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AUSTRALIA

PATENTS ACT 1990

NOTICE OF ENTITLEMENT

We, AD REM MANUFACTURING, INC., of 12290 US 19 North, Clearwater, Florida 34624, United States of America, being the applicant in respect of Application No. 42326/93, state the following:-

1. The person nominated for the grant of the patent has entitlement from the actual inventors by assignment.

2. The person nominated for the grant of the patent has entitlement from the applicants of the application listed in the declaration under Article 8 of the PCT by assignment.

3. The basic application listed in the declaration under Article 8 of the PCT is the first application made in a Convention country in respect of the invention.

For and on behalf of

AD REM MANUFACTURING, INC.

..... 1/11 , 1994

(Signature) (Date)

Name: ...Ronald C. Williams.....

Title: .....President.....

File: 16948.80

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GL25(o)

AU9342326

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ELECTROLYTIC CELL ASSEMBLY AND PROCESS FOR PRODUCTION OF BROMINE

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(56) Prior Art Documents
US 4100052
US 3305472

(57) Claim

1. A method for electrolyzing an aqueous electrolyte sodium bromide solution to produce bromine to provide brominated water for sanitizing a body of water, the method including passing the electrolyte through a canister having a compartment that houses an anode and a cathode and bipolar graphite electrode plate elements that can function as an anode on one face and as a cathode on the other face, the method comprising the steps of:

(a) passing direct current at constant amperage to the anode and cathode and through the aqueous solution in a bromine generator comprising the canister compartment and a plurality of the bipolar graphite plate elements positioned in the compartment with plate mounts to hold the plate elements in place and to provide a circulation of electrolyte around the plate elements;

.../2

(b) turning the electrical power furnishing the direct current on and off;

(c) adjusting the time of the on/off switching in step b, the turning off being for a predetermined selected time interval in a cycle of 1 to 60 seconds;

(d) reversing the polarity of the electrodes functioning as the anode and the cathode to remove deposits from the plate electrodes elements; and

(e) delivering brominated water for sanitizing a body of water.

6. A method for electrolyzing an aqueous electrolyte sodium bromide solution to produce bromine to provide brominated water for sanitizing a body of water, the method including passing the electrolyte through a canister having a compartment that houses an electrode that is an anode and cathode and bipolar electrode graphite plate elements, the method comprising the steps of:

(a) passing direct current to the anode and cathode and through the aqueous solution in a bromine generator comprising the canister compartment and a plurality of the bipolar graphite plate elements positioned in the compartment with plate mounts to hold the plate elements in place and to provide a circulation of electrolyte around the plate elements;

(b) turning the electrical power furnishing the direct current on and off;

(c) adjusting the time of the on/off switching in step (b), the power being off for a

predetermined selected time in a cycle of 1 to 60 seconds;

(d) reversing the polarity of the electrodes functioning as an anode and as a cathode to remove deposits from the plate electrodes; and

(e) just prior to reversing the polarity of the current in step (d), turning the power off for 3 to 8 seconds to help clean the electrode plate elements and help to keep bromine atoms from flipping back to their ionized state in response to the change in polarity; and

(f) delivering brominated water for sanitizing a body of water.

3. A method as defined in claim 1 in which there is a further step of, just prior to reversing the polarity of the current in step (d), turning off the power for 3 to 8 seconds to help keep the bromine atoms from quickly changing back from their ionized state.

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658317

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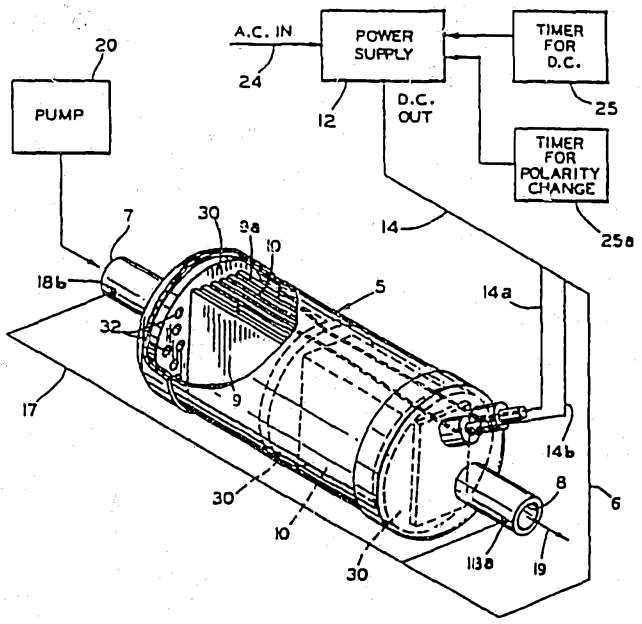


(57) Abstract

An easily installed, automatically operated sanitizing direct current, electrolytic cell canister assembly and a method of efficiently providing brominated water for swimming pools and the like, the method including furnishing d.c. power (12) at a constant amperage to the bipolar electrode graphite plate electrolytic cell canister (5), controlling the flow of electrolyte through the canister, turning the d.c. current on and off to provide d.c. on/off switching, turning the d.c. power off, adjusting the time of the on/off switching so that the current is off for a pretedermined selected time in a cycle of about 1 to 60 seconds, and, just prior to reversing the polarity of the electrodes, turning the power off for about five seconds, with separate polarity changing switching to help efficiently clean the graphite plates (10) and keep the bromine atoms from going back to their ionized state and reduce any power surge due to the reversal of the polarity.

TITLE

ELECTROLYTIC CELL ASSEMBLY AND PROCESS FOR PRODUCTION OF BROMINE

The present invention relates to an electrolytic cell assembly for the production of bromine for providing brominated water for sanitizing a body of water such as a swimming pool or hot tub. The invention also relates to a process for producing bromine by the electrolysis of sodium bromide in an electrolytic cell.

BACKGROUND OF THE INVENTION

The production of a halogen, especially chlorine, in an electrolytic cell using bipolar electrodes or monopolar electrodes for sanitizing a body of water, especially swimming pools, is known. The Fair et al. U.S. Patent No. 4,714,534 describe a monopolar electrode system and a bipolar electrode system, the patent being directed to the use of trapezoidal shaped electrode plates used in the monopolar electrode system.

The Sweeney U.S. Patent No. 4,256,552 discloses a chlorine generator for the chlorination of a body of water. The generator uses bipolar electrodes.

The Davis et al U.S. Patent No. 4,255,246 discloses an electrolytic cell and method of making hypochlorous acid from aqueous sodium chloride. An electronics control package is shown that is coupled to a source of alternating current and includes typically a rectifier and

voltage regulator to provide for a constant but adjustable direct current output voltage across the electrodes of the electrolytic cell.

The Davies U.S. Patent No. 4,917,78[illegible] shows an electrolytic cell including a cylindrical casing for housing a stack of electrode plates and mounting rings to maintain the plates in a fixed position.

The McCallum U.S. Patent No. 4,142,957 (also related U.S. Patent No. 4,085,028) is directed to an electrode assembly having bipolar electrode elements for use in producing chlorine. The assembly runs on a.c. current. It is indicated that the problem of unwanted deposits on the bipolar electrodes is reduced by controlling the electrolyte feed solution and by reversing the direction of current flow to the electrodes.

The Shindell U.S. Patent No. 4,263,114 is directed to treating swimming pool water electrochemically. Shindell uses a.c. current, and rectifies it to apply a unidirectional d.c. current to a pair of electrodes. The method includes reversing the polarity of the energy applied to the electrodes, the feed water flowing past the electrodes. The feed water is, for instance, pool water to which sodium chloride has added to make it electrically conductive.

The Jansen U.S. Patent No. 4,306,952 is directed to an electrolytic process for producing a halogen, including chlorine and bromine, using an electrolytic cell with bipolar graphite electrode plates. Jansen indicates that reversing the polarity of the plates will help to keep the

electrode plates clean. Jansen discloses that the polarity should be changed every 80 to 330 minutes to obtain the benefits of the invention. Jansen uses an electrolytic cell assembly that has one permanent anode and two other anodes, one being a co-anode and the other being a cathode.

The above described patents, especially the McCallum patent and the Jansen patent are incorporated by reference for the description of what is old in the background of the invention.

Also incorporated by reference are pages 671-80, Vol. 8, Third Edition, Kirk-Othmer Encyclopedia of Chemical Technology, 1979, John Wiley and Sons. As therein stated, in discussing electrochemical processing, electrolytic cells, and the electrolysis of brine, cells are often designed with a stack of bipolar electrodes between monopolar feeder electrodes (anode and cathode). The bipolar electrodes are not electrically connected to the d.c. power supply but are polarized by the potential gradients in the cell. Generally, the bipolar anodes are polarized anodically on the side facing the feeder anode electrode and cathodically on the reverse side.

However, the prior patents and the Kirk-Othmer reference do not solve the problems of (1) removing unwanted deposits efficiently from bipolar graphite plates and (2) controlling the flow of electrolyte to provide an efficient flow rate through the cell.

OBJECTS OF THE INVENTION

An object of the present invention is to provide an electrolytic cell assembly using bipolar plates and a method of producing bromine from sodium bromide, in which the problems of removing unwanted deposits (mainly calcium carbonate) from the bipolar electrode plates and providing an efficient, yet effective flow of the sodium bromide through the plates, are alleviated and solved.

It is an object of the present invention to provide a process of producing bromine to sanitize a body of water and to provide an easy to use, efficient electrolytic cell canister for quickly installing in a swimming pool piping system, the canister producing highly beneficially bromine (compared to chlorine) and being economical (low in power consumption) and being environmentally safe.

It is an object of the present invention to provide an easily installed and easily used low cost environmentally safe electrolytic cell canister, the canister being used in a highly efficient and economical method for electrolyzing an aqueous electrolyte sodium bromide solution to produce bromine to provide brominated water for sanitizing a body of water, the method including passing the electrolyte through a canister having a compartment that houses electrodes that are an anode and a cathode and bipolar graphite electrode plate elements that are polarized anodically on one side, the method comprising the steps of:

(a) passing direct current through the aqueous solution in a bromine generator comprising the canister compartment and a plurality of the bipolar graphite plate elements positioned in the compartment with plate mounts to provide a circulation of electrolyte around the plate elements;

(b) turning the electrical power furnishing the direct current on and off;

(c) adjusting the time of the on/off switching in step (b), the current being off for a predetermined selected time in a cycle of about 1 to 60 seconds;

(d) reversing the polarity of the electrodes functioning as a cathode and an anode and the polarity of the bipolar graphite plates to remove deposits from the plate electrodes; and

(e) delivering brominated water with a bromine content of about 1/2 to 7 parts per million for sanitizing a body of water.

These and other objects will be apparent from the specification, the appended claims and the drawings, in which:

Figure 1 is a schematic view of a bromination system showing a fragmentary perspective view of the electrolytic cell canister of the present invention;

Figure 2 is a sectional view of the graphite electrode plates positioned within the canister and held with a mounting plate with flow control apertures; and

Figure 3 is a flowsheet illustrating the efficient, low-cost method of the present invention.

SUMMARY OF THE INVENTION

The present invention provides a method for electrolyzing an aqueous electrolyte sodium bromide solution to produce bromine to provide brominated water for sanitizing a body of water, the method including passing the electrolyte through a canister having a compartment that houses an electrode that is an anode, a cathode, and bipolar electrode graphite plate elements, the method comprising the steps of:

(a) passing direct current through the aqueous solution in a bromine generator comprising the canister compartment and a plurality of the bipolar graphite plate elements positioned in the compartment with plate mounts to provide a circulation of electrolyte around the plate elements;

(b) turning the electrical power furnishing the direct current on and off;

(c) adjusting the time the power is off in the on/off switching in step (b), the current being off for a predetermined selected time in a cycle of about 1 to 60 seconds to aid in removing deposits from plate electrodes;

(d) reversing the polarity of the electrodes functioning as an anode and as a cathode to remove deposits from the plate elements; and

(e) just prior to reversing the polarity of the current in step (d), turning the power off by

polarity changing on/off switching, the power being off for about 3 to 8 seconds to help clean the electrode plate elements and help to keep bromine atoms from flipping back to their ionized state in response to the change in polarity and reduce any power surge; and

(f) delivering brominated water for sanitizing a body of water.

The method preferably further includes the step of controlling the flow of electrolyte in the canister to within a range of about 3 to 6 feet per second by means of mounting plates for holding the bipolar electrodes, the plates having a plurality of apertures to provide a bypass for the water so as to regulate the flow of electrolyte around the electrode plates and through the plates for bromination. A flow between the electrode plate in the range of about 3 to 6 feet per second is helpful in cleansing the electrode plate of unwanted deposits.

The present invention also provides an easily installed, easily automatically operated, sanitizing electrode assembly apparatus for delivering brominated water to a body of water, the assembly comprising:

a canister having an inlet for an aqueous sodium bromide electrolyte and an outlet for brominated water,

an anode and a cathode positioned in the canister and a plurality of bipolar electrode graphite plates separated from the anode and cathode with electrolyte, the anode and cathode electrodes connected to a direct current source,

means for passing the electrolyte through the canister,

means for applying direct current to the anode and cathode electrodes,

means for reversing the polarity of the anode and cathode and the faces of the bipolar electrodes, and

time adjustment on/off switching means for turning the direct current on and off during a selected predetermined cycle of about 1 to 60 seconds and preferably 1 or 2 seconds up to 9 or 10 seconds.

The assembly also preferably includes a polarity switching on/off means for turning off the power automatically for about 1 to 10 seconds, and preferably 3 to 8 seconds, just prior to reversing the polarity on the bipolar electrodes.

The process of the present invention and the electrolytic cell canister are safe, effective, care-free, economical and environmentally safe.

Compared to the use of chlorine, the use of bromine eliminates most of the unpleasant side effects such as odor, taste, dry skin and brittle hair. The use of bromine is effective in controlling algae and bacterial growth even at relatively high temperatures, chlorine being relatively ineffective as a sanitizing agent at temperatures above about 92°F.

The use of the method and canister of the present invention results in a care-free system, the flow of electrolyte beginning as soon as the pump is turned on and

the power being delivered at a constant amperage which is turned on and off by the time adjustment on/off switching for a selected predetermined time (say, being off about 1 to 3 or 4 seconds every 10 seconds) within a cycle of preferably about 10 seconds. While the 10 second cycle is preferred, the cycle can be 20, 30, 40, 50 or 60 seconds. The off portion of the cycle is preferably 10 to 30 or 40 percent of the predetermined cycle, although the off portion can be up to 80 to 90 percent, or more, of the cycle.

The on/off switching of the power, periodic reversal of polarity, on/off switching just prior to the periodic reversal of polarity, and control of the rate of fluid flow between the electrode plates are all advantageous in preventing the build-up of unwanted deposits on the electrode plates.

The bromine producing canister and system of the present invention is economical, the equipment life being extended such as pump life and also easily maintained pool surfaces. The energy used, for producing 1 to 3 parts per bromine water, is generally less than the energy from a 100 watt light bulb.

The system and canister are environmentally safe, and no compounds are produced that will stain a pool or its equipment.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

As seen in the drawings, there is provided a sanitizing electrode assembly apparatus for delivering

brominated water to a body of water, the assembly comprising a canister **5** having an inlet **7** for an aqueous sodium bromide electrolyte, preferably from a swimming pool, and an outlet **8** for brominated water. As seen in Figs. 1 and 2, there is an anode **9** and a cathode **9a** positioned in the canister and a plurality of bipolar electrode graphite plates **10** separated from the anode and cathode and from each other with the electrolyte. The anode and the cathode electrodes are connected to a direct current source **12**, by wires **14, 14a** and **14b** and wires **16** and **17** are connected to grounds **18a** and **18b**. There is provided means for passing the electrolyte through the canister, including a typical circulating pump **20**, there preferably being a typical filter (not shown) and an electrically operated on-off flow switch mounted in the feedline between the circulating pump **20** and the inlet of the canister **5**. The filter generally helps provide clean electrolyte for flowing through the canister.

The delivery of brominated water to a body of water, preferably a swimming pool, follows the direction of the arrow **19**. A typical a.c. power source is used, the a.c. current being rectified to provide a direct current power supply for the electrode. The assembly has means for applying direct current to the anode and bipolar electrode, and means for reversing the polarity of the bipolar electrodes at given intervals to help clean unwanted deposits (principally calcium carbonate) from the graphite plates **10**. It is advantageous in this regard to

change the polarity at intervals of from about 3 to about 10 minutes.

The assembly has power control timing means **25** for turning the direct current on and off, including timing adjust means for determining the percentage of time the unit is off during each cycle. Each cycle is between from about 1 to about 60 seconds, and is preferably about 10 seconds. The on/off timing allows the user to control the rate of bromine generation as well as aiding in the cleansing of the electrode plates.

The apparatus includes polarity changing on/off switching means 25a for turning the power off about generally 1 to 10 seconds, and preferably 3 to 8 seconds just prior to reversing the polarity of the anode and cathode and the polarity of the faces of the bipolar electrodes **10**. This short shut-off time is highly advantageous for cleaning the plates **10** and providing an efficient electrolyte cell.

As seen in Fig. 2, the apparatus also has means for controlling the flow of electrolyte through the canister including mounting plate means **30** for the bipolar electrodes and apertures **32** in the mounting plate means to regulate fluid velocity at 3 to 6 feet per second and provide an efficient flow between the bipolar electrode 10. Thus, fluid passing through apertures 32 bypasses bipolar electrodes 10. As best seen in Figs. 1 and 2, the apparatus shown has the mounting plate means **30** that comprises three (two would suffice) mounting plates, each

plate having a plurality of apertures **32** to control the flow of electrolyte. The graphite plates **10** are held in place by the mounts **30**, the walls of the canister preferably being transparent to show the interior of the canister. The mounts have small holes **35** for wires **14a**, **14b** carrying d.c. power to the feeder anode and cathode.

A preferred method of the invention is illustrated in the flowsheet of Fig. 3, the method including passing the sodium bromide electrolyte (such as from a swimming pool) through the electrolytes cell canister having an anode **9**, a cathode **9a**, and bipolar electrode graphite plates **10**. One of the improvements in the present method is in controlling the flow of electrolyte around the graphite plates. As seen in Fig. 3, the outstanding method steps are:

(a) passing direct current to an anode and cathode and through the aqueous solution in a bromine generator comprising the canister compartment, a plurality of the bipolar graphite plate elements positioned in the compartment with plate mounts with apertures to provide a circulation of electrolyte around the plate elements;

(b) controlling the flow of electrolyte around the graphite plate, with about 2 to 20 holes, and preferably 8 to 14 holes, on each side of the mount;

(c) turning the electrical power furnishing the direct current on and off to stop the

electrolyte treatment for a predetermined time in a cycle of about 1/2 to 10 seconds; the predetermined off time being dependent upon the amount of bromine generated as desired by the operator;

(d) reversing the polarity of the bipolar electrodes functioning as an anode on one side and a cathode on the other side to help remove deposits from the plate electrodes;

(e) just prior to reversing the polarity of the current in step (d), turning the power off for generally about 3 to 8 seconds and preferably about 5 seconds to help clean the electrode plate elements and help to keep bromine atoms from flipping back to their ionized state in response to the change in polarity and prevent a surge of current; and

(f) delivering brominated water from the electrolyte cell for sanitizing a body of water.

As indicated, the d.c. power delivered to the electrode is with constant amperage and efficiently uses both halves of the sine wave curve. Previously, generally only one-half of the curve was used and the amperage was varied. A bromine rate switch means has a low power setting for an economical normal bromine rate production of say, 1 to 3 ppm bromine water, in which only one-half of the sine curve (power train wave) is used. The rate switch, when on a high setting, delivers, say, 5 to 6 ppm

bromine water at about double the power of the low setting.

In general, the canister size is matched to the pump and the flow rate adjusted and controlled with apertures in the mount plates.

As seen in the drawings, the canister with the graphite electrode plates is easy to use and consumes a small amount of power. The graphite plates for use in commercial applications are generally use with about a 3/16" gap, while plates used in residential applications are used with about a 1/8" gap. The graphite plate assembly for one unit generally has 4 to 8 bipolar graphite plate electrodes and generally unipolar electrodes along the lines shown in Figs. 1 and 2 of the previously discussed McCallum U.S. Patent No. 4,085,028.

As seen in Figs. 1 and 2 of the drawings of this invention, the bipolar electrode assembly usually has four to eight graphite electrode plates held within the canister with a gap 34 of 1/8" or more as seen especially in Fig. 2.

The a.c. current is usually 110 volts, 60 hz and 15 amps although 200 volt current can be used. The d.c. output current is about 1 to 30 amps and preferably 2 to 8 amps, depending upon the concentration of the sodium bromide solution. The d.c. output voltage is about 20 to 90 volts and preferably about 30 volts. Occasionally the build-up of calcium carbonate can be removed easily with HCl, the plates cleaning up in only 3 to 4 minutes,

compared to 30 minutes or more prior to the present invention.

WHAT IS CLAIMED IS:

1. A method for electrolyzing an aqueous electrolyte sodium bromide solution to produce bromine to provide brominated water for sanitizing a body of water, the method including passing the electrolyte through a canister having a compartment that houses an anode and a cathode and bipolar graphite electrode plate elements that can function as an anode on one face and as a cathode on the other face, the method comprising the steps of

(a) passing direct current at constant amperage to the anode and cathode and through the aqueous solution in a bromine generator comprising the canister compartment and a plurality of the bipolar graphite plate elements positioned in the compartment with plate mounts to hold the plate elements in place and to provide a circulation of electrolyte around the plate elements;

(b) turning the electrical power furnishing the direct current on and off;

(c) adjusting the time of the on/off switching in step b, the turning off being for a predetermined selected time interval in a cycle of 1 to 60 seconds;

(d) reversing the polarity of the electrodes functioning as the anode and the cathode to

remove deposits from the plate electrodes elements; and

(e) delivering brominated water for sanitizing a body of water.

2. A method as defined in claim 1 in which the cycle in step (c) is 1 to 10 seconds.

3. A method as defined in claim 1 in which there is a further step of, just prior to reversing the polarity of the current in step (d), turning off the power for 3 to 8 seconds to help keep the bromine atoms from quickly changing back from their ionized state.

4. A method as defined in claim 1 in which there is a further step of controlling the velocity of the flow of the electrolyte to provide an efficient flow of 3 to 6 ft./second.

5. A method as defined in claim 1 in which the direct current is delivered at a predetermined constant amperage and the brominated water has a bromine content of 1 to 9 parts per million.

6. A method for electrolyzing an aqueous electrolyte sodium bromide solution to produce bromine to provide brominated water for sanitizing a body of water, the method including passing the electrolyte through a canister having a compartment that houses an electrode that is an anode and cathode and bipolar electrode graphite plate elements, the method comprising the steps of:

(a) passing direct current to the anode and cathode and through the aqueous solution in a bromine generator comprising the canister compartment and a plurality of the bipolar graphite plate elements positioned in the compartment with plate mounts to hold the plate elements in place and to provide a circulation of electrolyte around the plate elements;

(b) turning the electrical power furnishing the direct current on and off;

(c) adjusting the time of the on/off switching in step (b), the power being off for a predetermined selected time in a cycle of 1 to 60 seconds;

(d) reversing the polarity of the electrodes functioning as an anode and as a cathode to remove deposits from the plate electrodes; and

(e) just prior to reversing the polarity of the current in step (d), turning the power off for 3 to 8 seconds to help clean the electrode

plate elements and help to keep bromine atoms from flipping back to their ionized state in response to the change in polarity; and

(f) delivering brominated water for sanitizing a body of water.

7. A method as defined in claim 6 in which there is a step of controlling the velocity of the flow of electrolyte by means of apertures in the mounts for bypassing some of the flow to provide an efficient velocity of the flow.

8. A method as defined in claim 6 in which the delivering step (b) provides sanitizing water having a bromine content of 1 to 9 parts per million, the method being easily performed, being economical, and being environmentally safe.

9. A method as defined in claim 6 in which the cycle in step (c) is 1 to 10 seconds and the step (e) is for 5 seconds.

10. A sanitizing electrode assembly apparatus for delivering brominated water to a body of water, the assembly comprising:

a canister having an inlet for an aqueous sodium bromide electrolyte and an outlet for brominated water;

an anode and a cathode positioned in the canister and a plurality of bipolar electrode graphite plates separated from the anode and cathode with electrolyte, the anode and the cathode being connected to a direct current source;

means for passing the electrolyte through the canister;

means for applying direct current to the anode and cathode;

means for reversing the polarity of the anode and cathode and each of the faces of the bipolar electrodes;

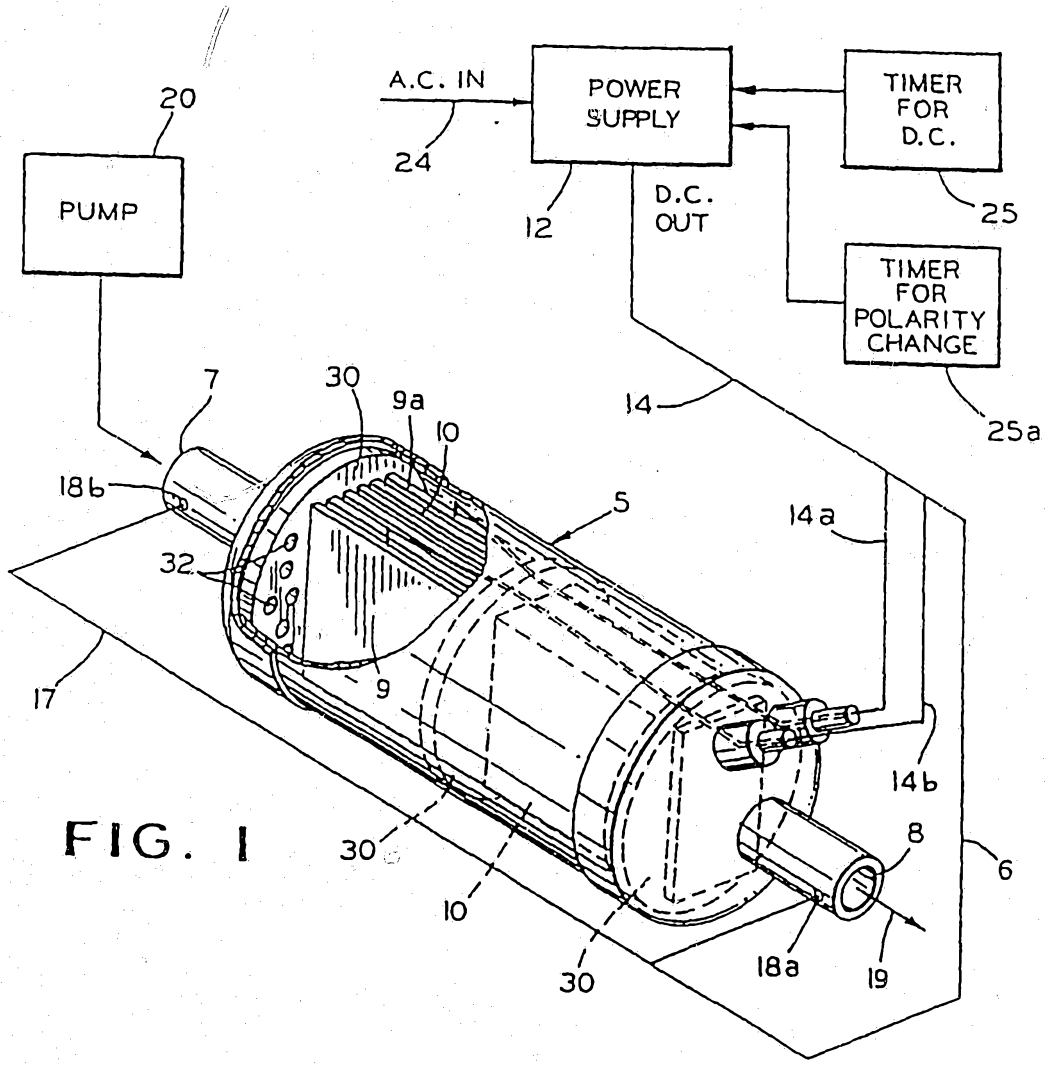
power control means for turning the direct current on and off; and,

time adjustment switching means for turning the power off in the power control means for a predetermined selected time during a cycle of 1 to 60 seconds.

11. An apparatus as defined in claim 10 including polarity changing switching means for turning the direct current to the anode and cathode off 1 to 10 seconds. just prior to reversing the polarity of the electrodes.

12. An apparatus as defined in claim 10 including means for controlling the flow of electrolyte through the canister including mounting plate means for the bipolar electrodes and apertures in the mounting plate means for bypassing some of the flow to control and provide an efficient flow for the water passing through the electrodes for bromination.

13. An apparatus as defined in claim 12 in which the mounting plate means comprises at least two plates, each plate having a plurality of apertures to provide a bypass for the flow and to control the flow of electrolyte through the electrodes for bromination.


A.C. IN
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POWER SUPPLY
12
TIMER FOR D.C.
25
D.C. OUT
TIMER FOR POLARITY CHANGE
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30
9a
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14a
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14b
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6
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18a
19
30

FIG. 1

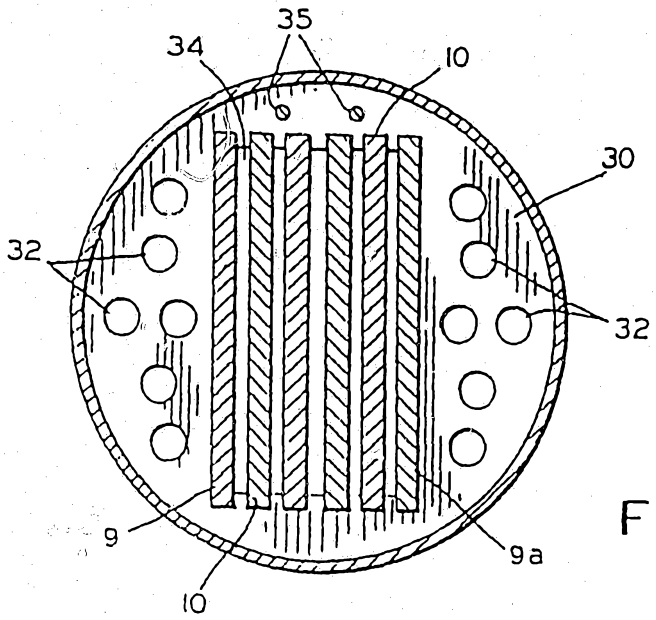
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FIG. 2

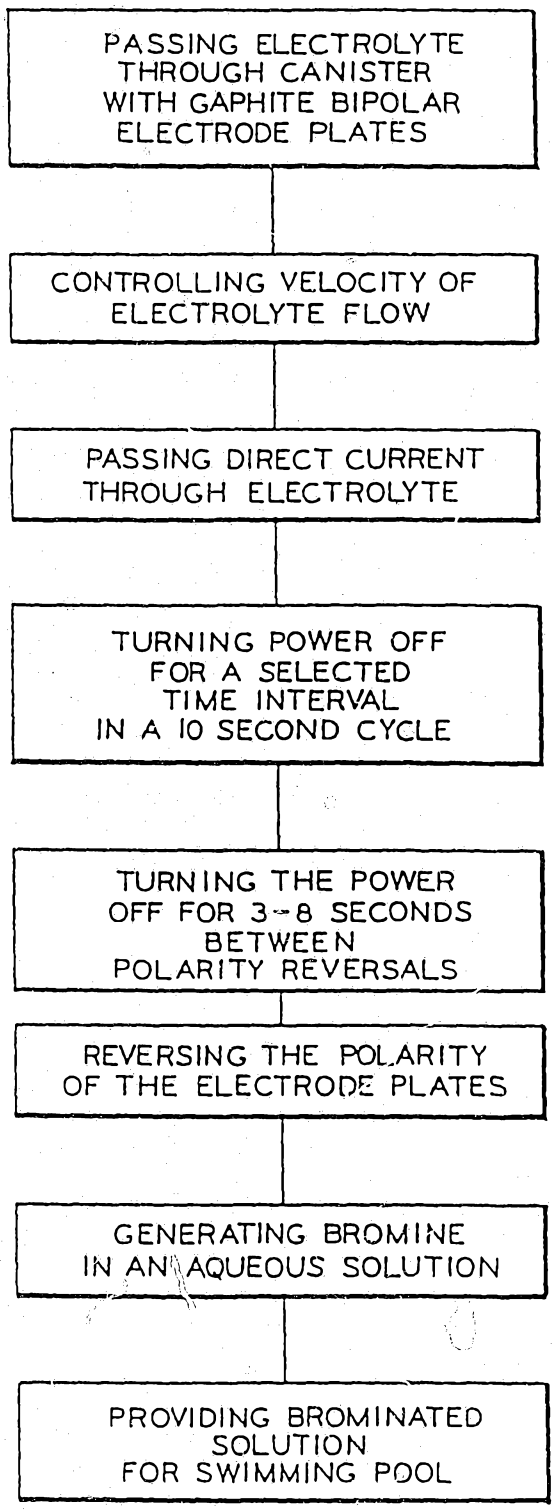
PASSING ELECTROLYTE THROUGH CANISTER WITH GAPHITE BIPOLAR ELECTRODE PLATES
CONTROLLING VELOCITY OF ELECTROLYTE FLOW
PASSING DIRECT CURRENT THROUGH ELECTROLYTE
TURNING POWER OFF FOR A SELECTED TIME INTERVAL IN A 10 SECOND CYCLE
TURNING THE POWER OFF FOR 3-8 SECONDS BETWEEN POLARITY REVERSALS
REVERSING THE POLARITY OF THE ELECTRODE PLATES
GENERATING BROMINE IN AN AQUEOUS SOLUTION
PROVIDING BROMINATED SOLUTION FOR SWIMMING POOL

FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US93/04206

A. CLASSIFICATION OF SUBJECT MATTER

IPC(5) :C25B 1/24, 9/00; B01D 17/06
US CL :204/268,269,144.5

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 204/268,269,144.5

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

APS: Electol? or Electrochem? Bromine, Bromido or Br; Bipolar?; Graphit?; Water; Swim?

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 3,305,472 (OLDERSHAW et al.) 21 February 1967 (see column 1, lines 28-35; col.2, lines 31-32; col.5, lines 7-8 and lines 28-80; col.6, lines 6-15 and fif.4).	1-13
Y	US, A, 4,100,052 (STILLMAN) 11 July 1978 (see abstract; col.5, lines 21-23; and col.6, lines 1-10).	1-13

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be part of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search	Date of mailing of the international search report
21 JUNE 1993	06 AUG 1993
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231	Authorized officer KATHRY GORGOS NGUYEN NGOC-HO INTERNATIONAL DIVISION
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