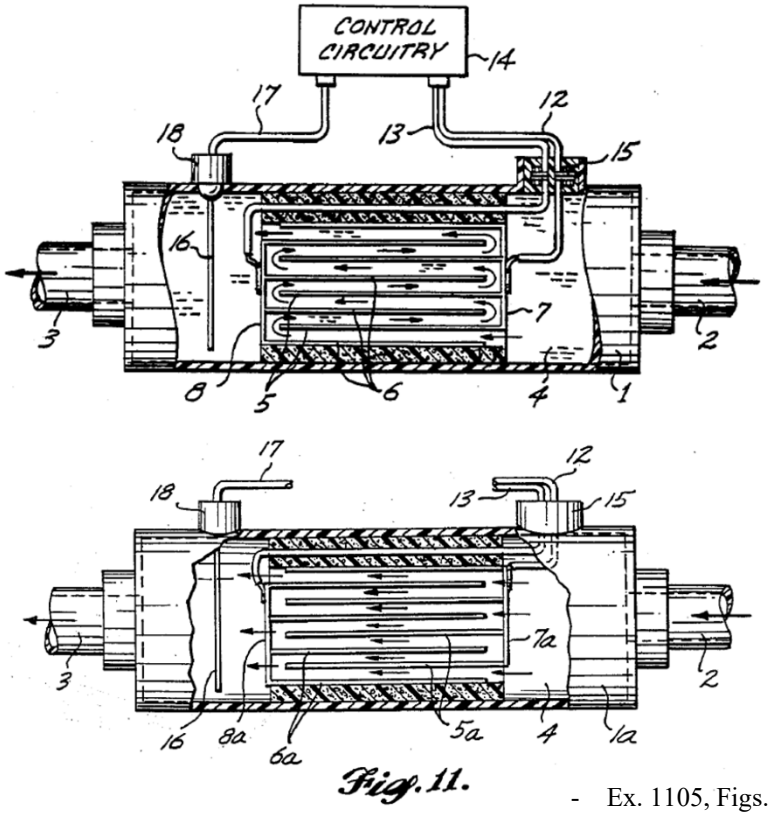
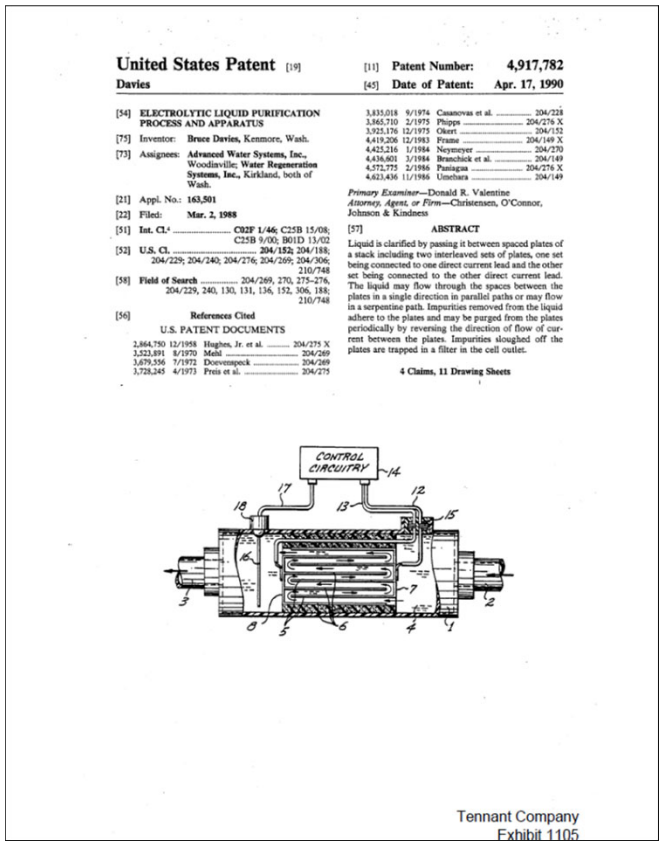


Fig. 11.

- Ex. 1105, Figs. 2 & 11
- Petition (Paper 1), 47-52
- Reply (Paper 42), 17, 20

Ground 7 – Davies Teaches the "Critical Distance"



United States Patent [19]
Davies

[11] Patent Number: 4,917,782
[45] Date of Patent: Apr. 17, 1990

[54] ELECTROLYTIC LIQUID PURIFICATION PROCESS AND APPARATUS

[75] Inventor: Bruce Davies, Kenmore, Wash.

[73] Assignees: Advanced Water Systems, Inc., Woodinville; Water Regeneration Systems, Inc., Kirkland, both of Wash.

[21] Appl. No.: 163,501

[22] Filed: Mar. 2, 1988

[51] Int. Cl.[4] C02F 1/46; C25B 15/08; C25B 9/00; B01D 13/02

[52] U.S. Cl. 204/152; 204/188; 204/229; 204/240; 204/276; 204/269; 204/306; 210/748

[58] Field of Search 204/269, 270, 275–276, 204/229, 240, 130, 131, 136, 152, 306, 188; 210/748

[56] References Cited
U.S. PATENT DOCUMENTS

2,864,750	12/1958	Hughes, Jr. et al.	204/275 X
3,523,891	8/1970	Mehl	204/269
3,679,556	7/1972	Doevenspeck	204/269
3,728,245	4/1973	Preis et al.	204/275
3,835,018	9/1974	Casanovas et al.	204/228
3,865,710	2/1975	Phipps	204/276 X
3,925,176	12/1975	Okert	204/152
4,419,206	12/1983	Pirsme	204/149 X
4,425,216	1/1984	Neymeyer	204/270
4,436,601	3/1984	Branchick et al.	204/149
4,572,775	2/1986	Paniagua	204/276 X
4,623,436	11/1986	Umehara	204/149

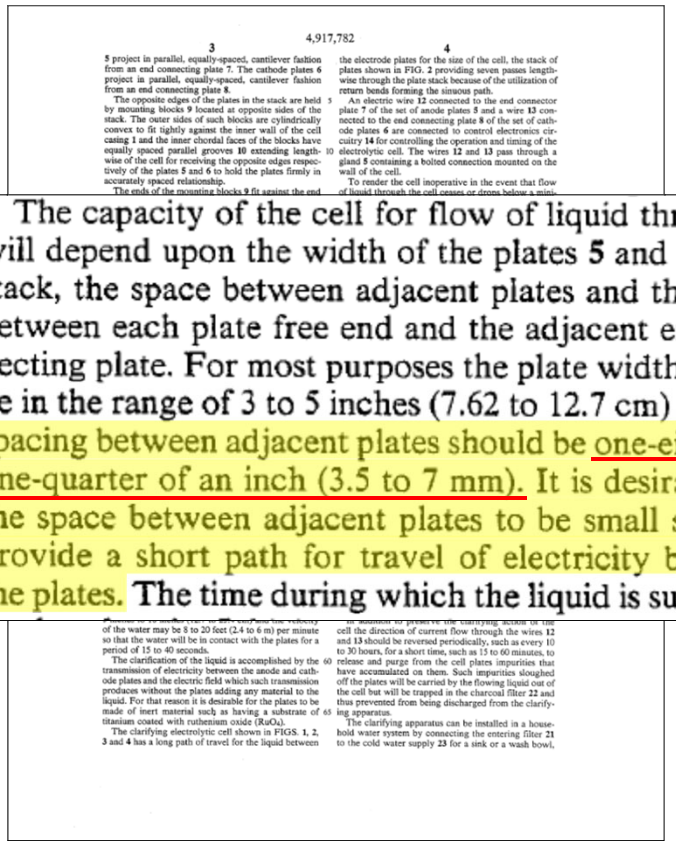
Primary Examiner—Donald R. Valentine
Attorney, Agent, or Firm—Christensen, O'Connor, Johnson & Kindness

[57] ABSTRACT

Liquid is clarified by passing it between spaced plates of a stack including two interleaved sets of plates, one set being connected to one direct current lead and the other set being connected to the other direct current lead. The liquid may flow through the spaces between the plates in a single direction in parallel paths or may flow in a serpentine path. Impurities removed from the liquid adhere to the plates and may be purged from the plates periodically by reversing the direction of flow of current between the plates. Impurities sloughed off the plates are trapped in a filter in the cell outlet.

4 Claims, 11 Drawing Sheets

Tennant Company
Exhibit 1105



4,917,782

3 project in parallel, equally-spaced, cantilever fashion from an end connecting plate 7. The cathode plates 6 project in parallel, equally-spaced, cantilever fashion from an end connecting plate 8.

The opposite edges of the plates in the stack are held by mounting blocks 9 located at opposite sides of the stack. The outer sides of such blocks are cylindrically convex to fit tightly against the inner wall of the cell casing 1 and the inner chordal faces of the blocks have equally spaced parallel grooves 10 extending lengthwise of the cell for receiving the opposite edges respectively of the plates 5 and 6 to hold the plates firmly in accurately spaced relationship.

4 the electrode plates for the size of the cell, the stack of plates shown in FIG. 2 providing seven passes lengthwise through the plate stack because of the utilization of return bends forming the sinuous path.

An electric wire 12 connected to the end connector plate 7 of the set of anode plates 5 and a wire 13 connected to the end connecting plate 8 of the set of cathode plates 6 are connected to control electronics circuitry 14 for controlling the operation and timing of the electrolytic cell. The wires 12 and 13 pass through a gland 5 containing a bolted connection mounted on the wall of the cell.

To render the cell inoperative in the event that flow of liquid through the cell ceases or drops below a mini-

The capacity of the cell for flow of liquid through it will depend upon the width of the plates 5 and 6 in the stack, the space between adjacent plates and the space between each plate free end and the adjacent end connecting plate. For most purposes the plate width should be in the range of 3 to 5 inches (7.62 to 12.7 cm) and the spacing between adjacent plates should be one-eighth to one-quarter of an inch (3.5 to 7 mm). It is desirable for the space between adjacent plates to be small so as to provide a short path for travel of electricity between the plates. The time during which the liquid is subjected

of the water may be 8 to 20 feet (2.4 to 6 m) per minute so that the water will be in contact with the plates for a period of 15 to 40 seconds.

The clarification of the liquid is accomplished by the transmission of electricity between the anode and cathode plates and the electric field which such transmission produces without the plates adding any material to the liquid. For that reason it is desirable for the plates to be made of inert material such as having a substrate of titanium coated with ruthenium oxide (RuO_4).

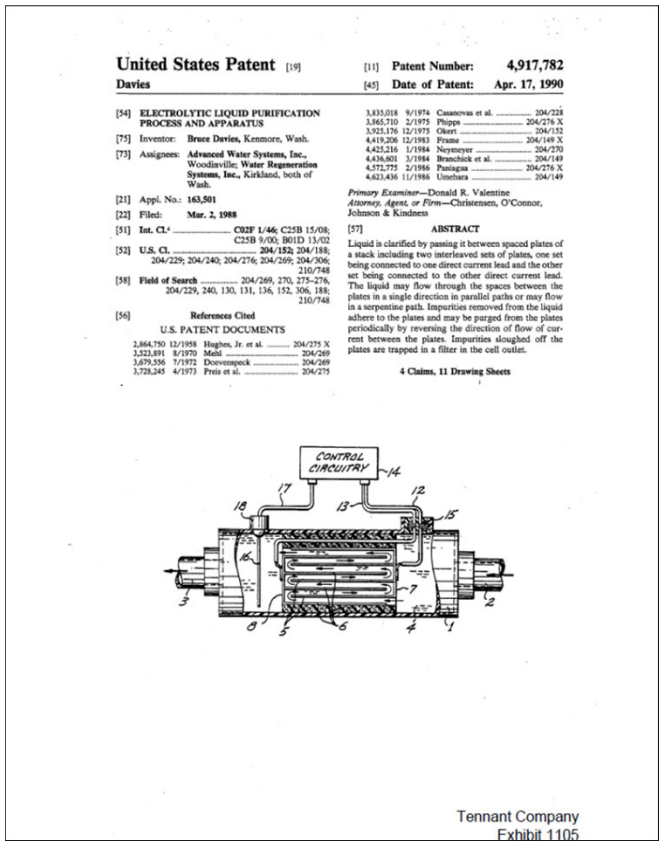
The clarifying electrolytic cell shown in FIGS. 1, 2, 3 and 4 has a long path of travel for the liquid between

cell the direction of current flow through the wires 12 and 13 should be reversed periodically, such as every 10 to 30 hours, for a short time, such as 15 to 60 minutes, to release and purge from the cell plates impurities that have accumulated on them. Such impurities sloughed off the plates will be carried by the flowing liquid out of the cell but will be trapped in the charcoal filter 22 and thus prevented from being discharged from the clarifying apparatus.

The clarifying apparatus can be installed in a household water system by connecting the entering filter 21 to the cold water supply 23 for a sink or a wash bowl,

- Ex. 1105, 3:39-48
- Petition (Paper 1), 49-50
- Reply (Paper 42), 16

Ground 7 – Davies Teaches the Claimed Voltage, Applied to Aquarium Water and Drinking Water



United States Patent [19]
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[54] ELECTROLYTIC LIQUID PURIFICATION PROCESS AND APPARATUS

[75] Inventor: Bruce Davies, Kenmore, Wash.

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[52] U.S. Cl. 204/152; 204/188; 204/229; 204/240; 204/276; 204/269; 204/306; 210/748

[58] Field of Search 204/269, 270, 275-276, 204/229, 240, 130, 131, 136, 152, 306, 188; 210/748

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3,925,176	12/1975	Okert	204/152
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4,436,601	3/1984	Branchick et al.	204/149
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Primary Examiner—Donald R. Valentine
Attorney, Agent, or Firm—Christensen, O'Connor, Johnson & Kindness

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Liquid is clarified by passing it between spaced plates of a stack including two interleaved sets of plates, one set being connected to one direct current lead and the other set being connected to the other direct current lead. The liquid may flow through the spaces between the plates in a single direction in parallel paths or may flow in a serpentine path. Impurities removed from the liquid adhere to the plates and may be purged from the plates periodically by reversing the direction of flow of current between the plates. Impurities sloughed off the plates are trapped in a filter in the cell outlet.

4 Claims, 11 Drawing Sheets

Tennant Company
Exhibit 1105

The clarifying apparatus can be installed in a household water system by connecting the entering filter **21** to the cold water supply **23** for a sink or a wash bowl,

In FIG. **15** the clarifying electrolytic cell **1***a* is used for maintaining the liquid in the aquarium **40** in clean condition to obviate the formation of scum on the surface of the water, formation of deposits on the interior wall of the aquarium tank and clouding of the water.

FIG. **8** is a diagram of apparatus used for clarifying water in the water system of a house trailer, a recreational vehicle or a cabin cruiser. Such apparatus includes the same clarifying cell control mechanism, monitor, flow switch and filters as used in the apparatus described in connection with FIG. **5**. In this instance, however, the power source will not be rectified alternating current but can be a primary source of direct current electricity such as a 12 volt battery **19**′.

- Ex. 1105, 4:66-68, 5:60-68, 7:36-40
- Petition (Paper 1), 50, 52
- Reply (Paper 42), 18

Ground 7 – Davies Inherently Discloses the Claimed Current

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

TENNANT COMPANY,

Petitioner,

v.

OXYGENATOR WATER TECHNOLOGIES, INC.,

Patent Owner.

Patent No. RE45,415

Reissue Date: March 17, 2015

Title: FLOW-THROUGH OXYGENATOR

DECLARATION OF DR. MARIO TREMBLAY

124. Following are relevant parameters/measurements obtained from Operation #3:

Parameters/Measurements	Value
electrode spacing	1/8 inch (0.125 inch)
water type	well water
voltage	12V
flow rate	1gpm
current	10.2 amp
conductivity	352.8 ppm
dissolved oxygen content	66.2%
3 hour dissolved oxygen content	103.4%

147. Following are relevant parameters/measurements obtained from Operation #5:

Parameters/Measurements	Value
electrode spacing	1/8 inch (0.125 inch)
water type	well water
voltage	12V
flow rate	1gpm
current	11.0 amps
conductivity	352.8 ppm
dissolved oxygen content	66.2%
3 hour dissolved oxygen content	125.6%

130. Following are relevant parameters/measurements obtained from Operation #4:

Parameters/Measurements	Value
electrode spacing	1/8 inch (0.125 inch)
water type	municipal water
voltage	12V
flow rate	1gpm
current	8.8 amp
conductivity	281 ppm
dissolved oxygen content	104.2%
3 hour dissolved oxygen content	115.9%

153. Following are relevant parameters/measurements obtained from Operation #6:

Parameters/Measurements	Value
electrode spacing	1/8 inch (0.125 inch)
water type	well water
voltage	12V
flow rate	0.3 gpm
current	12.4 amps
conductivity	352.8 ppm
dissolved oxygen content	66.2%
3 hour dissolved oxygen content	106.3%

- Ex. 1103 ¶¶ 124, 130, 147, 153
- Petition (Paper 1), 52-53
- Reply (Paper 42), 17

Ground 7 – Davies Inherently Discloses the Claimed Current

E-Cell 1

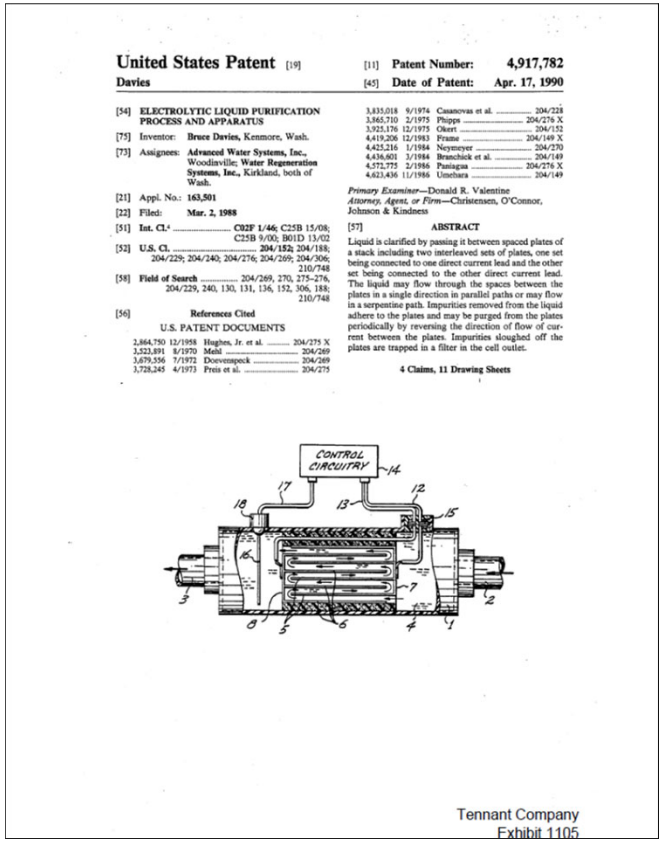
Operation number	Water Type	Flow rate (GPM)	Power supply Setpoint (V)	Current (Amp)
1	Tap water	1	12	10.2
2	Tap water	1	24	25.2
3	Sodium bicarbonate+Tap water	1	12	26.0
4	"Muni" water	1	12	8.8
5	"Muni" water	1	24	20.7

E-Cell 2

Operation number	Water Type	Flow rate (GPM)	Power supply Setpoint (V)	Current (Amp)
1	Tap water	1	12	11.0
2	Tap water	1	24	27.8
3	Tap water	0.3	12	12.4
4	Tap water	0.3	24	28.9
5	Sodium bicarbonate+Tap water	1	12	31.9
6	Sodium bicarbonate+Tap water	0.3	12	32.3-34

- Ex. 2179, 9, 17
- PO Resp. (Paper 35), 36
- Reply (Paper 42), 17-18

Ground 7 – Davies Inherently Discloses the Creation of "Microbubbles" and "Nanobubbles"



United States Patent [19]
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[52] U.S. Cl. 204/152; 204/188; 204/229; 204/240; 204/276; 204/269; 204/306; 210/748

[58] Field of Search 204/269, 270, 275-276, 204/229, 240, 130, 131, 136, 152, 306, 188; 210/748

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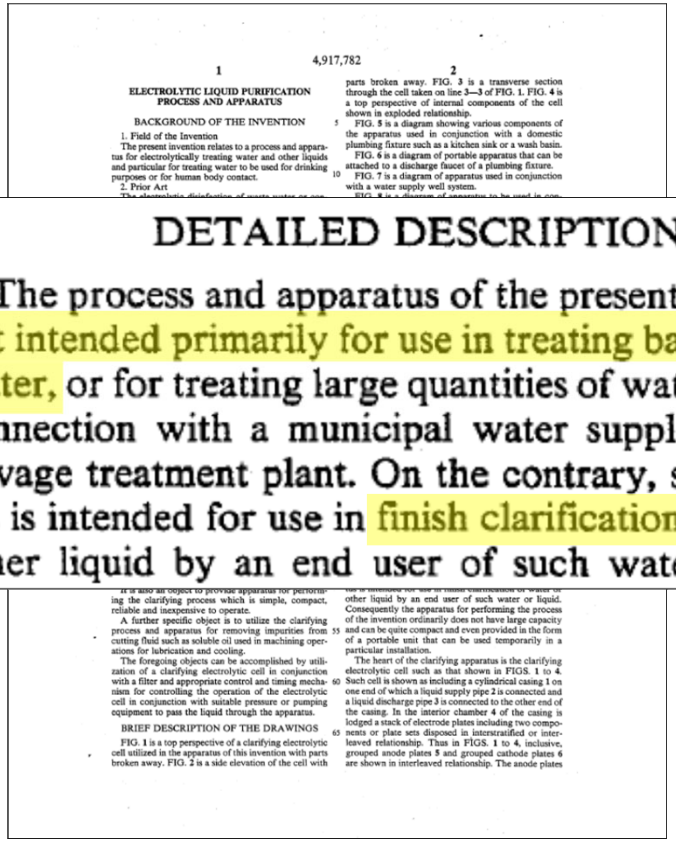
4 Claims, 11 Drawing Sheets

Tennant Company
Exhibit 1105



4,917,782

1

ELECTROLYTIC LIQUID PURIFICATION PROCESS AND APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a process and apparatus for electrolytically treating water and other liquids and particular for treating water to be used for drinking purposes or for human body contact.

2. Prior Art

2

parts broken away. FIG. 3 is a transverse section through the cell taken on line 3—3 of FIG. 1. FIG. 4 is a top perspective of internal components of the cell shown in exploded relationship.

FIG. 5 is a diagram showing various components of the apparatus used in conjunction with a domestic plumbing fixture such as a kitchen sink or a wash basin.

FIG. 6 is a diagram of portable apparatus that can be attached to a discharge faucet of a plumbing fixture.

FIG. 7 is a diagram of apparatus used in conjunction with a water supply well system.

DETAILED DESCRIPTION

The process and apparatus of the present invention is not intended primarily for use in treating badly polluted water, or for treating large quantities of water such as in connection with a municipal water supply system or sewage treatment plant. On the contrary, such apparatus is intended for use in finish clarification of water or other liquid by an end user of such water or liquid.

It is also an object to provide apparatus for performing the clarifying process which is simple, compact, reliable and inexpensive to operate.

A further specific object is to utilize the clarifying process and apparatus for removing impurities from cutting fluid such as soluble oil used in machining operations for lubrication and cooling.

The foregoing objects can be accomplished by utilization of a clarifying electrolytic cell in conjunction with a filter and appropriate control and timing mechanism for controlling the operation of the electrolytic cell in conjunction with suitable pressure or pumping equipment to pass the liquid through the apparatus.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a top perspective of a clarifying electrolytic cell utilized in the apparatus of this invention with parts broken away. FIG. 2 is a side elevation of the cell with

other liquid by an end user of such water or liquid. Consequently the apparatus for performing the process of the invention ordinarily does not have large capacity and can be quite compact and even provided in the form of a portable unit that can be used temporarily in a particular installation.

The heart of the clarifying apparatus is the clarifying electrolytic cell such as that shown in FIGS. 1 to 4. Such cell is shown as including a cylindrical casing 1 on one end of which a liquid supply pipe 2 is connected and a liquid discharge pipe 3 is connected to the other end of the casing. In the interior chamber 4 of the casing is lodged a stack of electrode plates including two components or plate sets disposed in interstratified or interleaved relationship. Thus in FIGS. 1 to 4, inclusive, grouped anode plates 5 and grouped cathode plates 6 are shown in interleaved relationship. The anode plates

- Ex. 1105, 2:44-52
- Reply (Paper 42), 18

Ground 7 – Davies Inherently Discloses the Creation of "Microbubbles" and "Nanobubbles"

UNITED STATES PATENT AND TRADEMARK OFFICE

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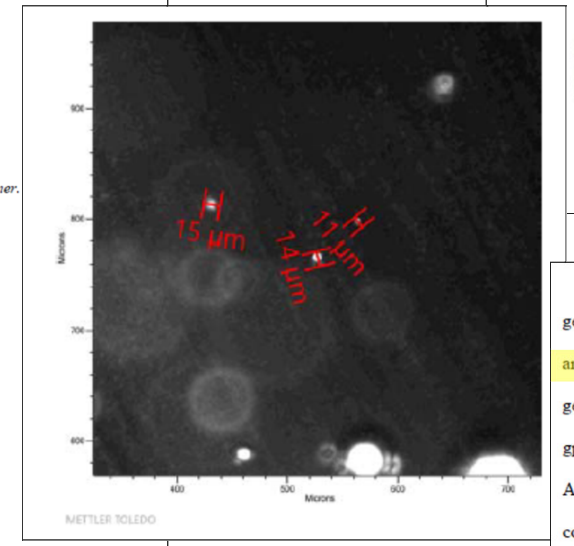
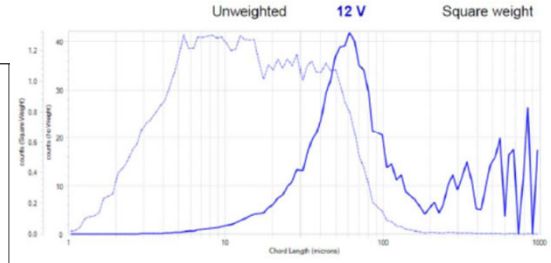


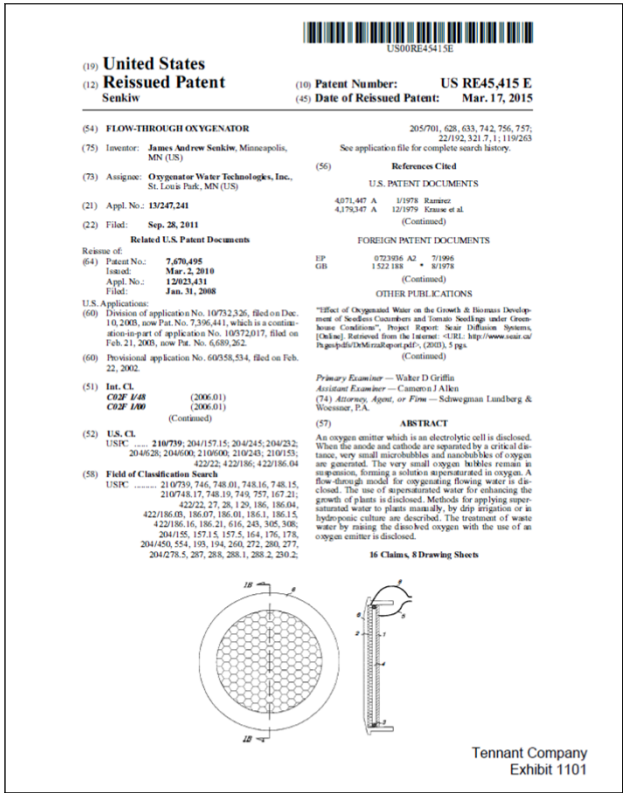
125. The particle size measurement probe measured the following chord lengths (microns) of bubbles. Bubbles having a size of below 50 microns, and even below 15 microns, were present.



127. The results from Operation #3 show that Reproduced Davies cell #1 generated water that included bubbles having a bubble size of less than 50 microns, and even less than 15 microns (0.0006 inches). Additionally, this bubble size was generated using well water, an electrode spacing of 0.125 inch, a flow rate of 1 gpm, and a voltage of 12 volts, which are parameters taught in Davies. Additionally, a current of 10.2 amps was generated. The well water also had a conductivity of 352.8 ppm and a dissolved oxygen content that increased after 3 hours.

- Ex. 1103 ¶¶ 125-128; *see also* ¶¶ 131-134, 148-151, 154-157
- Petition (Paper 1), 52-63

Ground 7 – Dr. Tremblay's Prior Art Testing Follows the '415 Patent Specification



US00RE45415E

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

(10) **Patent Number: US RE45,415 E**
(45) **Date of Reissued Patent: Mar. 17, 2015**

(54) **FLOW-THROUGH OXYGENATOR**

(75) Inventor: **James Andrew Senkiw**, Minneapolis, MN (US)

(73) Assignee: **Oxygenator Water Technologies, Inc.**, St. Louis Park, MN (US)

(21) Appl. No.: **13/247,241**

(22) Filed: **Sep. 28, 2011**

Related U.S. Patent Documents

Reissue of:
(64) Patent No.: **7,670,495**
Issued: **Mar. 2, 2010**
Appl. No.: **12/023,431**
Filed: **Jan. 31, 2008**

U.S. Applications:
(60) Division of application No. 10/732,326, filed on Dec. 10, 2003, now Pat. No. 7,306,441, which is a continuation-in-part of application No. 10/372,017, filed on Feb. 21, 2003, now Pat. No. 6,689,262.

(60) Provisional application No. 60/358,534, filed on Feb. 22, 2002.

(51) **Int. Cl.**
C02F 1/48 (2006.01)
C02F 1/00 (2006.01)
(Continued)

(52) **U.S. Cl.**
USPC **210/739**; 204/157.15; 204/245; 204/232; 204/628; 204/600; 210/600; 210/243; 210/153; 422/22; 422/186; 422/186.04

(58) **Field of Classification Search**
USPC 210/739, 746, 748.01, 748.16, 748.15, 210/748.17, 748.19, 749, 757, 167.21; 422/22, 27, 28, 129, 186, 186.04, 422/186.05, 186.07, 186.01, 186.1, 186.15, 422/186.16, 186.21, 616, 243, 305, 308; 204/155, 157.15, 157.5, 164, 176, 178, 204/450, 554, 193, 194, 260, 272, 280, 277, 204/278.5, 287, 288, 288.1, 288.2, 230.2; 205/701, 628, 633, 742, 756, 757; 22/192, 321.7.1; 119/263
See application file for complete search history.

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(Continued)

Primary Examiner — Walter D Griffin
Assistant Examiner — Cameron J Allen
(74) *Attorney, Agent, or Firm* — Schwegman Lundberg & Woessner, P.A.

(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 mixing the dissolved oxygen with the use of an oxygen emitter is disclosed.

16 Claims, 8 Drawing Sheets

Tennant Company
Exhibit 1101

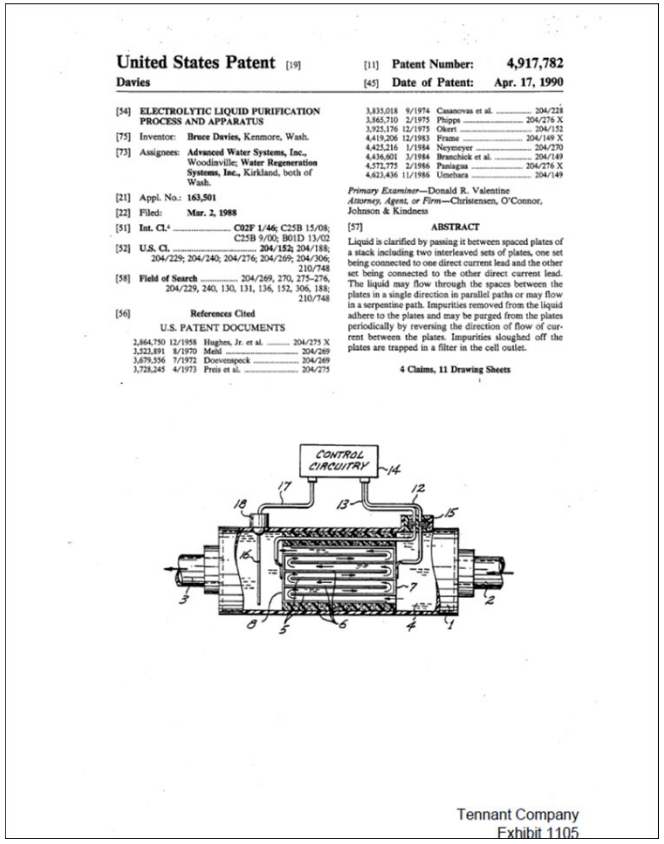
Measurement of O_2 Bubbles

Attempts were made to measure the diameter of the O_2 bubbles emitted by the device of Example 1. In the case of particles other than gasses, measurements can easily be made by scanning electron microscopy, but gasses do not survive electron microscopy. Large bubble may be measured by pore exclusion, for example, which is also not feasible when measuring a gas bubble. A black and white digital, high contrast, backlit photograph of treated water with a millimeter scale reference was shot of water produced by the emitter of Example 1. About 125 bubbles were seen in the area selected for measurement. Seven bubbles ranging from the smallest clearly seen to the largest were measured. The area was enlarged, giving a scale multiplier of 0.029412.

Recorded bubble diameters at scale were 0.16, 0.22, 0.35, 0.51, 0.76, 0.88 and 1.09 millimeters. The last three were considered outliers by reverse analysis of variance and were assumed to be hydrogen bubbles. When multiplied by the scale multiplier, the assumed O_2 bubbles were found to range from 4.7 to 15 microns in diameter. This test was limited by the resolution of the camera and smaller bubbles in the nanometer range could not be resolved. It is known that white light cannot resolve features in the nanometer size range, so monochromatic laser light may give resolution sensitive enough to measure smaller bubbles. Efforts continue to

- Ex. 1101, 5:40-67
- Reply (Paper 42), 19, 21

Ground 7 – Davies Teaches the Claimed Flow Rate



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4,419,206	12/1983	Frame	204/149 X
4,425,216	1/1984	Neymeyer	204/270
4,436,601	3/1984	Branchick et al.	204/149
4,572,775	2/1986	Paniagua	204/276 X
4,623,436	11/1986	Umehara	204/149

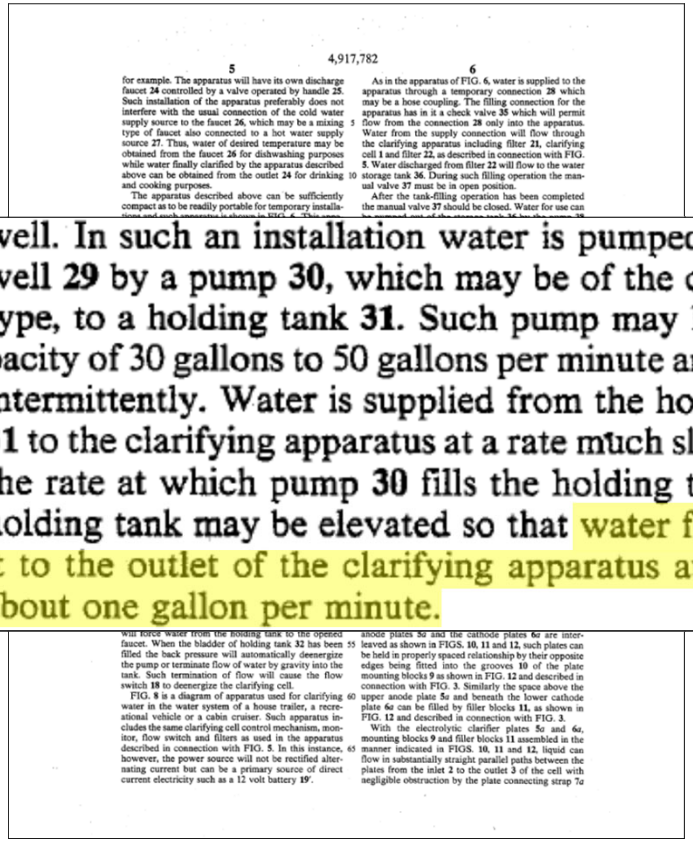
Primary Examiner—Donald R. Valentine
Attorney, Agent, or Firm—Christensen, O'Connor, Johnson & Kindness

[57] ABSTRACT

Liquid is clarified by passing it between spaced plates of a stack including two interleaved sets of plates, one set being connected to one direct current lead and the other set being connected to the other direct current lead. The liquid may flow through the spaces between the plates in a single direction in parallel paths or may flow in a serpentine path. Impurities removed from the liquid adhere to the plates and may be purged from the plates periodically by reversing the direction of flow of current between the plates. Impurities sloughed off the plates are trapped in a filter in the cell outlet.

4 Claims, 11 Drawing Sheets

Tennant Company
Exhibit 1105



4,917,782

5 6

for example. The apparatus will have its own discharge faucet **24** controlled by a valve operated by handle **25**. Such installation of the apparatus preferably does not interfere with the usual connection of the cold water supply source to the faucet **26**, which may be a mixing type of faucet also connected to a hot water supply source **27**. Thus, water of desired temperature may be obtained from the faucet **26** for dishwashing purposes while water finally clarified by the apparatus described above can be obtained from the outlet **24** for drinking and cooking purposes.

The apparatus described above can be sufficiently compact as to be readily portable for temporary installa-

As in the apparatus of FIG. **6**, water is supplied to the apparatus through a temporary connection **28** which may be a hose coupling. The filling connection for the apparatus has in it a check valve **35** which will permit flow from the connection **28** only into the apparatus. Water from the supply connection will flow through the clarifying apparatus including filter **21**, clarifying cell **1** and filter **22**, as described in connection with FIG. **5**. Water discharged from filter **22** will flow to the water storage tank **36**. During such filling operation the manual valve **37** must be in open position.

After the tank-filling operation has been completed the manual valve **37** should be closed. Water for use can

well. In such an installation water is pumped from the well **29** by a pump **30**, which may be of the centrifugal type, to a holding tank **31**. Such pump may have a capacity of 30 gallons to 50 gallons per minute and operate intermittently. Water is supplied from the holding tank **31** to the clarifying apparatus at a rate much slower than the rate at which pump **30** fills the holding tank. Such holding tank may be elevated so that water flows from it to the outlet of the clarifying apparatus at a rate of about one gallon per minute.

will force water from the holding tank to the opened faucet. When the bladder of holding tank **32** has been filled the back pressure will automatically deenergize the pump or terminate flow of water by gravity into the tank. Such termination of flow will cause the flow switch **18** to deenergize the clarifying cell.

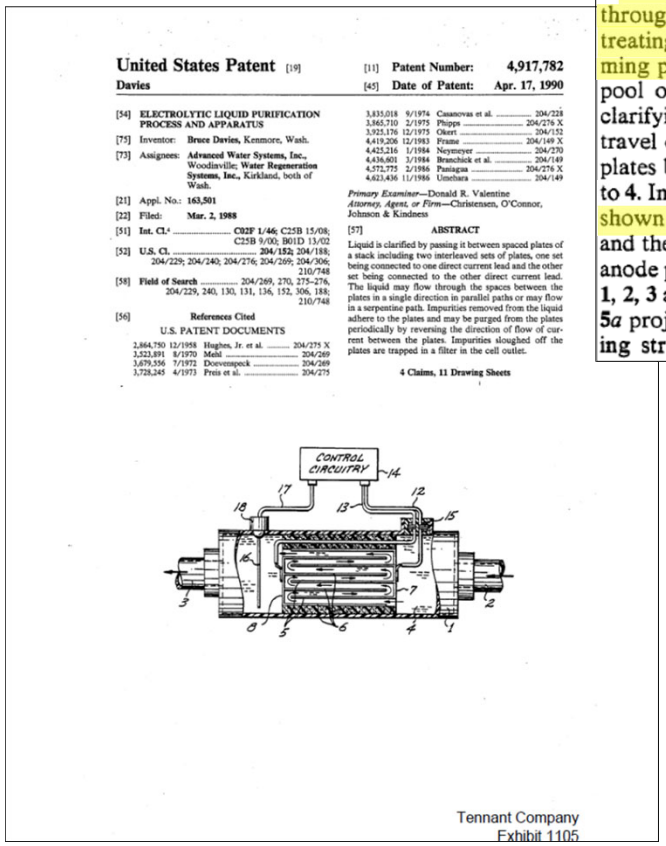
FIG. **8** is a diagram of apparatus used for clarifying water in the water system of a house trailer, a recreational vehicle or a cabin cruiser. Such apparatus includes the same clarifying cell control mechanism, monitor, flow switch and filters as used in the apparatus described in connection with FIG. **5**. In this instance, however, the power source will not be rectified alternating current but can be a primary source of direct current electricity such as a 12 volt battery **19**.

anode plates **5a** and the cathode plates **6a** are interleaved as shown in FIGS. **10**, **11** and **12**, such plates can be held in properly spaced relationship by their opposite edges being fitted into the grooves **10** of the plate mounting blocks **9** as shown in FIG. **12** and described in connection with FIG. **3**. Similarly the space above the upper anode plate **5a** and beneath the lower cathode plate **6a** can be filled by filler blocks **11**, as shown in FIG. **12** and described in connection with FIG. **3**.

With the electrolytic clarifier plates **5a** and **6a**, mounting blocks **9** and filler blocks **11** assembled in the manner indicated in FIGS. **10**, **11** and **12**, liquid can flow in substantially straight parallel paths between the plates from the inlet **2** to the outlet **3** of the cell with negligible obstruction by the plate connecting strap **7a**

- Ex. 1105, 5:27-36
- Petition (Paper 1), 62
- Reply (Paper 42), 20

Ground 7 – Davies Teaches the Claimed Flow Rate



United States Patent [19]
Davies

[11] Patent Number: 4,917,782
[45] Date of Patent: Apr. 17, 1990

[54] ELECTROLYTIC LIQUID PURIFICATION PROCESS AND APPARATUS

[75] Inventor: Bruce Davies, Kenmore, Wash.

[73] Assignees: Advanced Water Systems, Inc., Woodinville; Water Regeneration Systems, Inc., Kirkland, both of Wash.

[21] Appl. No.: 163,501

[22] Filed: Mar. 2, 1988

[51] Int. Cl.[4] C02F 1/46; C25B 15/08; C25B 9/00; B01D 13/02

[52] U.S. Cl. 204/152; 204/188; 204/229; 204/240; 204/276; 204/269; 204/306; 210/748

[58] Field of Search 204/269, 270, 275-276, 204/229, 240, 130, 131, 136, 152, 306, 188; 210/748

[56] References Cited
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3,679,556	7/1972	Doevenspeck	204/269
3,728,245	4/1973	Preis et al.	204/275
3,835,018	9/1974	Casanovas et al.	204/228
3,865,710	2/1975	Phipps	204/276 X
3,925,176	12/1975	Okert	204/152
4,419,206	12/1983	Frame	204/149 X
4,425,216	1/1984	Neymeyer	204/270
4,436,601	3/1984	Branchick et al.	204/149
4,572,775	2/1986	Paniagua	204/276 X
4,623,436	11/1986	Umehara	204/149

Primary Examiner—Donald R. Valentine
Attorney, Agent, or Firm—Christensen, O'Connor, Johnson & Kindness

[57] ABSTRACT

Liquid is clarified by passing it between spaced plates of a stack including two interleaved sets of plates, one set being connected to one direct current lead and the other set being connected to the other direct current lead. The liquid may flow through the spaces between the plates in a single direction in parallel paths or may flow in a serpentine path. Impurities removed from the liquid adhere to the plates and may be purged from the plates periodically by reversing the direction of flow of current between the plates. Impurities sloughed off the plates are trapped in a filter in the cell outlet.

4 Claims, 11 Drawing Sheets

Tennant Company
Exhibit 1105

In other installations water can be recirculated through clarifying apparatus repeatedly, such as by treating successive portions of the contents of a swimming pool or a hot tub where water from a swimming pool or a hot tub is recirculated repeatedly through clarifying apparatus it is not necessary that the path of travel of the liquid in contact with the electrolytic cell plates be as long as in the apparatus shown in FIGS. **1** to **4**. In the alternative type of clarifying electrolytic cell shown in FIGS. **10**, **11**, **12** and **13** the anode plates **5***a* and the cathode plates **6***a* can be of the same size as the anode plates **5** and the cathode plates **6**, shown in FIGS. **1**, **2**, **3** and **4**. In this instance, however, the anode plates **5***a* project in cantilever fashion from a central connecting strap **7***a* instead of from a connecting end plate.

In FIG. **15** the clarifying electrolytic cell **1***a* is used for maintaining the liquid in the aquarium **40** in clean condition to obviate the formation of scum on the surface of the water, formation of deposits on the interior wall of the aquarium tank and clouding of the water. Because of the recirculation of water in the aquarium by the pump **41** through the cell **1***a*, it is not necessary to provide a filter ahead of the cell. The filter **22** beyond

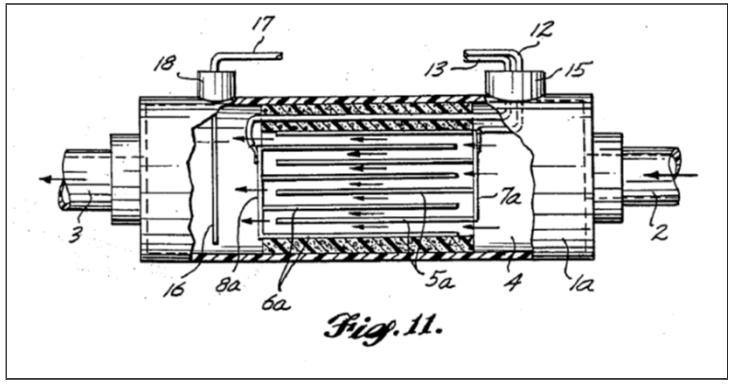


Fig. 11.

- Ex. 1105, 6:35-49, 7:36-43, Fig. 11
- Petition (Paper 1), 50-52
- Reply (Paper 42), 20

Ground 7 – Davies Teaches the Claimed Flow Rate

UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE PATENT TRIAL AND APPEAL BOARD

- -

TENNANT COMPANY,

Petitioner,

v.

OXYGENATOR WATER TECHNOLOGIES, INC.,

Patent Owner.

Case IPR2021-00625
Patent No. RE 45,415

COPY

- -

Video Deposition of
Ralph E. White, Ph.D.
Wednesday, February 9, 2022
8:05 a.m.

Court Stenographer:
Patrick J. Mahon
Registered Merit Reporter
Certified Realtime Reporter

So for flow rate purposes, if we measure it at the inlet or the outlet, it doesn't matter which arrangement we have in the middle?

A That's what I'm saying is, the gallons per minute of a device, the volumetric flow rate, would be measured for the device as a device.

Q Right.

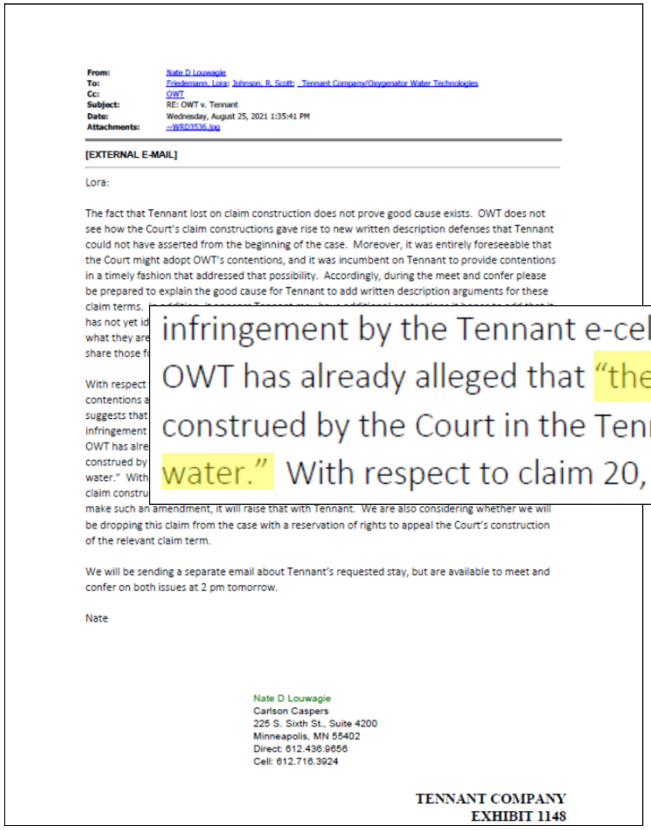
A That's...

Q It doesn't matter the arrangement of the electrodes inside of that device?

A There would be a different, I'm not sure if we should call it flow rate or distribution, a different distribution of the fluid within the straight-through compared to the serpentine.

- Ex. 1147, 213:10-214:1
- Reply (Paper 42), 20

"The Water has a Temperature No Greater than About Ambient… and the Water Temperature is a Factor for Formation of the Suspension" (Claim 18)



From: Nate D Louwagie
To: Friedemann, Lora; Johnson, R. Scott; _Tennant Company/Oxygenator Water Technologies
Cc: OWT
Subject: RE: OWT v. Tennant
Date: Wednesday, August 25, 2021 1:35:41 PM
Attachments: ~WRD3536.jpg

[EXTERNAL E-MAIL]

Lora:

The fact that Tennant lost on claim construction does not prove good cause exists. OWT does not see how the Court's claim constructions gave rise to new written description defenses that Tennant could not have asserted from the beginning of the case. Moreover, it was entirely foreseeable that the Court might adopt OWT's contentions, and it was incumbent on Tennant to provide contentions in a timely fashion that addressed that possibility. Accordingly, during the meet and confer please be prepared to explain the good cause for Tennant to add written description arguments for these claim terms.

With respect to claim 18, OWT has already alleged that "the water temperature is a factor for formation of the suspension" as construed by the Court in the Tennant process since Tennant instructs its user to use "clear ***cool*** water." With respect to claim 20, OWT is still in the process of analyzing the impact of the Court's claim construction. If we make such an amendment, it will raise that with Tennant. We are also considering whether we will be dropping this claim from the case with a reservation of rights to appeal the Court's construction of the relevant claim term.

We will be sending a separate email about Tennant's requested stay, but are available to meet and confer on both issues at 2 pm tomorrow.

Nate

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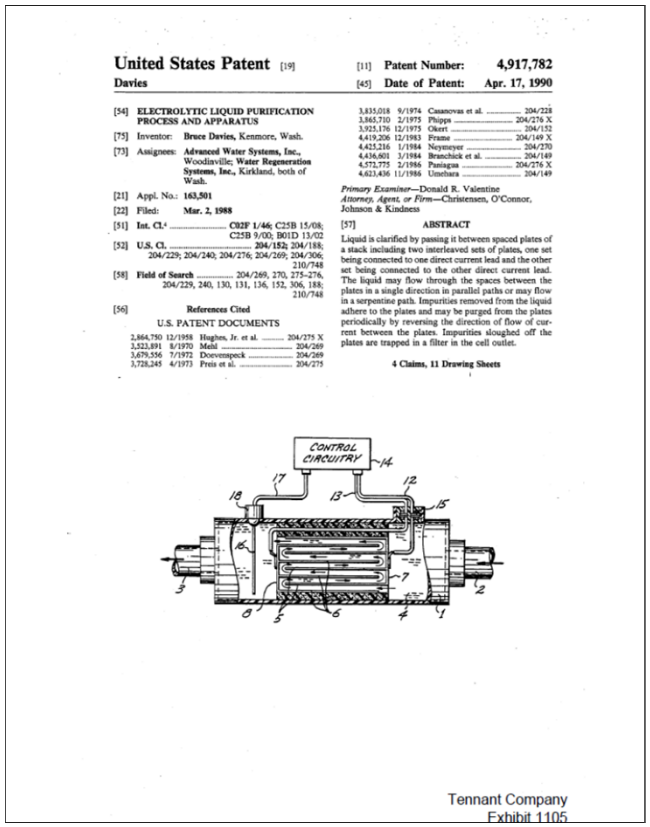
Carlson Caspers
225 S. Sixth St., Suite 4200
Minneapolis, MN 55402
Direct: 612.436.9656
Cell: 612.716.3924

TENNANT COMPANY
EXHIBIT 1148

- Ex. 1148
- Reply (Paper 42), 5

"The Water has a Temperature No Greater than About Ambient… and the Water Temperature is a Factor for Formation of the Suspension" (Claim 18)



United States Patent [19]
Davies

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[45] Date of Patent: Apr. 17, 1990

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[73] Assignees: Advanced Water Systems, Inc., Woodinville; Water Regeneration Systems, Inc., Kirkland, both of Wash.

[21] Appl. No.: 163,501

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[51] Int. Cl.[4] C02F 1/46; C25B 15/08; C25B 9/00; B01D 13/02

[52] U.S. Cl. 204/152; 204/188; 204/229; 204/240; 204/276; 204/269; 204/306; 210/748

[58] Field of Search 204/269, 270, 275–276, 204/229, 240, 130, 131, 136, 152, 306, 188; 210/748

[56] References Cited
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3,835,018	9/1974	Casanovas et al.	204/228
3,865,710	2/1975	Phipps	204/276 X
3,925,176	12/1975	Okert	204/152
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4,425,216	1/1984	Neymeyer	204/270
4,436,601	3/1984	Branchick et al.	204/149
4,572,775	2/1986	Panigua	204/276 X
4,623,436	11/1986	Umehara	204/149

Primary Examiner—Donald R. Valentine
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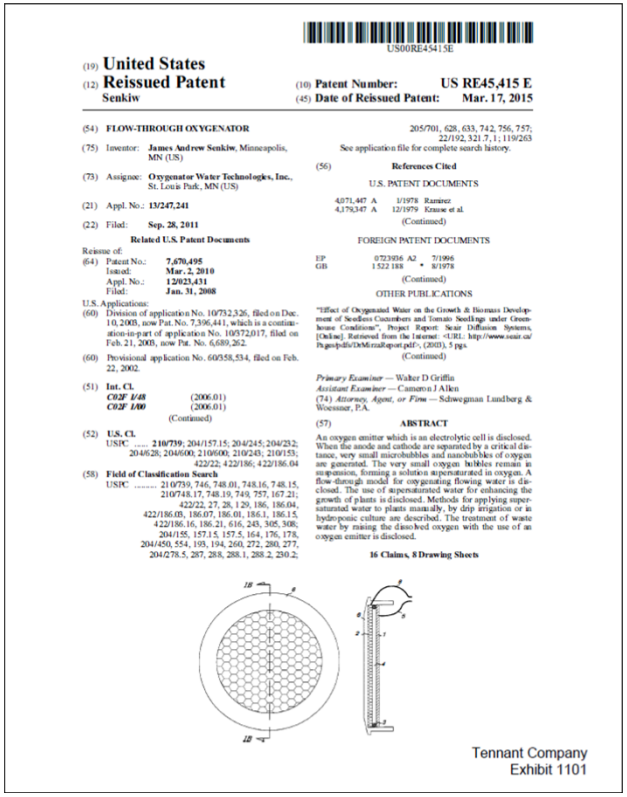
4 Claims, 11 Drawing Sheets

Tennant Company
Exhibit 1105

In FIG. **15** the clarifying electrolytic cell **1***a* is used for maintaining the liquid in the aquarium **40** in clean condition to obviate the formation of scum on the surface of the water, formation of deposits on the interior wall of the aquarium tank and clouding of the water. Because of the recirculation of water in the aquarium by the pump **41** through the cell **1***a*, it is not necessary to provide a filter ahead of the cell. The filter **22** beyond

- Ex. 1105, 7:36-43
- Petition (Paper 1), 52, 66
- Reply (Paper 42), 20

"The Microbubbles and Nanobubbles Supersaturate the Water" (Claim 21)



US00RE45415E

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

(10) **Patent Number: US RE45,415 E**
(45) **Date of Reissued Patent: Mar. 17, 2015**

(54) **FLOW-THROUGH OXYGENATOR**

(75) Inventor: **James Andrew Senkiw**, Minneapolis, MN (US)

(73) Assignee: **Oxygenator Water Technologies, Inc.**, St. Louis Park, MN (US)

(21) Appl. No.: **13/247,241**

(22) Filed: **Sep. 28, 2011**

Related U.S. Patent Documents

Reissue of:
(64) Patent No.: **7,670,495**
Issued: **Mar. 2, 2010**
Appl. No.: **12/023,431**
Filed: **Jan. 31, 2008**

U.S. Applications:
(60) Division of application No. 10/732,326, filed on Dec. 10, 2003, now Pat. No. 7,396,441, which is a continuation-in-part of application No. 10/372,017, filed on Feb. 21, 2003, now Pat. No. 6,689,262.

(60) Provisional application No. 60/358,534, filed on Feb. 22, 2002.

(51) **Int. Cl.**
C02F 1/48 (2006.01)
C02F 1/00 (2006.01)
(Continued)

(52) **U.S. Cl.**
USPC **210/739**; 204/157.15; 204/245; 204/252; 204/628; 204/600; 210/600; 210/243; 210/153; 422/22; 422/186; 422/186.04

(58) **Field of Classification Search**
USPC 210/739, 746, 748.01, 748.16, 748.15, 210/748.17, 748.19, 749, 757, 167.21; 422/22, 27, 28, 129, 186, 186.04, 422/186.05, 186.07, 186.01, 186.1, 186.15, 422/186.16, 186.21, 616, 243, 305, 308; 204/158, 157.15, 157.5, 164, 176, 178, 204/450, 554, 195, 194, 260, 272, 280, 277, 204/278.5, 287, 288, 288.1, 288.2, 230.2; 205/701, 628, 633, 742, 756, 757; 22/192, 321.7, 1; 119/263
See application file for complete search history.

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(Continued)

Primary Examiner — Walker D Griffin
Assistant Examiner — Cameron J Allen
(74) *Attorney, Agent, or Firm* — Schwegman Lundberg & Woessner, P.A.

(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 mixing the dissolved oxygen with the use of an oxygen emitter is disclosed.

16 Claims, 8 Drawing Sheets

Tennant Company
Exhibit 1101

"Supersaturated" means oxygen at a higher concentration than normal calculated oxygen solubility at a particular temperature and pressure.

reacts to form molecular oxygen, O_2. In the special dimensions of the invention, as explained in more detail in the following examples, O_2 forms bubbles which are too small to break the surface tension of the fluid. These bubbles remain suspended indefinitely in the fluid and, when allowed to build up, make the fluid opalescent or milky. Only after several hours do the bubbles begin to coalesce on the sides of the container and the water clears. During that time, the water is supersaturated with oxygen. In contrast, the H_2 formed readily coalesces into larger bubbles which are discharged into the atmosphere, as can be seen by bubble formation at the cathode.

TABLE III

MODEL	ACTIVE ELECTRODE AREA, SQ. IN.	VOLTAGE	CURRENT, AMPS.	FLOW RATE GAL/MINUTE	DO OF* SAMPLE AT ONE MINUTE
2-Inch "T"	2	28.3	0.72	12	N/A
3-inch "T"	3	28.3	1.75	12	N/A
2-plate Tube	20	28.3	9.1	12	8.4
3-Plate tube	30	28.3	12.8	12	9.6

*As the apparatus runs longer, the flowing water becomes milky, indicating supersaturation. The one-minute time point shows the rapid increase in oxygenation.

- Ex. 1101, 4:16-18, 4:30-41, 9:38-50
- Petition (Paper 1), 10-11, 18, 68
- Reply (Paper 42), 20-21

"The Microbubbles and Nanobubbles Supersaturate the Water" (Claim 21)

process development

E-Cell 1

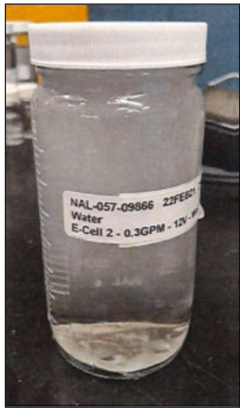
Operation number	Water Type	Flow rate (GPM)	Power supply Setpoint (V)	Current (Amp)	Initial measurements: Dissolved Oxygen (%)	Initial measurements: Conductivity (uS/cm)	Initial measurements: pH	Sample measurements after 3 h: Time collected	Sample measurements after 3 h: Time measured	Sample measurements after 3 h: Dissolved Oxygen (%)	Sample measurements after 3 h: Conductivity (uS/cm)	Sample measurements after 3 h: pH
1	Tap water	1	12	10.2	66.2%	551.2	7.6	1:05 PM	4:09 PM	103.4%	535.0	7.7
2	Tap water	1	24	25.2	66.2%	551.2	7.6	1:24 PM	4:26 PM	92.7%	520.5	7.8
3	Sodium bicarbonate+Tap water	1	12	26.0	80.0%	2086.0	8.2	1:38 PM	4:41 PM	90.6%	1060.0	8.1
4	"Muni" water	1	12	8.8	104.2%	440.5	8.5	2:05 PM	5:01 PM	115.9%	452.5	8.0
5	"Muni" water	1	24	20.7	104.2%	440.5	8.5	2:15 PM	5:13 PM	110.2%	458.3	8.1

E-Cell 2

Operation number	Water Type	Flow rate (GPM)	Power supply Setpoint (V)	Current (Amp)	Initial measurements: Dissolved Oxygen (%)	Initial measurements: Conductivity (uS/cm)	Initial measurements: pH	Sample measurements after 3 h: Time collected	Sample measurements after 3 h: Time measured	Sample measurements after 3 h: Dissolved Oxygen (%)	Sample measurements after 3 h: Conductivity (uS/cm)	Sample measurements after 3 h: pH
1	Tap water	1	12	11.0	66.2%	551.2	7.6	9:21 AM	12:54 PM	125.6%	548.3	9.3
2	Tap water	1	24	27.8	66.2%	551.2	7.6	9:30 AM	12:56 PM	108.0%	534.8	9.3
3	Tap water	0.3	12	12.4	66.2%	551.2	7.6	9:44 AM	1:00 PM	106.3%	537.1	9.4
4	Tap water	0.3	24	28.9	66.2%	551.2	7.6	9:56 AM	1:13 PM	92.8%	545.6	9.6
5	Sodium bicarbonate+Tap water	1	12	31.9	80.0%	2086	8.2	11:00 AM	2:19 PM	94.9%	2387.0	9.1
6	Sodium bicarbonate+Tap water	0.3	12	32.3-34	80.0%	2086	8.2	11:10 AM	2:22 PM	90.0%	2408.0	9.4

Nalas Engineering Services Proprietary

TC_IPR_00000158



- Ex. 2179, 9, 17
- PO Resp. (Paper 35), 36
- Paper 42, 21

"The Bubble Diameter… is Less than 0.0006 Inches" (Claim 22)

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

TENNANT COMPANY,

Petitioner,

v.

OXYGENATOR WATER TECHNOLOGIES, INC.,

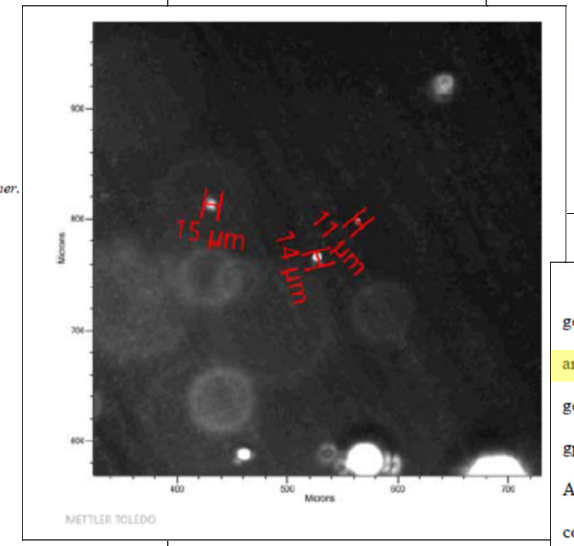
Patent Owner.

Patent No. RE45,415

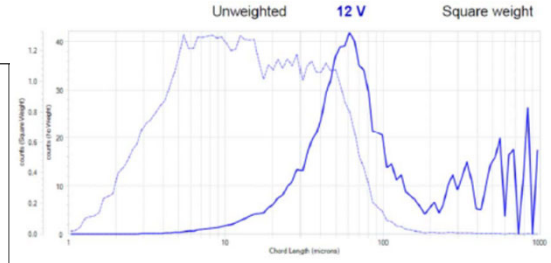
Reissue Date: March 17, 2015

Title: FLOW-THROUGH OXYGENATOR

DECLARATION OF DR. MARIO TREMBLAY



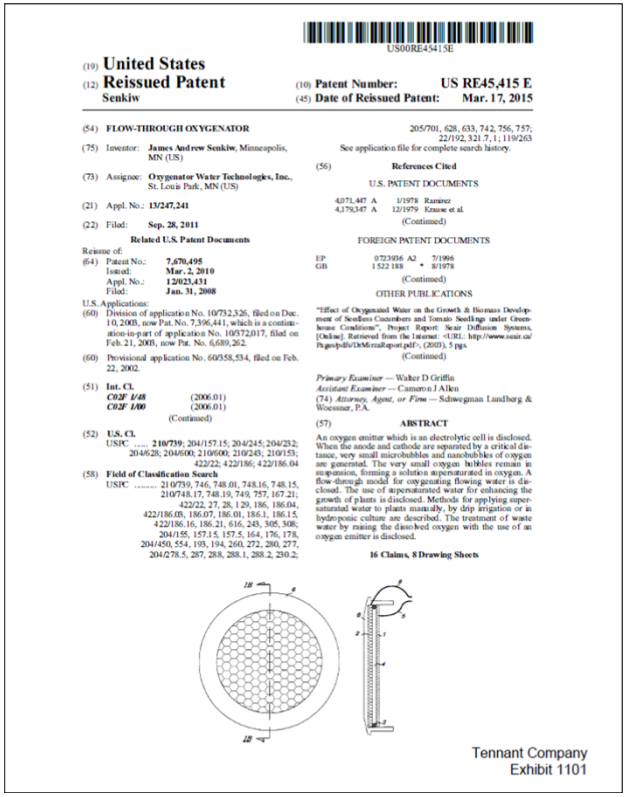
125. The particle size measurement probe measured the following chord lengths (microns) of bubbles. Bubbles having a size of below 50 microns, and even below 15 microns, were present.



127. The results from Operation #3 show that Reproduced Davies cell #1 generated water that included bubbles having a bubble size of less than 50 microns, and even less than 15 microns (0.0006 inches). Additionally, this bubble size was generated using well water, an electrode spacing of 0.125 inch, a flow rate of 1 gpm, and a voltage of 12 volts, which are parameters taught in Davies. Additionally, a current of 10.2 amps was generated. The well water also had a conductivity of 352.8 ppm and a dissolved oxygen content that increased after 3 hours.

- Ex. 1103 ¶¶ 125-128; *see also* ¶¶ 131-134, 148-151, 154-157
- Petition (Paper 1), 52-63, 68-69
- Reply (Paper 42), 21-22

"The Bubble Diameter… is Less than 0.0006 Inches" (Claim 22)



US00RE45415E

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

(10) **Patent Number: US RE45,415 E**
(45) **Date of Reissued Patent: Mar. 17, 2015**

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(64) Patent No.: **7,670,495**
Issued: **Mar. 2, 2010**
Appl. No.: **12/023,431**
Filed: **Jan. 31, 2008**

U.S. Applications:
(60) Division of application No. 10/732,326, filed on Dec. 10, 2003, now Pat. No. 7,396,441, which is a continuation-in-part of application No. 10/372,017, filed on Feb. 21, 2003, now Pat. No. 6,689,262.

(60) Provisional application No. 60/358,534, filed on Feb. 22, 2002.

(51) **Int. Cl.**
C02F 1/48 (2006.01)
C02F 1/00 (2006.01)
(Continued)

(52) **U.S. Cl.**
USPC **210/739**; 204/157.15; 204/245; 204/252; 204/628; 204/600; 210/600; 210/243; 210/153; 422/22; 422/186; 422/186.04

(58) **Field of Classification Search**
USPC 210/739, 746, 748.01, 748.16, 748.15, 210/748.17, 748.19, 749, 757, 167.21; 422/22, 27, 28, 129, 186, 186.04, 422/186.05, 186.07, 186.01, 186.1, 186.15, 422/186.16, 186.21, 616, 243, 305, 308; 204/158, 157.15, 157.5, 164, 176, 178, 204/450, 554, 195, 194, 260, 272, 280, 277, 204/278.5, 287, 288, 288.1, 288.2, 230.2; 205/701, 628, 633, 742, 756, 757; 22/192, 321.7, 1; 119/263
See application file for complete search history.

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(Continued)

Primary Examiner — Walker D Griffin
Assistant Examiner — Cameron J Allen
(74) *Attorney, Agent, or Firm* — Schwegman Lundberg & Woessner, P.A.

(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 mixing the dissolved oxygen with the use of an oxygen emitter is disclosed.

16 Claims, 8 Drawing Sheets

Tennant Company
Exhibit 1101

Measurement of O_2 Bubbles

Attempts were made to measure the diameter of the O_2 bubbles emitted by the device of Example 1. In the case of particles other than gasses, measurements can easily be made by scanning electron microscopy, but gasses do not survive electron microscopy. Large bubble may be measured by pore exclusion, for example, which is also not feasible when measuring a gas bubble. A black and white digital, high contrast, backlit photograph of treated water with a millimeter scale reference was shot of water produced by the emitter of Example 1. About 125 bubbles were seen in the area selected for measurement. Seven bubbles ranging from the smallest clearly seen to the largest were measured. The area was enlarged, giving a scale multiplier of 0.029412.

Recorded bubble diameters at scale were 0.16, 0.22, 0.35, 0.51, 0.76, 0.88 and 1.09 millimeters. The last three were considered outliers by reverse analysis of variance and were assumed to be hydrogen bubbles. When multiplied by the scale multiplier, the assumed O_2 bubbles were found to range from 4.7 to 15 microns in diameter. This test was limited by the resolution of the camera and smaller bubbles in the nanometer range could not be resolved. It is known that white light cannot resolve features in the nanometer size range, so monochromatic laser light may give resolution sensitive enough to measure smaller bubbles. Efforts continue to

- Ex. 1101, 5:40-67
- Reply (Paper 42), 19, 21

"Substantially Incapable of Breaking the Surface Tension of Water" (Claim 25)

US00RE45415E

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

(10) **Patent Number: US RE45,415 E**
(45) **Date of Reissued Patent: Mar. 17, 2015**

(54) **FLOW-THROUGH OXYGENATOR**

(75) Inventor: **James Andrew Senkiw**, Minneapolis, MN (US)

(73) Assignee: **Oxygenator Water Technologies, Inc.**, St. Louis Park, MN (US)

205/701, 628, 633, 742, 756, 757; 22/192, 321.7, 1; 119/263
See application file for complete search history.

(56) **References Cited**
U.S. PATENT DOCUMENTS

The present invention produces microbubbles and nanobubbles of oxygen via the electrolysis of water. As molecular oxygen radical (atomic weight 8) is produced, it reacts to form molecular oxygen, O_2. In the special dimensions of the invention, as explained in more detail in the following examples, O_2 forms bubbles which are too small to break the surface tension of the fluid. These bubbles remain suspended indefinitely in the fluid and, when allowed to build up, make the fluid opalescent or milky. Only after several hours do the bubbles begin to coalesce on the sides of the container and the water clears. During that time, the water is supersaturated with oxygen. In contrast, the H_2 formed readily coalesces into larger bubbles which are discharged into the atmosphere, as can be seen by bubble formation at the cathode.

Tennant Company
Exhibit 1101

S/N 13/247,241 **REISSUE PATENT**
IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	James Andrew Senkiw	Examiner:	Cameron Allen
Serial No.:	13/247,241	Group Art Unit:	1774
Filed:	September 28, 2011	Docket No.:	3406.005USR
Customer No.:	21186	Confirmation No.:	1737
Title:	FLOW-THROUGH OXYGENATOR		

Re-issue of U.S. Patent No. 7,670,495

AMENDMENT & RESPONSE UNDER 37 C.F.R. § 1.111

Applicant's system, method and suspension are the opposite. Applicant's micro and nanobubbles do not rise to the surface and do not break water surface tension. Applicant's claims now recite the conditions needed to produce this result, including voltage, amperage, total water solids indicating conductivity, and the electrode spacing. In particular, Applicant's electrode spacing is significantly smaller than the one ince spacing of Murrell. As Applicant states:

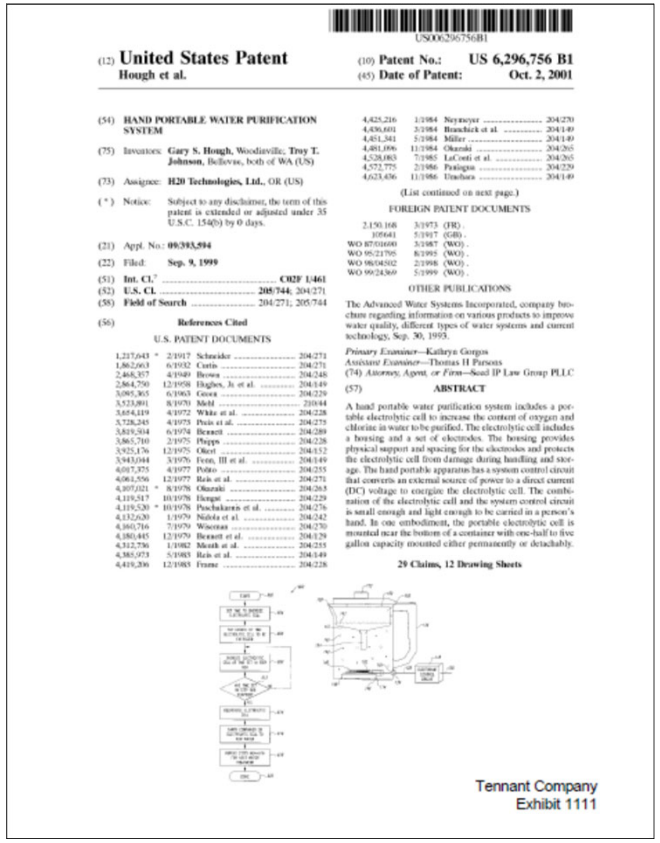
> Above that thickness (0.0140 inches), the power needs are higher and the oxygen bubbles formed at a higher voltage will coalesce and escape the fluid.
> Reissue patent - 5:4-10

In other words, higher voltages and higher electrode separations cause larger bubbles that will rise to the surface like Murrell's development.

Exhibit 1102_0186

- Ex. 1101, 4:27-41
- Ex. 1102, 198
- Petition (Paper 1), 69
- Reply (Paper 42), 22

Grounds 8, 10, 12, 14, 16, 18, 20, 22, 24 – Davies and Hough



US006296756B1

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

(10) **Patent No.: US 6,296,756 B1**
(45) **Date of Patent: Oct. 2, 2001**

(54) **HAND PORTABLE WATER PURIFICATION SYSTEM**

(75) Inventors: **Gary S. Hough**, Woodinville; **Troy T. Johnson**, Bellevue, both of WA (US)

(73) Assignee: **H2O Technologies, Ltd.**, OR (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/393,594**

(22) Filed: **Sep. 9, 1999**

(51) **Int. Cl.**[7] **C02F 1/461**
(52) **U.S. Cl.** **205/744**; 204/271
(58) **Field of Search** 204/271; 205/744

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Assistant Examiner—Thomas H Parsons
(74) *Attorney, Agent, or Firm*—Seed IP Law Group PLLC

(57) **ABSTRACT**

A hand portable water purification system includes a portable electrolytic cell to increase the content of oxygen and chlorine in water to be purified. The electrolytic cell includes a housing and a set of electrodes. The housing provides physical support and spacing for the electrodes and protects the electrolytic cell from damage during handling and storage. The hand portable apparatus has a system control circuit that converts an external source of power to a direct current (DC) voltage to energize the electrolytic cell. The combination of the electrolytic cell and the system control circuit is small enough and light enough to be carried in a person's hand. In one embodiment, the portable electrolytic cell is mounted near the bottom of a container with one-half to five gallon capacity mounted either permanently or detachably.

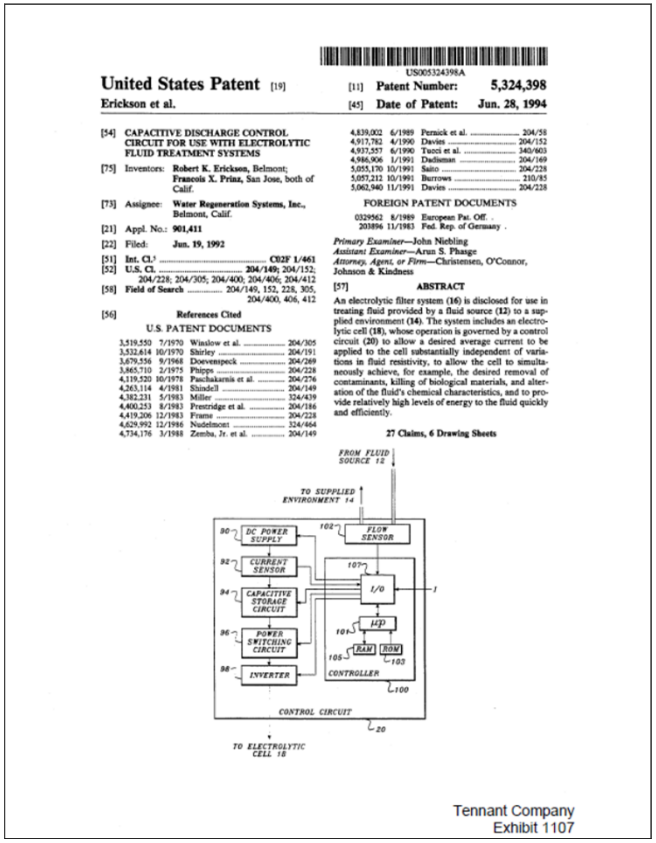
29 Claims, 12 Drawing Sheets

Tennant Company
Exhibit 1111

Another known technique to place oxygen in water is electrolysis, which operates as follows. A voltage is applied to an electrolytic cell that is immersed in water, resulting in current flow in the water. The current flow in the water causes the water molecules to break up into their component parts of hydrogen and oxygen. Hydrogen gas and oxygen gas are thereby freed from the water. Typically, most of the hydrogen gas escapes as a gas from the water, while some of the oxygen gas is dissolved into the water. See, for example, the systems described in U.S. Pat. No. 5,728,287, issued Mar. 17, 1998, and U.S. Pat. No. 5,911,870, issued Jun. 15, 1999, owned by the same assignee as this invention. Current water treatment systems using electrolysis are usually designed to be installed in-line with the water flow path. Additionally, these systems are commonly designed to handle large volumes of water. What is not currently available is a system and method that efficiently increase the dissolved oxygen content of water off-line, and which is small enough for home use.

- Ex. 1111, 1:26-45
- Petition (Paper 1), 70-71
- Reply (Paper 42), 22

Grounds 9-12, 15-18, 21-24 – Davies and Erickson



US005324398A

United States Patent [19]
Erickson et al.

[11] **Patent Number: 5,324,398**
[45] **Date of Patent: Jun. 28, 1994**

[54] **CAPACITIVE DISCHARGE CONTROL CIRCUIT FOR USE WITH ELECTROLYTIC FLUID TREATMENT SYSTEMS**

[75] Inventors: **Robert K. Erickson**, Belmont; **Francois X. Prinz**, San Jose, both of Calif.

[73] Assignee: **Water Regeneration Systems, Inc.**, Belmont, Calif.

[21] Appl. No.: **901,411**

[22] Filed: **Jun. 19, 1992**

[51] **Int. Cl.**[5] **C02F 1/461**
[52] **U.S. Cl.** **204/149**; 204/152; 204/228; 204/305; 204/400; 204/406; 204/412
[58] **Field of Search** 204/149, 152, 228, 305, 204/400, 406, 412

[56] **References Cited**

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Primary Examiner—John Niebling
Assistant Examiner—Arun S. Phange
Attorney, Agent, or Firm—Christensen, O'Connor, Johnson & Kindness

[57] **ABSTRACT**

An electrolytic filter system (16) is disclosed for use in treating fluid provided by a fluid source (12) to a supplied environment (14). The system includes an electrolytic cell (18), whose operation is governed by a control circuit (20) to allow a desired average current to be applied to the cell substantially independent of variations in fluid resistivity, to allow the cell to simultaneously achieve, for example, the desired removal of contaminants, killing of biological materials, and alteration of the fluid's chemical characteristics, and to provide relatively high levels of energy to the fluid quickly and efficiently.

27 Claims, 6 Drawing Sheets

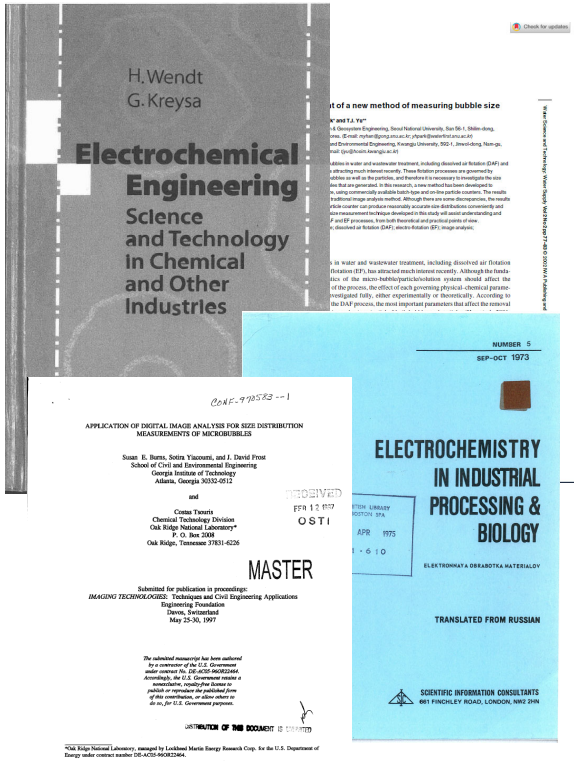
Tennant Company
Exhibit 1107

The voltage and/or current range is selected based upon the nature of the water to be treated and the desired relative performance of the system **16** in removing impurities, killing biological materials, and altering the fluid's chemical composition. In that regard, assume that the fluid is water and includes bacteria and organic chemicals. To kill bacteria, a voltage on the order of 24 volts or more, and a current on the order of 10 amperes is desirable to break down the chemical bonds in the water molecules and, hence, increase the oxygenation of the water. The higher oxygen levels then kill the bacteria.

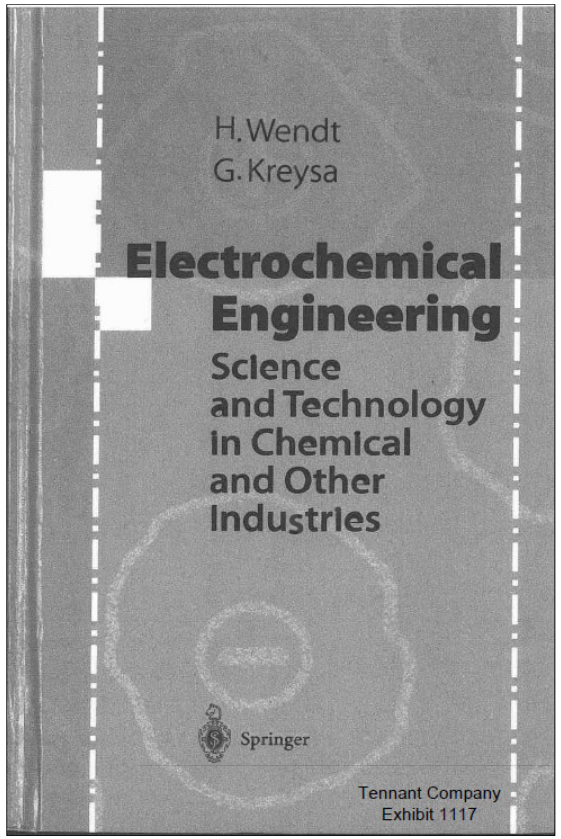
- Ex. 1107, 11:8-19
- Ex. 1103 ¶¶ 188, 189
- Petition (Paper 1), 73-74

Grounds 11-12, 17-18, 23-24 – Davies Combinations in View of the General Knowledge, Experience and Common Sense of a POSITA as Reflected in Wendt, Han, Glembotsky and Burns

- These textbooks merely reflect the general knowledge and understanding of a POSITA.
- Show how a POSITA would understand Davies and combined references
- A POSITA would have understood water electrolysis systems were known to produce bubbles smaller than 50 microns. – Pet. 40-44, 74-75, 78-79, 83; Ex. 1103, ¶¶170-183, 191-192, 197-198, 205-206.



Grounds 11-12, 17-18, 23-24 – Producing Oxygen Bubbles Smaller than 50 Microns was Well Known



5.4.7
Mass Transfer at Gas Evolving Electrodes

Mass transfer at gas evolving electrodes can be remarkably enhanced, provided gas evolution is intense enough to influence the flow of the electrolyte along the electrode. As radii of electrochemically evolved gas bubbles are usually relative small (5–50 µm), bubbles can perturb concentration boundary layers very effectively thereby enhancing mass transfer and compressing Nernst-diffusion layers.

- Ex. 1117, 103
- Ex. 1103 ¶¶ 16, 170, 181, 191-192, 197-198, 205-206
- Petition (Paper 1), 40-41, 74-75, 78-79, 83
- Reply (Paper 42), 25

Grounds 11-12, 17-18, 23-24 – Producing Oxygen Bubbles Smaller than 50 Microns was Well Known

Development of a new method of measuring bubble size

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Abstract The use of bubbles in water and wastewater treatment, including dissolved air flotation (DAF) and electro-flotation (EF), is attracting much interest recently. These flotation processes are governed by characteristics of the bubbles as well as the particles, and therefore it is necessary to investigate the size distribution of the bubbles that are generated. In this research, a new method has been developed to measure the bubble size, using commercially available batch-type and on-line particle counters. The results are compared with the traditional image analysis method. Although there are some discrepancies, the results show that an on-line particle counter can produce reasonably accurate size distributions conveniently and efficiently. The bubble size measurement technique developed in this study will assist understanding and improvement of the DAF and EF processes, from both theoretical and practical points of view.

Keywords Bubble size; dissolved air flotation (DAF); electro-flotation (EF); image analysis; particle counter

Introduction

The use of bubbles in water and wastewater treatment, including dissolved air flotation (DAF) and electro-flotation (EF), has attracted much interest recently. Although the fundamental characteristics of the micro-bubble/particle/solution system should affect the removal efficiency of the process, the effect of each governing physical–chemical parameter has not been investigated fully, either experimentally or theoretically. According to recent modeling of the DAF process, the most important parameters that affect the removal efficiency are the size and zeta potential of both bubbles and particles (Han *et al*., 2001; Han, 2002).

In DAF, bubbles are generated when air-saturated water is released into atmospheric pressure. The size of bubbles is mostly affected by pressure difference across the injection system and type of nozzle (AWWA, 1999). The size range is generally reported to be 10–100 μm, with the average being approximately 40 μm, under a pressure of 4–6 atmospheres (Edzwald, 1995). In EF, hydrogen and oxygen bubbles are generated when current is applied to the solution through metal electrodes. The average size range is reported to be around 20–40 μm, which is a smaller range than that of DAF (Burns *et al*., 1997).

Several methods have been developed to measure the size of bubbles. The most straightforward method is image analysis. Because this method requires a complicated experimental setup and is time-consuming, it is not easy to produce enough data to generate size distributions under different conditions. Another method is to measure the rising velocity of the bubbles and to calculate the sizes by Stokes' Law. However, because the sizes of bubbles are not uniform, and because the rising velocity of many bubbles is different from that of a single bubble, no general equations are available to predict the size distribution of bubbles from the rising velocities.

In this study, a new method to measure the size of bubbles, using particle counters, was developed. The bubble counting results obtained from both image analysis and particle

Tennant Company Exhibit 1137

Introduction

The use of bubbles in water and wastewater treatment, including dissolved air flotation (DAF) and electro-flotation (EF), has attracted much interest recently. Although the fundamental characteristics of the micro-bubble/particle/solution system should affect the removal efficiency of the process, the effect of each governing physical–chemical parameter has not been investigated fully, either experimentally or theoretically. According to recent modeling of the DAF process, the most important parameters that affect the removal efficiency are the size and zeta potential of both bubbles and particles (Han *et al*., 2001; Han, 2002).

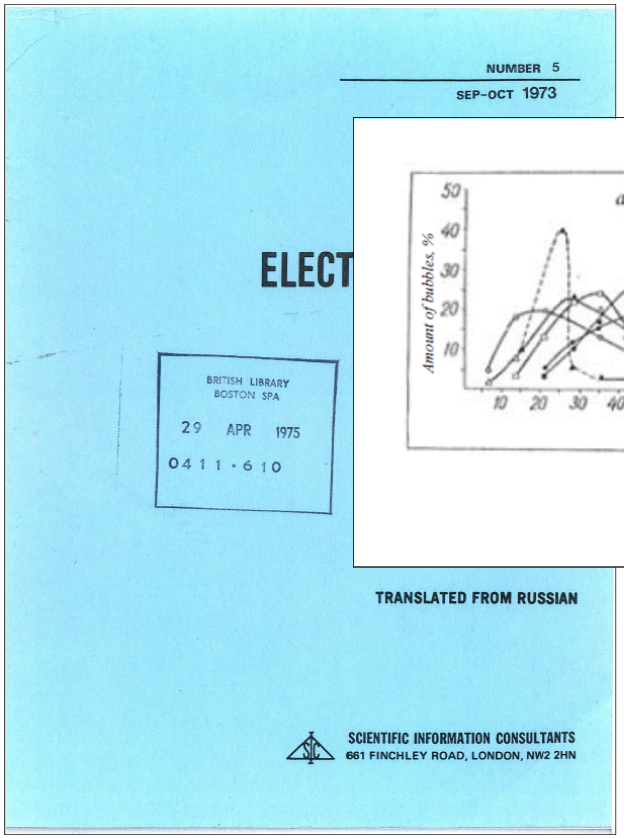
In DAF, bubbles are generated when air-saturated water is released into atmospheric pressure. The size of bubbles is mostly affected by pressure difference across the injection system and type of nozzle (AWWA, 1999). The size range is generally reported to be 10–100 μm, with the average being approximately 40 μm, under a pressure of 4–6 atmospheres (Edzwald, 1995). In EF, hydrogen and oxygen bubbles are generated when current is applied to the solution through metal electrodes. The average size range is reported to be around 20–40 μm, which is a smaller range than that of DAF (Burns *et al*., 1997).

- Ex. 1137, 77
- Ex. 1103 ¶¶ 16, 171, 181, 191-192, 197-198, 205-206
- Petition (Paper 1), 41, 74-75, 78-79, 83
- Reply (Paper 42), 25

DEMONSTRATIVE EXHIBIT - NOT EVIDENCE

Fredrikson & Byron, P.A.

Grounds 11-12, 17-18, 23-24 – Producing Oxygen Bubbles Smaller than 50 Microns was Well Known



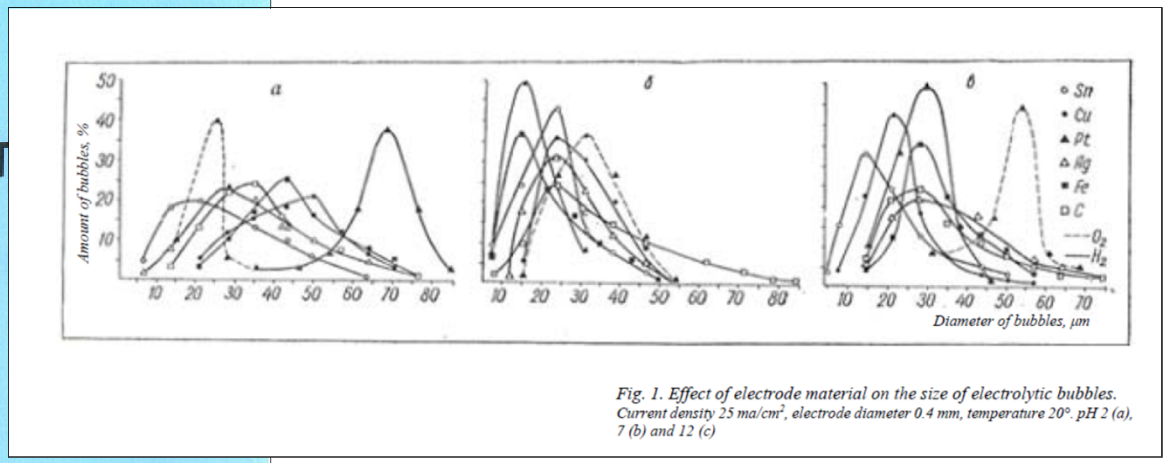


Fig. 1. Effect of electrode material on the size of electrolytic bubbles. Current density 25 ma/cm², electrode diameter 0.4 mm, temperature 20°. pH 2 (a), 7 (b) and 12 (c)

- Ex. 1124, Fig. 1
- Ex. 1103 ¶¶ 16, 172-175, 181, 191-192, 197-198, 205-206
- Petition (Paper 1), 41-42, 74-75, 78-79, 83
- Reply (Paper 42), 25

Grounds 11-12, 17-18, 23-24 – Producing Oxygen Bubbles Smaller than 50 Microns was Well Known

CONF-970583--1

APPLICATION OF DIGITAL IMAGE ANALYSIS FOR SIZE DISTRIBUTION MEASUREMENTS OF MICROBUBBLES

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May 25-30, 1997

*Oak Ridge National Laboratory, managed by Lockheed Martin Energy Research Corp. for the U.S. Department of Energy under contract number DE-AC05-96OR22464.

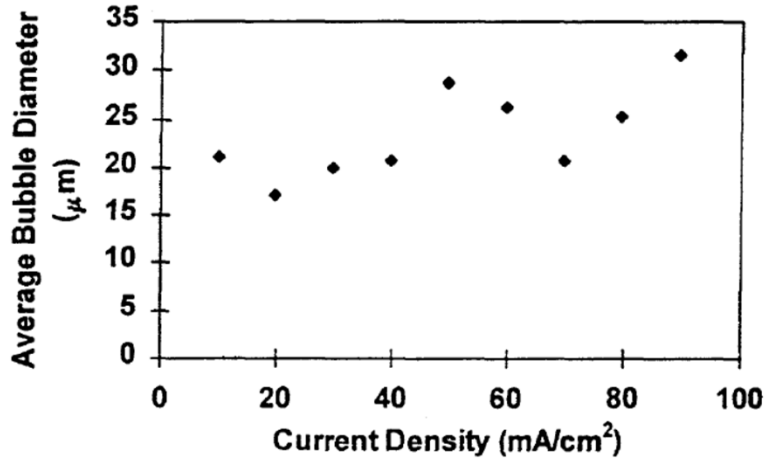
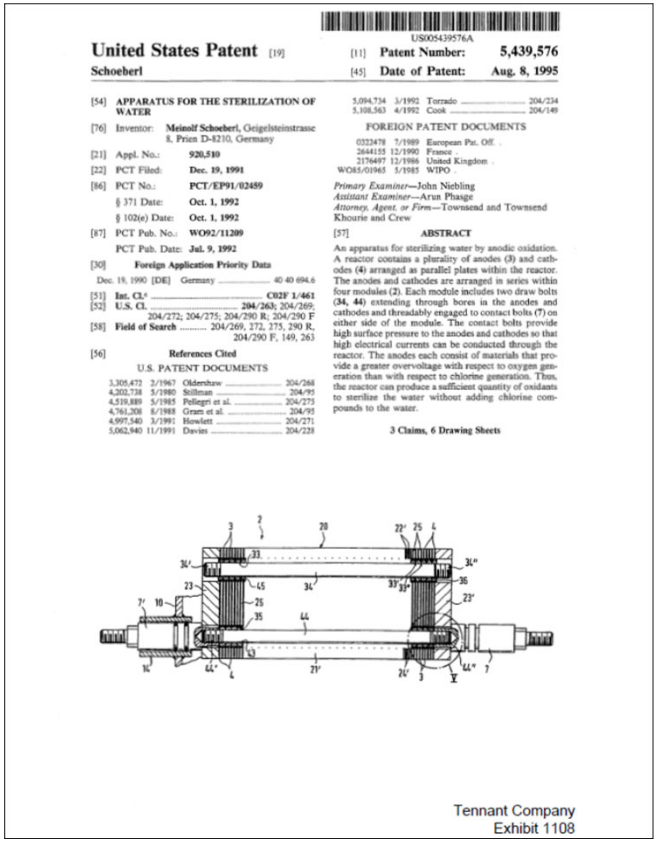


Figure 1. Oxygen bubble diameter as a function of current density: I = 0.1 M.

- Ex. 1131, Fig. 1
- Ex. 1103 ¶¶ 16, 176-181, 191-192, 197-198, 205-206
- Petition (Paper 1), 42-43, 74-75, 78-79, 83
- Reply (Paper 42), 25

Grounds 13-18 – Schoeberl Teaches the Separation Distance of Claim 24



US005439576A

United States Patent [19]
Schoeberl

[11] **Patent Number: 5,439,576**
[45] **Date of Patent: Aug. 8, 1995**

[54] **APPARATUS FOR THE STERILIZATION OF WATER**

[76] Inventor: **Meinolf Schoeberl**, Geigelsteinstrasse 8, Prien D-8210, Germany

[21] Appl. No.: **920,510**

[22] PCT Filed: **Dec. 19, 1991**

[86] PCT No.: **PCT/EP91/02459**
§ 371 Date: **Oct. 1, 1992**
§ 102(e) Date: **Oct. 1, 1992**

[87] PCT Pub. No.: **WO92/11209**
PCT Pub. Date: **Jul. 9, 1992**

[30] **Foreign Application Priority Data**
Dec. 19, 1990 [DE] Germany 40 40 694.6

[51] **Int. Cl.**[6] **C02F 1/461**
[52] **U.S. Cl.** ..... **204/263**; 204/269; 204/272; 204/275; 204/290 R; 204/290 F
[58] **Field of Search** ..... 204/269, 272, 275, 290 R, 204/290 F, 149, 263

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Assistant Examiner—Arun Phasge
Attorney, Agent, or Firm—Townsend and Townsend Khourie and Crew

[57] **ABSTRACT**

An apparatus for sterilizing water by anodic oxidation. A reactor contains a plurality of anodes (3) and cathodes (4) arranged as parallel plates within the reactor. The anodes and cathodes are arranged in series within four modules (2). Each module includes two draw bolts (34, 44) extending through bores in the anodes and cathodes and threadably engaged to contact bolts (7) on either side of the module. The contact bolts provide high surface pressure to the anodes and cathodes so that high electrical currents can be conducted through the reactor. The anodes each consist of materials that provide a greater overvoltage with respect to oxygen generation than with respect to chlorine generation. Thus, the reactor can produce a sufficient quantity of oxidants to sterilize the water without adding chlorine compounds to the water.

3 Claims, 6 Drawing Sheets

Tennant Company
Exhibit 1108

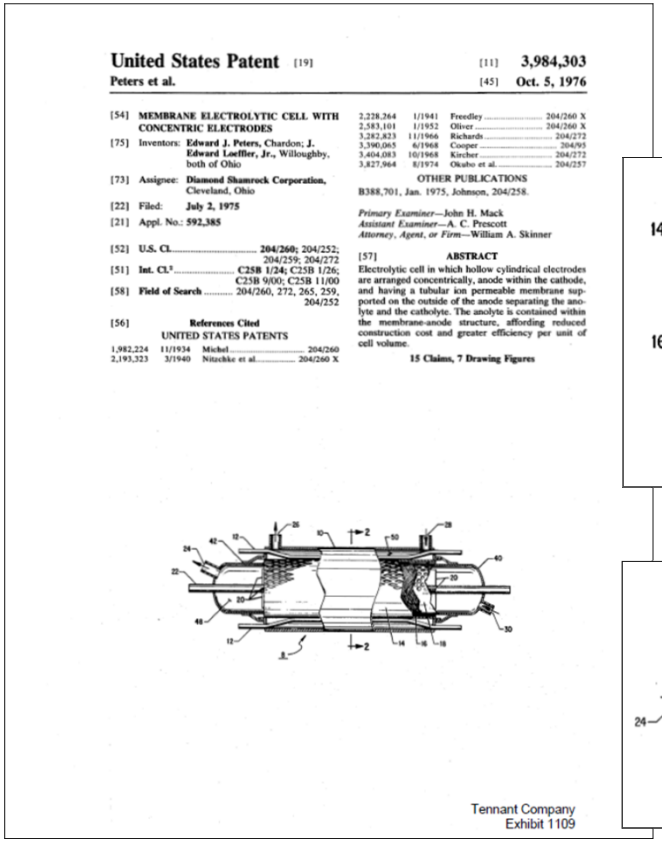
This object is satisfied in the apparatus of the invention, in that a gap of constant gap width is provided between the mutually confronting surfaces of the anode and cathode. The gap width is dimensioned such that a pronounced and preferably laminar flow forms between the mutually confronting surfaces of the anode and cathode in the water flowing through the gap. The and in that the anode consists of a material which has an anode overpotential greater with respect to the generation of oxygen than with respect to the generation of chlorine from chloride ions.

The grooves **24** serve for the guidance of plate-like electrodes **3**, **4** which are inserted into the frame 20, which extend parallel to the side walls **23**, **23'** of the frame **20** and the plate size of which amounts preferably to approximately 200 mm×100 mm. Although only three electrodes are drawn in by way of example in FIG. **2**, each groove pair **24**, **24'** serves to guide an electrode, with the cathode **4** and anode **3** alternating and respectively determining a gap **25** between them which has the width of the associated web **22** or 22' (preferably about 1.3 mm,) with the respective thickness of the anode and cathode being about 1 mm. With this

Schoeberl then provides a preferred electrode separation of about 1.3 mm (0.051 inch). *Id.*, 4:16-17. Based on their disclosure of similar structures and components to achieve similar goals, a POSITA would have been motivated, and found it obvious, to combine them. It would have been obvious to a POSITA provide the preferred electrode separation of 1.3 mm (i.e., 0.051 inch) taught in Schoeberl to the flat sheet electrodes of Davies to achieve an advantageous laminar flow between the electrodes.

- Ex. 1108, 1:50-60, 4:7-18
- Ex. 1103 ¶ 193
- Petition (Paper 1), 76-77
- Reply (Paper 42), 23

Grounds 19-24 – Peters Teaches the Electrode Configuration of Claims 26 and 27



United States Patent [19]
Peters et al.

[11] 3,984,303
[45] Oct. 5, 1976

[54] MEMBRANE ELECTROLYTIC CELL WITH CONCENTRIC ELECTRODES

[75] Inventors: Edward J. Peters, Chardon; J. Edward Loeffler, Jr., Willoughby, both of Ohio

[73] Assignee: Diamond Shamrock Corporation, Cleveland, Ohio

[22] Filed: July 2, 1975

[21] Appl. No.: 592,385

[52] U.S. Cl. 204/260; 204/252; 204/259; 204/272

[51] Int. Cl.[2] C25B 1/24; C25B 1/26; C25B 9/00; C25B 11/00

[58] Field of Search 204/260, 272, 265, 259, 204/252

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Primary Examiner—John H. Mack
Assistant Examiner—A. C. Prescott
Attorney, Agent, or Firm—William A. Skinner

[57] ABSTRACT
Electrolytic cell in which hollow cylindrical electrodes are arranged concentrically, anode within the cathode, and having a tubular ion permeable membrane supported on the outside of the anode separating the anolyte and the catholyte. The anolyte is contained within the membrane-anode structure, affording reduced construction cost and greater efficiency per unit of cell volume.

15 Claims, 7 Drawing Figures

Tennant Company
Exhibit 1109

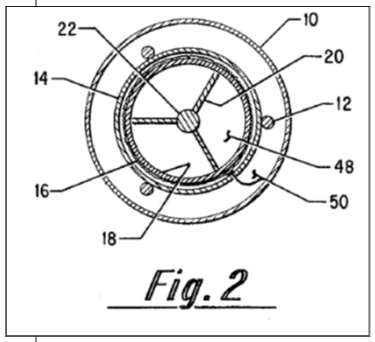

Fig. 2

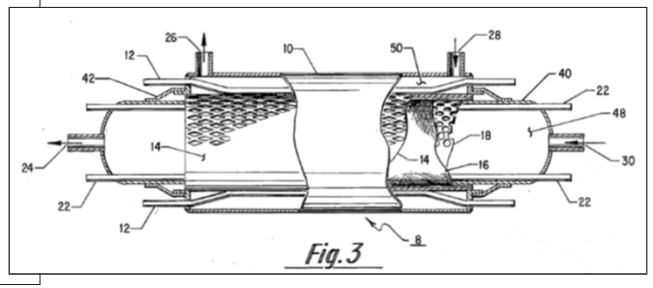

Fig. 3

Additionally, the tubular concentric electrode configuration allows the use of conductor means which can be placed in contact with the electrodes along substantially their entire length, providing more even current distribution and improved current density.

Further, due to its tubular design, the problems of sealing the membrane at its junction with the cell walls is greatly reduced. The membrane sealing area per unit area of electrode is much smaller than in the conventional design, and the nature of the membrane material allows for either a forced fit or a shrink seal around the ends of the anode. Construction tolerances are also more easily achieved, since the cylindrical shape is inherently more stable than flat sheets of equivalent area.

The apparatus of the invention also provides for a greater efficiency per unit of cell volume and reduced cell construction costs, due to the elimination of numerous joints by use of the tubular design.

- Ex. 1109, Figs. 2 & 3, 2:37-55
- Ex. 1103 ¶ 200
- Petition (Paper 1), 79-81
- Reply (Paper 42), 24

Grounds 19-24 – Peters Teaches the Electrode Configuration of Claims 26 and 27

UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE PATENT TRIAL AND APPEAL BOARD

- -

TENNANT COMPANY,

Petitioner,

v.

OXYGENATOR WATER TECHNOLOGIES, INC.,

Patent Owner.

Case IPR2021-00625
Patent No. RE 45,415

COPY

- -

Video Deposition of
Ralph E. White, Ph.D.
Wednesday, February 9, 2022
8:05 a.m.

Court Stenographer:
Patrick J. Mahon
Registered Merit Reporter
Certified Realtime Reporter

Q Okay. And this appears to show that it was known by at least 1976 to form electrodes out of mesh and to form those mesh electrodes into cylindrical shapes; is that fair to say?

MR. LOUWAGIE: Objection to form.

A I think the statement that you made is consistent with what we see in the patent, yes. Uh-huh.

BY MR. JOHNSON:

Q Yeah.

And apparently this structure affords "reduced construction cost and greater efficiency per unit of cell volume," according to the ABSTRACT; is that right?

MR. LOUWAGIE: Objection to form.

A (Reviewing.) Yes, it says, "affording reduced construction cost and greater efficiency per unit of cell volume." I see that in the ABSTRACT.

While the invention will be described in connection with a preferred embodiment, i.e. the electrolysis of sodium chloride brine to produce chlorine and caustic soda, it is to be understood that this is only for purposes of illustration and is not intended to limit the invention to that embodiment. On the contrary, it is intended to cover all alternatives, modifications and equivalents as may be included within the spirit and scope of the invention as defined by the appended claims.

- Ex. 1147, 238:3-18
- Ex. 1109, 3:10-19
- Reply (Paper 42), 24

Thank you!