

Nov. 23, 1937.

R. B. EVERSON

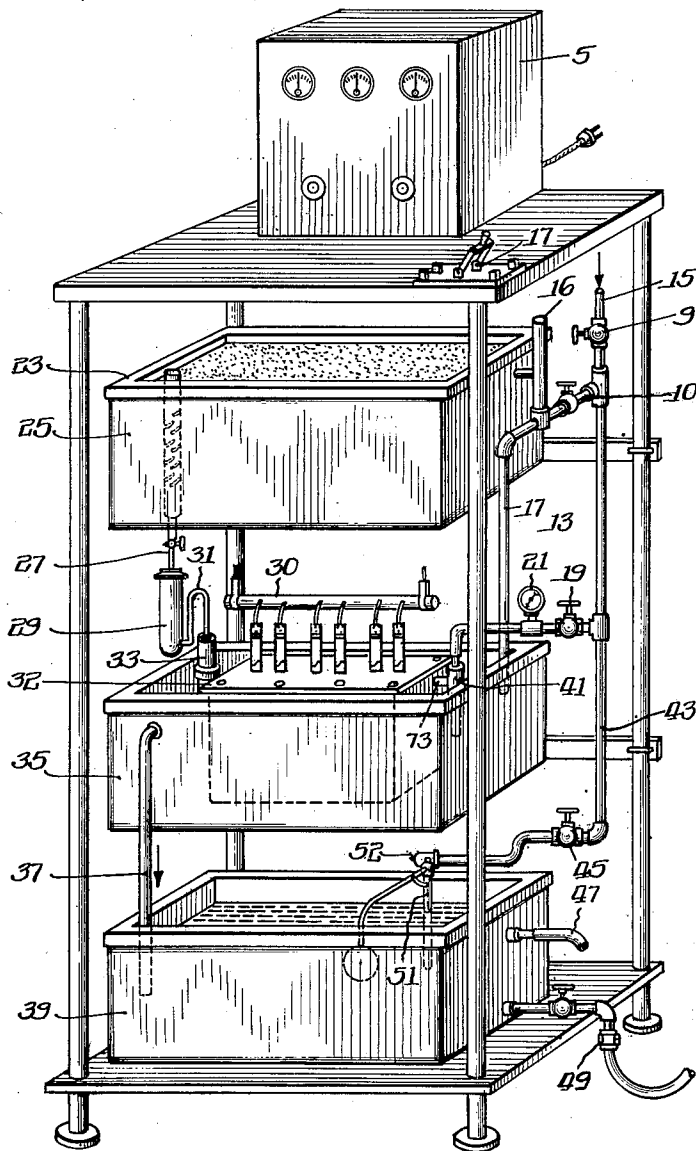
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ELECTROLYTIC APPARATUS FOR PREPARING CHEMICAL SOLUTIONS

Filed Oct. 11, 1934

2 Sheets-Sheet 1

Fig. 1.



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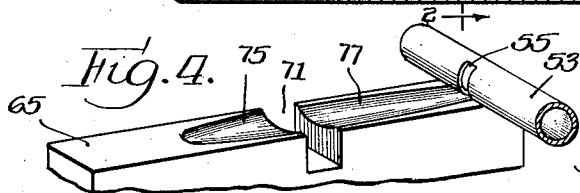
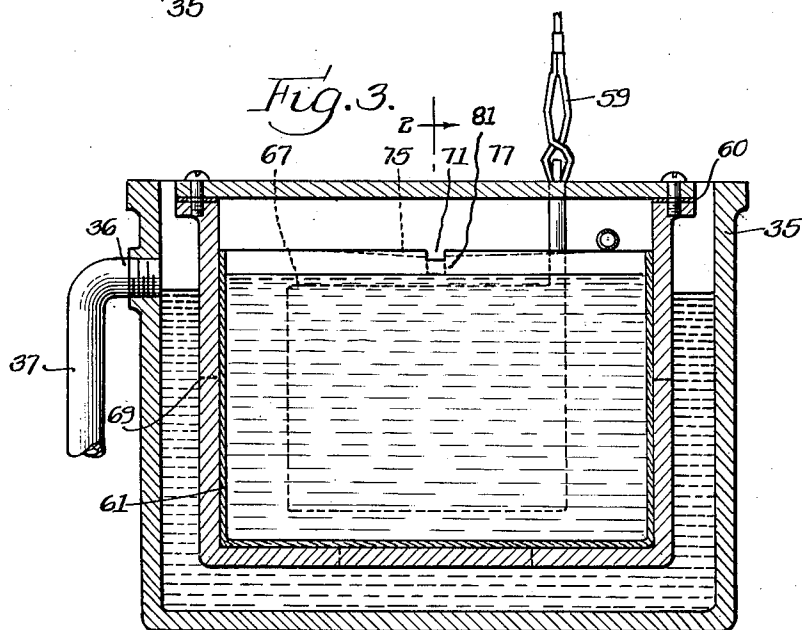
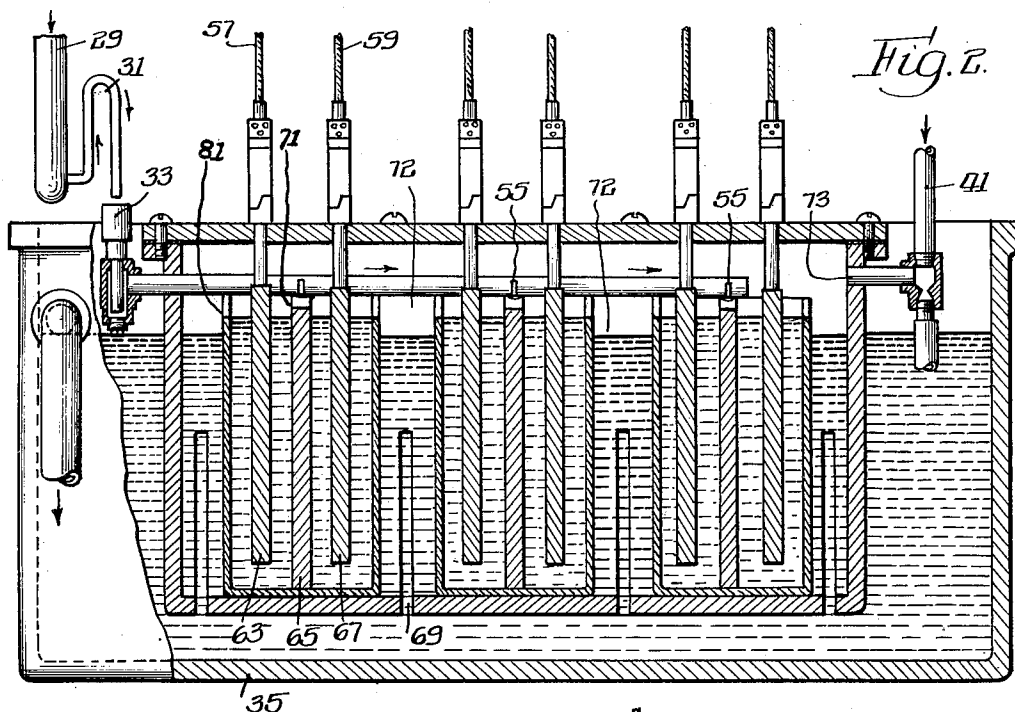
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ELECTROLYTIC APPARATUS FOR PREPARING CHEMICAL SOLUTIONS

Roy Blair Everson, Chicago, Ill.

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12 Claims. (Cl. 204—59)

This application, in general, relates to the electrolytic preparation of chemical solutions, and more particularly relates to an apparatus and method of producing a hypochlorite solution by means of the electrolysis of a chloride of an alkaline earth metal.

It is an object of this invention to provide a means for the electrolytic preparation of a sterilizing agent.

It is another object of this invention to provide an apparatus and process for the preparation of hypochlorite solutions.

It is another object of this invention to provide an electrolytic apparatus and process for hypochlorite treatment of water for commercial purposes other than human consumption.

It is another object of this invention to provide a unitary apparatus for the continuous production of hypochlorite sterilizing solution to be used in connection with the purification of water for swimming pools and other commercial purposes in which the water to be treated is not used for human consumption directly.

Numerous other objects and advantages will become apparent from a consideration of the following specification.

In general, this invention involves the continuous feeding of a solution of a chloride salt of an alkaline earth metal through an electrolytic cell wherein the solution is electrolyzed to produce gaseous chlorine at some of the electrodes and alkali at other of the electrodes, in combination with a continuous flow of water in such a manner, that the alkali may be re-dissolved in the water while the alkali is being also dissolved in water to form a hydroxide, the two liquors thus prepared being continuously brought together to form the hypochlorite, said hypochlorite solution being drawn off and diluted in the apparatus to a desired strength, whereupon it may be injected into the water or liquid to be treated. The hypochlorite solution thus prepared may be used for any of the purposes to which hypochlorite solutions are adapted, such as, for instance, the sterilization of swimming pool water, or the sterilization of process water to be used in cleansing and washing containers for food products, such as containers in canning and milk bottles and milk cans in dairies.

In the accompanying drawings is shown a preferred embodiment of this invention.

Fig. 1 shows a perspective view of said preferred embodiment.

Fig. 2 is a longitudinal cross-sectional view of the electrolysis cell of this preferred embodiment.

Fig. 3 is a transverse cross-sectional view of the electrolytic cell in Fig. 2.

Fig. 4 is a perspective view of a detail of the raw liquor inlet and cell partition duct arrangement.

The preferred embodiment shown in the accompanying drawings comprises a metallic or other suitable framework on which are mounted three preferably acid-proof tanks or containers 25, 35 and 39. As a source of electric current we have shown the use of an electric rectifier 5. However, it is possible to substitute instead a motor generator set or even a direct connection to an electric supply, if such supply of proper voltage and amperage is available. The apparatus is connected by means of the pipe line 15 and the valve 9 to a water supply. The water enters through the valve 9 into the pipe line 10, said flow of water being adjusted by the valve 9 so as to be great enough to provide a continuous flow of liquid through the connection 11 into the tank 25 and also through the pipe line 17. The connection 11 is connected to the pipe line 10 through a vertical stand pipe 16, which is open to atmospheric pressure at its top, this stand-pipe 16 acting as a pressure release, thus equalizing the flow of water through the two lines 11 and 17 respectively. The tank 25 is filled with salt through which the water coming in at the connection 11 flows slowly, producing thereby a substantially saturated solution of salt or brine.

The outlet pipe 23 in the tank 25 runs through and terminates substantially above the salt bed, and is open at the top, this structure being provided to prevent any solid salt from falling down into the outlet cock 27, and obstructing the flow therethrough. This pipe 23 is perforated along its length with a series of small holes in such a manner that brine will flow into the outlet pipe, but solid salt will be held back. Meanwhile, the remainder of the water flowing through pipe 10 passes into the pipe 17 and thence downward into the tank 35, the flow through pipe 10 being so controlled by the valve 9 as to maintain a desired level of liquid in both the tank 25 and the tank 35. The brine is allowed to flow in a controlled quantity through the cock 27 into the syphon device 29, 31. The brine level in the syphon reservoir 29 rises until the level passes over the bend in the inverted syphon U-tube 31, whereupon the U-tube evacuates itself and the reservoir by syphon action, flooding the electrolytic cell 32 with a given quantity of brine through the entrance trap 33. This trap is so designed as to allow the brine to flow into the cell and yet to prevent any

escape of gas backward through it. The brine upon entering the electrolytic unit 32 is electrolyzed by a current impressed across the electrodes through the current manifold 30, said current manifold being fed with current from the rectifier 5 or other source of current supply through the double throw double pole switch 7. Upon electrolysis, the brine is disassociated into sodium ions and chlorine ions, which collect at the anodes and cathodes respectively of the cell. The sodium immediately reacts with the water in the cell to form sodium hydroxide, meanwhile the chlorine deposited at the other electrode bubbles to the top of the cell, where it is drawn off through the vacuum ejector mechanism 41 into the water outside the cell in the tank 35.

The ejector mechanism 41 is connected to a valve 19 and a pressure gauge 21. Water flows from the main water supply line through valve 19 and thence downwardly through a narrowed passageway or sort of Venturi construction in the ejector 41. The pipe 73 leads off of the ejector 41 at the narrowest point of the constriction, so that when water flows through the constriction, the change in velocity of that flow sets up a vacuum in the pipe line 73 leading from the upper portion of the electrolytic cell. Thus, the gaseous chlorine is drawn off and mixed with the water passing through the ejector 41 to form an aqueous solution of chlorine, and discharged into the water bath which is also being fed with fresh water through the pipe 17.

The electrolytic unit 32 is provided with openings 69 in its sides communicating with the water bath outside the cell in the tank 35 to permit the flow of the sodium hydroxide solution outward into this water bath. At this point, the sodium hydroxide solution and the chlorine water react to form sodium hypochlorite in the tank 35, and this sodium hypochlorite solution flows through the constant level opening in the side of the tank 35 into the pipe line 37 and thence downward by gravity into the tank 39. The water bath in the tank 35 serves not only as a solution forming medium, but also operates to cool the electrolytic unit. The tank 39 receives a flow of water through the float valve mechanism 51 which is connected to the main water supply, so that a constant level of fresh water is maintained in the tank. By reason of the influx of concentrated hypochlorite solution through the pipe line 37, the water in the tank 39 is continuously treated with hypochlorite solution. By adjusting the flow of brine into the electrolytic cell at the cock 27, and furthermore by adjusting the flow of water through the connection 11, the pipe line 17 and the ejector 41, the rate of operation of the electrolytic cell may be controlled so as to produce any given quantity of hypochlorite up to the maximum capacity of the cell. This, of course, will control the amount of concentrated hypochlorite solution which enters the tank 39, and finally, since the float valve mechanism 51 may be adjusted by an adjustment device 52, to permit the maintenance of various desired volumes of water in this tank 39, it will be seen that a diluted hypochlorite solution of a desired concentration may be continuously maintained in the tank 39. This solution may then be drawn off through the valve and pipe line element 49 to the point of application. The tank 39 is furthermore provided with an overflow pipe 47 which will accommodate any overflow due to faulty operation or mistakes on the part of the operator,

and prevent the accidental overflow of the tank 39.

The electrolytic unit 32 is shown in cross-section in Figs. 2 and 3, respectively.

Referring to these drawings, it will be seen that the brine entering through the syphon tube 29 into the trap 33, floods through the pipe 53. The electrolytic unit may consist of any number of cells arranged in parallel, the capacity of the unit being controlled by the number of cells so used. A 3-cell unit has been shown in the drawings for the purpose of describing the operation of my invention. This unit comprises an outside container 60 inside of which there are three similar boxes or compartments 61. Each of these compartments 61 comprises a cell, the operation of which is similar each to the other. In each cell are located two graphite electrodes 63 and 67. Between the electrodes and fastened to the sides and bottom of the cell, so as to divide the same into an anode and cathode compartment, is located a graphite partition 65.

The top of the unit is fastened to the case by screws and a rubber gasket 58 which prevents the leakage of gas through the top of the cell. The electrode posts are inserted through holes in this top, and cemented in to form a gas-tight connection to the electric supply lines 57 and 59, respectively. The brine intake pipe 53 rests on the top of the cell partition 65, and is provided with slits 55 so that the brine upon entering the intake line will flood through the slits into the channel 77, which is fashioned in the top of the partition as shown in Fig. 4. The top of the partition is furthermore provided with a slot 71, which aligns with similar slots 81 in the side walls of the compartment 61, these slots being located centrally of the top. The slot 71 in the cell partition, however, is not as deep as those in the side walls, since it must form a physical separation between the anolyte and the catholyte. The cell partition is furthermore provided with a channel 75 to redirect any overflow of the brine in that direction backward into the slot 71, where the brine flow divides substantially equally and flows downwardly on both sides of the partition into the anode and cathode compartments. The fresh brine being heavier than the electrolyte, tends to flow downwardly through the chambers, and become dispersed in the electrolyte. In order to insure equal brine flow to all of the individual cells, it is necessary to flood the pipe 53, thus the pipe 53 is of relatively reduced diameter with respect to the flow of brine which it must accommodate, and hence is completely flooded periodically at each evacuation of the syphon device 29, 31. If a large number of cells are to be used in parallel, it may be necessary to provide several supply lines to small groups of them to achieve uniform distribution of brine.

Since it is desirable to have a controlled restricted continuous flow of brine out of the brine tank 25, the syphon mechanism has been employed, whereby the continuous restricted flow is maintained through the cock 27, and is collected temporarily in the syphon tube 29 until a sufficient quantity is there to flood the pipe 53 and achieve uniform distribution of brine in the several cells. By this means, a measured but slow flow of brine may be maintained to the cells, and yet the flooding action for the sake of uniform distribution may also be maintained. The cell case 60 is provided with L-shaped slots 69 in its sides and bottom, which provide for communication between the interior of the cell and 75

the bath outside of the cell in the tank 35. These slots run upward along the sides of the cell casing far enough to provide free interchange of liquors therethrough, and yet stopping far enough from the top of the casing so as to be continuously below fluid level. The cell casing 60 is so designed as to provide a substantial space above the electrolyte for the collection of chlorine gas which is given off at the cathode. The side of the casing is also provided with a pipe 73 leading to the ejector mechanism 41, which operates to draw the gas from this gas space, and cause it to be dissolved in the water flowing therethrough, ejecting it into the bath of liquid outside the cell in the tank 35. The level of liquor in this tank and correspondingly in the cell, since they are communicative, is maintained by the influx of water through the pipe 17 as well as through the influx of chlorine water from the ejector 41. The tank 35 is provided with an opening 36 into the pipe 37, which not only acts as a "draw-off" line for the concentrated hypochlorite solution when made, but also operates as an overflow pipe maintaining substantially constant level.

When current is impressed across the electrodes, the graphite partition operates to allow an interchange of electrolytic current between the chambers of each cell or compartment, but serves to separate the electrolytes, whereupon sodium is produced at the cathode, and chlorine is produced at the anode, respectively. Periodically, when the cells are flooded with incoming brine, the level of electrolyte in the cell will tend to rise momentarily. The brine, coming into the slot 71 in the partition and falling to the bottom of the compartments, forces the electrolyzed solution in the compartments outwardly through the slots in the sides 61, resulting in a sort of "wash" action into the intercell space 72. Meanwhile, the sodium liberated at the cathode dissolves in the water to form sodium hydroxide and hydrogen gas. The sodium hydroxide solution thus formed inside the cell passes outward into the intercell space 72 and thence through the slot 69 into the bath outside the cell, while the hydrogen gas bubbles up from the catholyte into the free space above. The chlorine liberated at the cathode likewise bubbles up from the anolyte into the gas space over the electrolyte. Both gases being drawn off through the injector, the chlorine is dissolved in the incoming water through the ejector 41 to make chlorine water. The hydrogen is partially dissolved, but since hydrogen is relatively insoluble, substantially all of it passes off to the atmosphere, the chlorine water being injected into the bath and reacting thereupon with the sodium hydroxide formed as above described, to make sodium hypochlorite. As the process of electrolysis continues, the hypochlorite solution in the bath outside the cell in the tank 35 becomes comparatively concentrated and flows out of the opening 36 into the pipe 37 and thence to the tank 39.

It has further been discovered that as the operation of the device is continued over a period of time, its efficiency decreases somewhat by reason of what we term a sodium stagnation at the cathode. This sodium stagnation tends to raise the current density necessary at that electrode, and may even lower the hydrogen overvoltage to such an extent that hydrogen is discharged electrolytically rather than being freed from the chemical reaction of sodium with water as above described. This difficulty may easily be overcome by reversing the polarity of the electrodes

and operating the cell "backwards", so to speak. This may be accomplished by reversing the double-pole double-throw switch 7.

It is to be understood that the invention is not to be confined to the details of the construction hereinbefore given by way of example, nor to the particular application described, as the invention may be embodied in various modifications and equivalents of the elements in the above specification.

What is claimed as new and desired to be secured by Letters Patent is:

1. An electrolytic apparatus for preparing a chemical solution comprising in combination a raw electrolyte preparation tank, means for conveying electrolyte prepared therein to an electrolytic cell, said electrolytic cell being disposed within a second tank in such a manner as to be surrounded by an appreciable quantity of water continuously being supplied to said second named tank, means attached to said electrolytic unit adapted to convey off the products of electrolysis, said means being also adapted to convey said products of electrolysis into the water of said second named tank, means for drawing solution from said second named tank and conveying it to a third tank, said third named tank being continuously supplied with water up to a constant level for the purpose of further diluting the solution drawn off from the second named tank.

2. An electrolytic apparatus for continuously preparing a chemical solution comprising means for dissolving the chloride of an alkaline earth metal in a stream of water to make an electrolyte thereof, means for controlling a flow of said electrolyte from the aforesaid means, means for collecting the controlled flow of said electrolyte solution, means to intermittently supply a flooding flow of said electrolyte solution to an electrolytic unit from said collecting means, said electrolytic unit comprising a plurality of electrodes, said electrodes being inserted in pairs into a plurality of cells within a casing, said casing being provided with a gas-tight top closure, said top closure having a plurality of current conducting means inserted therethrough establishing electric contact with the electrodes, said casing of the electrolytic unit being within an outer tank, means for supplying water continuously to said tank, said casing being further provided with openings to permit communication between the interior of the electrolytic unit and the water in the tank, means for drawing off the gaseous product of electrolysis and injecting same into the water of the tank, so as to make a solution of the product electrolysis, means for continuously drawing off the solution in the tank, and conveying said solution to another tank, said last named tank having therein a continuous volume of water for diluting the above-named solution to a predetermined concentration, and means for drawing off the diluted solution from said last tank and conveying same to point of use.

3. An electrolytic apparatus for continuously preparing a sterilizing solution comprising means for dissolving sodium chloride in a stream of water to make a brine, means for controlling a flow of brine from the aforesaid means, means for collecting the controlled flow of brine, means to intermittently supply a flooding flow of brine to an electrolytic unit from said collecting means, said electrolytic unit comprising a plurality of electrodes, said electrodes being inserted in pairs into a plurality of cells within a casing, said casing being provided with a gas-tight top closure,

said top closure having a plurality of current conducting means inserted therethrough establishing electric contact with the electrodes, said casing of the electrolytic unit being within an outer tank, means for supplying water continuously to said tank, said casing being further provided with openings to permit communication between the interior of the electrolytic unit and the water in the tank, means for drawing off the gaseous product of electrolysis and injecting same into the water of the tank, so as to make a solution of the product of electrolysis, means for continuously drawing off the solution in the tank, and conveying said solution to another tank, said last named tank having therein a continuous volume of water for diluting the above-named solution to a predetermined concentration, and means for drawing off the diluted solution from said last tank and conveying same to point of use.

4. In an electrolytic cell, an intermediate conductive partitioning element dividing said cell into an anode and cathode compartment respectively, said element being electrically conductive but impermeable to the passage of solution therethrough, said element being provided with trough means, and means cooperating with the trough in the partition for feeding the electrolyte equally to said compartments.

5. In an electrolytic cell, an intermediate conductive partitioning element dividing said cell into a cathode and anode compartment respectively, said element being electrically conductive but impermeable to the passage of solution through, and said element being provided with a slot located in the top portion thereof and adapted to communicate with said compartments, said element being further provided with a depressed trough running longitudinally along the top edge of said element and communicating with the aforementioned slot.

6. In an electrolytic system, an electrolytic unit comprising an outer tank and an inner casing disposed therein, said casing having a gas-tight dome, a plurality of cells within said casing, an intermediate conductive partitioning element dividing each of said cells into an anode and cathode compartment, said partition being impermeable to the passage of electrolyte there-through, an anode and a cathode within each of said cells, the casing having an opening for permitting communication between the electrolyte inside said casing and the tank, means for continuously maintaining a level of water in the tank outside the casing, means for continuously drawing off the gaseous products of electrolysis and injecting same into the water in the tank outside the casing, and means for continuously supplying fresh electrolyte to the cells within the casing.

7. An electrolytic apparatus for continuously preparing a chemical solution comprising means for dissolving the chloride of an alkaline earth metal in a stream of water to make an electrolyte thereof, means for controlling a flow of said electrolyte from the aforesaid means, means for collecting the controlled flow of said electrolyte solution, an electrolytic unit, means to intermittently supply a flow of said electrolyte solution to said electrolytic unit from said collecting means, said electrolytic unit comprising a plurality of electrodes, a casing, said electrodes being inserted in pairs into a plurality of cells within said casing, said casing being provided with a gas-tight top closure, said top closure having a plurality of current conducting means inserted

therethrough establishing electric contact with the electrodes, an outer tank, said casing of the electrolytic unit being within said outer tank, means for supplying water continuously to said tank, said casing being further provided with openings to permit communication between the interior of the electrolytic unit and the water in the tank, means for drawing off the gaseous product of electrolysis and injecting same into the water of the tank, so as to make a solution of the product of electrolysis, means for continuously drawing off the solution in the tank, and conveying said solution to another tank, said last named tank having therein a continuous volume of water for diluting the above named solution to a predetermined concentration, and means for drawing off the diluted solution from said last tank and conveying same to point of use.

8. An electrolytic apparatus for continuously preparing a sterilizing solution comprising means for dissolving sodium chloride in a stream of water to make a brine, means for controlling a flow of brine from the aforesaid means, means for collecting the controlled flow of brine, an electrolytic unit, means to intermittently supply a flow of brine to said electrolytic unit from said collecting means, said electrolytic unit comprising a plurality of electrodes, a casing, said electrodes being inserted in pairs into a plurality of cells within the casing, said casing being provided with a gas-tight top closure, said top closure having a plurality of current conducting means inserted therethrough establishing electric contact with the electrodes, an outer tank, said casing of the electrolytic unit being within the outer tank, means for supplying water continuously to said tank, said casing being further provided with openings to permit communication between the interior of the electrolytic unit and the water in the tank, means for drawing off the gaseous product of electrolysis and injecting same into the water of the tank, so as to make a solution of the product of electrolysis, means for continuously drawing off the solution in the tank, and conveying said solution to another tank, said last named tank having therein a continuous volume of water for diluting the above named solution to a predetermined concentration, and means for drawing off the diluted solution from said last tank and conveying same to point of use.

9. An electrolytic apparatus for preparing a chemical solution comprising an electrolytic cell in which a plurality of separate electrolytic products are adapted to be produced, means for introducing raw electrolyte into said cell, a reservoir, means for conveying off separately the products of electrolysis from said cell, means for continuously introducing water to said reservoir, means for introducing one of the electrolytic products into said water whereby to dissolve the major portion of said product therein, means for introducing another of said electrolytic products separately into said reservoir, and discharge means for said reservoir.

10. An electrolytic apparatus for preparing a solution of a chemical compound comprising a tank for preparing raw electrolyte, means for drawing off the raw electrolyte from said tank and for conveying the electrolyte to the cell of an electrolytic unit, said electrolytic unit comprising a plurality of electrodes inserted in the cell, said cell being housed within a casing, said casing being in communication with a reservoir adapted to receive diluting water, means for

introducing water into said casing, means associated with the casing of the electrolytic unit for conveying off separately from the cell the products of electrolysis and for introducing them into
5 the water in the casing, and means associated with said reservoir for drawing off the solution of the products of electrolysis.

11. In an electrolytic apparatus, an electrolytic unit comprising a plurality of electrolytic cells,
10 and means for supplying electrolyte to said cells comprising a conduit member having communicating passageways with said cells, and entirely hydraulic intermittently operating feeding means for said conduit to intermittently discharge a
15 body of electrolyte into said conduit, the discharge capacity of said feeding means being sufficiently large with respect to the capacity of said communicating passageways to flood the conduit

on operation of the feeding means whereby to secure even electrolyte distribution to said cells.

12. An electrolytic apparatus for preparing a chemical solution comprising an electrolytic cell in which a plurality of separate electrolytic products are adapted to be produced, a reservoir,
5 means for introducing an alkaline halogen compound into said cell whereby to produce products of electrolysis including a free halogen, means for separately conveying off the products of electrolysis from said cell, means for continuously
10 introducing water to said reservoir, means for introducing the halogen into said water whereby to dissolve the major portion of the halogen therein, and means for introducing another of
15 said products of electrolysis separately into said reservoir.

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