No. 707,804. Patented Aug. 26, 1902.

A. SOMMER.

ELECTROLYTIC CELL.

(Application filed Aug. 17, 1899.)

(No Model.)

FIG. 1.

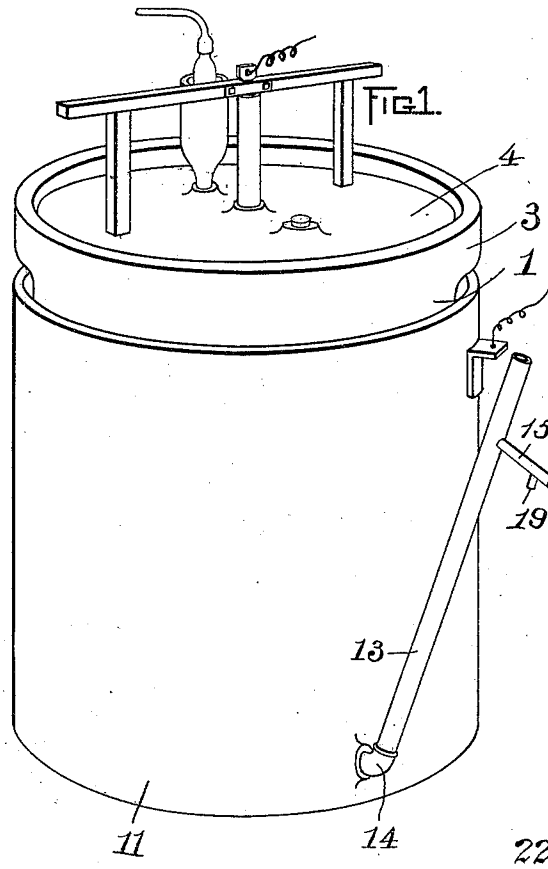


FIG. 3.

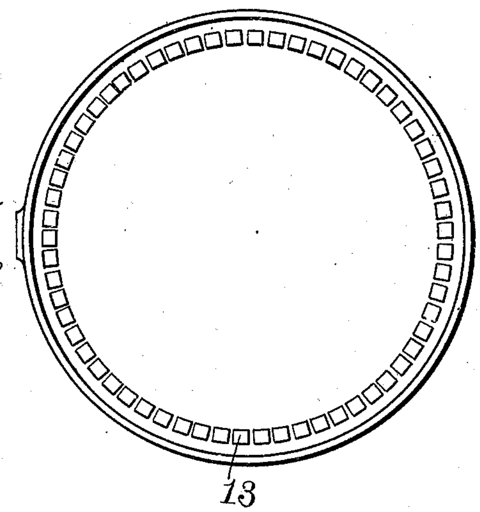
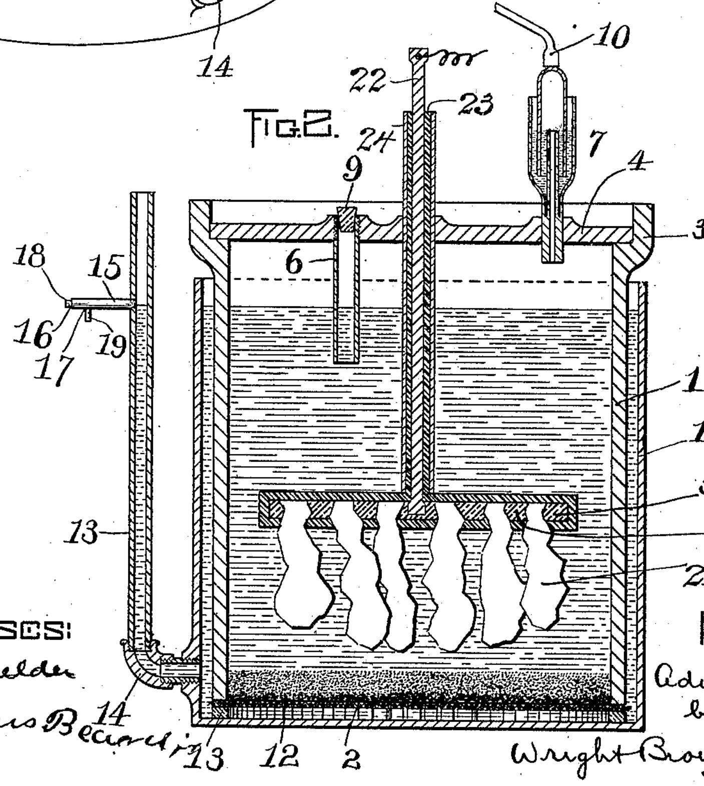


FIG. 2.



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UNITED STATES PATENT OFFICE.

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ELECTROLYTIC CELL.

SPECIFICATION forming part of Letters Patent No. 707,804, dated August 26, 1902.

Application filed August 17, 1899. Serial No. 727,521. (No model.)

To all whom it may concern:

Be it known that I, ADOLPH SOMMER, of Cambridge, in the county of Middlesex and State of Massachusetts, have invented certain new and useful Improvements in Electrolytic Cells, of which the following is a specification.

This invention has relation to electrolytic cells; and it consists of certain new and useful improvements therein which I have illustrated upon the accompanying drawings and shall now proceed to describe in detail.

Referring to said drawings, Figure 1 represents the front view of a cell embodying my invention. Fig. 2 represents a vertical cross-section of the same. Fig. 3 represents a horizontal cross-section made above the bottom of the cathode through the support of the anode-compartment.

The apparatus belongs to that class of electrolytic devices, generally termed "cells," in which obstructions are interposed to prevent the mingling of the ions. In this description the term "ion" is used in its wider sense and comprises not only the direct but also the indirect products of electrolysis, which in the case of the alkaline chlorids are principally chlorin at the anode and principally caustic alkali at the cathode. The obstructions by which these ions are, at least for the most part, prevented from mingling in the new cell consists in a substantially vertical partition in the form of a short wide gas-tight non-conducting tube 1 of cylindrical or other shape and of a loose porous diaphragm 2 at the bottom of this tube. The tube 1 may be made of earthenware or any other material capable of resisting for a long time the action of the ions and saline solution. The height and area of tube 1 depend primarily on the size of the anode which is placed into it; but in practice I find cylindrical stone or earthenware tubes ranging from two to three feet in diameter and from eighteen to thirty-six inches in height to be most satisfactory. The upper end of tube 1 is provided with a flange 3, projecting outward and upward. Into the thus-enlarged opening of the tube is placed a flat cover 4, made of an impervious material, such as stoneware or slate. This cover is provided with three holes, one at its center for the reception of the stem of the positive electrode or anode 5, which forms the subject of a concurrent application, Serial No. 727,522, filed August 17, 1899, the second a few inches to one side of the first hole for the reception of tube 6, and the third near the outer edge of the cover for the reception of a liquid seal 7, commonly known as "water-joint." As set forth in my said application, the anode consists of a metallic base 20, in which a plurality of pieces of carbon 21 or other suitable substance are embedded. Likewise embedded in the metallic base 22 is the lower end of a metal rod, by which the base is suspended, the upper end of the rod being adapted for the reception of the terminal of the conductor by which current is supplied to the cell. The metallic base and the lower part of the metallic suspending-rod are entirely coated with a protective covering of asphaltum or other suitable substance 23, proof against the attack of chlorin and not liquefiable at the temperatures prevailing in the cell. Over the covering on the rod is placed a tube or sleeve 24, of glass, porcelain, or other substance, which holds the covering in place.

The anode 5 is somewhat smaller in diameter and much shorter than tube 1, so that there is room for a gas and liquid to pass between it and said tube 1 and that there is a distance of several inches between the flat top of the anode and cover 4. When the anode has been placed in position, its lowest point is close to but does not touch the layer of granular material forming the upper part of the diaphragm 2.

The tube 6, made of glass, porcelain, or earthenware, is cemented into the cover 4 and serves for introducing solid material, more particularly some or all of the salt to be electrolyzed, into the inner or anode compartment of the cell. According to the height of the space between the cover 4 and the top of the anode 5 tube 6 is longer or shorter; but its lowest point should always be at least an inch above the top of the anode. Its upper opening is usually kept closed with a stopper 9. When the cell is in operation, the lower orifice of this feed-tube is below the surface of the liquid. This construction and arrangement, in view of the facts that all of the chlorin gas rises at the circumference of the anode and that none is given off from the top of the anode, prevents the chlorin from entering the feed-tube. Another advantage gained by this arrangement is that the salt which is fed through the tube into the anode-space is deposited on the top of the anode, where it is rapidly dissolved by the liquid surrounding it.

The water-joint 7 is usually made of glass, and its outer wall is considerably higher than its vent-pipe. It serves the double purpose of allowing water or any other liquid to flow into the anode-compartment and of allowing the gas, usually chlorin, to escape from its vent-pipe into a gas-pipe 10. This gas-pipe 10 is placed so loosely into the water-joint and over the vent-pipe that a liquid can readily flow underneath it from the outer to the inner space of the joint, or vice versa. Said gas-pipe 10 is generally connected with a gas-main which receives the gas from a large number of anode-compartments. All the joints in and around the cover other than the water-joint are made gas-tight by luting. The only place where a gas can escape from the anode-compartment is through the vent-pipe of the water-joint.

The tube 1 is placed into an iron tank 11, which forms the outer part of the cell and at the same time constitutes the negative electrode or cathode. Between the lower end of tube 1 and the bottom of tank 11 are interposed in the order named a sheet of moderately rigid non-fibrous foraminous material, such as fairly fine wire-cloth 12, covering the entire lower opening of tube 1, and a support 13. The latter is placed underneath and in line with the walls of tube 1 and lies directly on the bottom of tank 11. It is usually made of some non-conducting material—such as glass, porcelain, or stoneware—which is capable of withstanding the action of the caustic alkali generated at the cathode. The support serves not only to bear the weight of the whole anode-compartment, but also to keep the non-fibrous foraminous sheet 12 from resting on the bottom of the tank 11. It may consist of one piece, in which case its upper edge must be serrated or notched in order to permit of ready egress of any liquid or gas which may want to escape from the space inclosed by the support, or it may consist of several pieces, in which case they are set a trifle apart, so as to permit the gas or liquid to pass between them.

In place of a support made of a non-conducting material a metallic (preferably iron) support may be used; but in this case I deem it advisable to place between the metallic support and the non-fibrous foraminous sheet or the bottom of the iron tank a thin layer of one of the non-conducting materials mentioned above, so as to avoid metallic contact between the non-fibrous foraminous sheet and the bottom of the tank.

Upon the non-fibrous foraminous sheet 12 and inside of tube 1 is placed a fairly heavy layer of non-conducting granular material insoluble in the liquids to which it will be exposed. Quartz sand or crushed glass are well suited for this purpose. The particles of this material should be just large enough not to pass through the meshes of the non-fibrous foraminous sheet. This layer of granular material and the non-fibrous foraminous sheet constitute the diaphragm of the cell.

The iron tank 11 is usually made somewhat shorter than tube 1. To one side of this tank, close to its bottom, is attached an iron pipe 13 in such a manner that it can be swung back and forth. The device I prefer for making the pipe movable is a so-called "street-elbow" 14, the male end of which is screwed into the side of the tank or into a flange formed on or attached to the side of the tank, while the other end of the elbow is fastened to the pipe 13. The end of the pipe is slightly higher than the tank and is open, as shown. Some distance below the open end of the pipe 13, but above the level of the lower opening of pipe 6, there is screwed into pipe 13 a short branch pipe 15. This branch pipe has two openings 16 and 17 aside from the opening leading into pipe 13. The opening 16 is at the end of the pipe and is usually kept closed with a stopper or plug 18, and the opening 17 is on the under side of the pipe and points downward, being preferably provided with a projection in the form of a short nipple 19. The tank which is illustrated in the drawings is cylindrical in form and contains only one anode-compartment. With this style of cell it is best to make the iron tank only slightly wider than the tube 1. Sometimes, however, it is advisable to place several tubes with anodes into one iron tank, which then serves as cathode for all the anodes it holds and is then made preferably rectangular in form.

The manner in which this cell is used is as follows: After all parts have been placed in position and the joints of the anode-compartment made gas-tight the solution of the salt to be electrolyzed is run into the cell till it has reached a level slightly higher than that of the lower opening of pipe 8. Discharge-pipe 13 is then inclined till the solution just begins to drip from the opening 17. The cell is now put into the electric circuit by making proper connections with the anode and cathode, and a continuous supply of saline solution or water is allowed to drip or flow into the outer space of the water-joint 7. The liquid running into the outer space of the water-joint finds its way to the inner space of the water-joint by flowing underneath the gas-pipe 10. When the liquid reaches the level of the vent-pipe of the water-joint, it overflows this vent-pipe and runs into the anode-compartment. At about the same rate at which the liquid flows into the anode-compartment a solution more or less charged with the ion produced at the cathode, principally caustic alkali, runs out of the outlet 17 of the discharge-pipe. This solution is collected and converted into a commercial commodity in the manner well known to chemists. The gas, principally hydrogen, which is liberated at the cathode underneath the diaphragm 2 passes through the openings in the support 13 and rises through the solution, which fills the space between tube 1 and tank 11. At the anode gas, consisting principally of chlorin, is liberated and rising through the solution in the anode-compartment escapes through the vent-pipe of the water-joint into the gas-pipe 10. In order to maintain a practically uniform conductivity in the solution contained in the cell, there is introduced from time to time into the anode-compartment through pipe 6 a fresh supply of the salt to be electrolyzed. While the cell is working, especially during the first day, it sometimes happens that an incrustation of the salt used forms in pipe 13 and branch 15 and stops the outflow of the solution. When this occurs, the incrustation is removed from pipe 13 through the open end and from pipe 15 through the opening 16, ordinarily closed by a stopper or plug. When the diaphragm has worn out or become clogged or the anode has become defective or for any other reason the cell needs cleaning or mending, the solution is drawn off by inclining pipe 13, the construction of the cell making it possible to take it apart easily and to clean or replace any particular part of it without rendering the other parts useless.

One of the advantageous features of the cell hereinbefore described is the tubular anode-compartment. By using a tube and closing it with a separable cover it is possible to remove the anode without disturbing any part of the apparatus except the cover. In some cells of earlier design the anode-compartment consisted of an inverted bell resting upon the diaphragm, the anode being suspended by rods projecting through the bottom of the bell. With these earlier cells it was necessary to separate the bell from the diaphragm and to lift the bell out of the cell before access could be gained to the anode.

Another advantage this new cell has over earlier ones is that the anode-compartment is placed into an iron tank, which constitutes the negative electrode or cathode, and that the lower surface of the anode is in close proximity to the bottom of the tank or cathode. By this arrangement separate cathodes, (such as wire-gauze, sheets of metal, &c.,) which have been heretofore employed, are rendered unnecessary.

One of the points in which this cell differs from all others is the diaphragm. In the new cell the diaphragm is made of a sheet of fairly rigid foraminous non-fibrous material having small openings and a layer of granular material which lies on top of said sheet and closes the openings. The sheet of foraminous material is not in metallic contact with the cathode, nor does it form a part or the whole of the cathode, as in earlier forms of cells. In the earlier cells, in which sand forms a part of the diaphragm, the sand was placed always on some fibrous material—such as paper, asbestos fiber, or asbestos-cloth—and this fibrous material rested on wire-cloth or some other metallic support, which formed the whole or a part of the cathode. I, however, find that all of these fibrous materials are gradually disintegrated and eventually allow the hydrogen to ascend into the anode-compartment, where it is liable to unite with the chlorin and cause an explosion. No disintegration has ever been noticed in the diaphragm employed by me, nor does, with a properly-constructed diaphragm, any hydrogen ever pass through it. The only thing which renders my diaphragm useless is clogging by fine particles of carbon and metallic hydroxids, resulting from decomposition of the small quantities of metallic salts contained in the saline solution.

Another distinctive feature of this cell is the open support, upon which rest the diaphragm and the anode-compartment. This open support permits the hydrogen to escape readily, while the supports of the diaphragms in earlier cells were either solid blocks or metallic bars or netting, all of which would, if applied to the present cell, interfere with the escape of the hydrogen and the operation of the cell. The escape of the hydrogen is generally facilitated in my cell by causing the foraminous sheet to be somewhat inclined. This may be accomplished by either tilting the cell and placing under one side of the iron tank a support or by employing a rather thin foraminous sheet, such as a thin sheet of wire-cloth, which will bulge downward from the weight of the sand placed upon it.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. In an apparatus for the electrolysis of saline solutions, an anode-compartment, a cover therefor, a cathode, an anode in said compartment having a non-conducting horizontal flat upper surface, and a tube for the introduction of material to be electrolyzed, said tube leading through said cover and terminating above said anode.

2. In an apparatus for the electrolysis of saline solutions, an anode-compartment, a cover therefor, an anode in said compartment, a cathode, and a liquid seal or water-joint leading through said cover, said liquid seal or water-joint having a high outer wall or cup, and a relatively low inner tube providing an unobstructed passage to permit of the introduction of a liquid into the compartment and the discharge of the liberated gas.

3. In an apparatus for the electrolysis of saline solutions, an anode-compartment, a cover therefor, a cathode, a tube for the discharge of gas, a cup surrounding said tube and forming therewith an annular receptacle for the reception of liquid, the outer wall of said cup projecting above said tube so that liquid introduced in said cup will flow through said

tube into the compartment, and a gas-conducting pipe having its end placed in said annular receptacle whereby the escape of gas except through said pipe is prevented by the liquid in said receptacle.

4. In an apparatus for the electrolysis of saline solutions, an anode, a cathode, a diaphragm consisting of a layer of insoluble granular non-conducting material and a foraminous non-fibrous sheet of conducting material supporting said granular material, and means for maintaining said sheet out of contact with said cathode.

5. In an apparatus for the electrolysis of saline solutions, an anode, a cathode, a diaphragm consisting of a layer of insoluble granular non-conducting material, a foraminous non-fibrous sheet of conducting material supporting said granular material, means for maintaining said sheet out of contact with said cathode, and a gas-tight non-conducting tube which forms the vertical wall of the anode-compartment and is placed upon the said foraminous sheet.

6. In an apparatus for the electrolysis of saline solutions, an anode, a cathode, a diaphragm consisting of a layer of insoluble granular non-conducting material and a foraminous non-fibrous sheet of conducting material, a gas-tight non-conducting tube which forms the vertical wall of the anode-compartment and is placed upon the said sheet, and electrically non-conducting means for supporting the said sheet and tube, and maintaining said sheet out of contact with said cathode.

7. In an apparatus for the electrolysis of saline solutions, a conductive receptacle, a wall forming an anode-compartment, an anode in said compartment, a cathode, a diaphragm separating the anode and cathode and located at the bottom of the anode-compartment, and a support for the said wall and diaphragm, said support being made of a non-conducting material and having openings on a plane with the lower surface of the diaphragm, substantially as described.

8. An apparatus for the electrolysis of saline solutions comprising a metallic tank which alone constitutes the cathode, an open-ended tube in said tank, the walls of which are non-conducting and impermeable to gas, an anode in said tube, a porous diaphragm closing the bottom of said tube, and a separable cover closing the top of said tube, substantially as described.

9. An apparatus for the electrolysis of saline solutions, comprising a metallic tank, which constitutes the cathode, a non-conducting impervious tube in said tank, an anode in said tube, a non-conducting open support for said tube, and a diaphragm consisting of a foraminous non-fibrous sheet closing the bottom of said tube and held between said tube and said support, and a layer of sand or other insoluble granular non-conducting material on said sheet.

In testimony whereof I have affixed my signature in presence of two witnesses.

ADOLPH SOMMER.

Witnesses:
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E. BATCHELDER.