G. HALTER.

ELECTROLYTIC PLANT.

APPLICATION FILED OCT. 20, 1914.

1,172,887.

Patented Feb. 22, 1916.

6 SHEETS—SHEET 1.

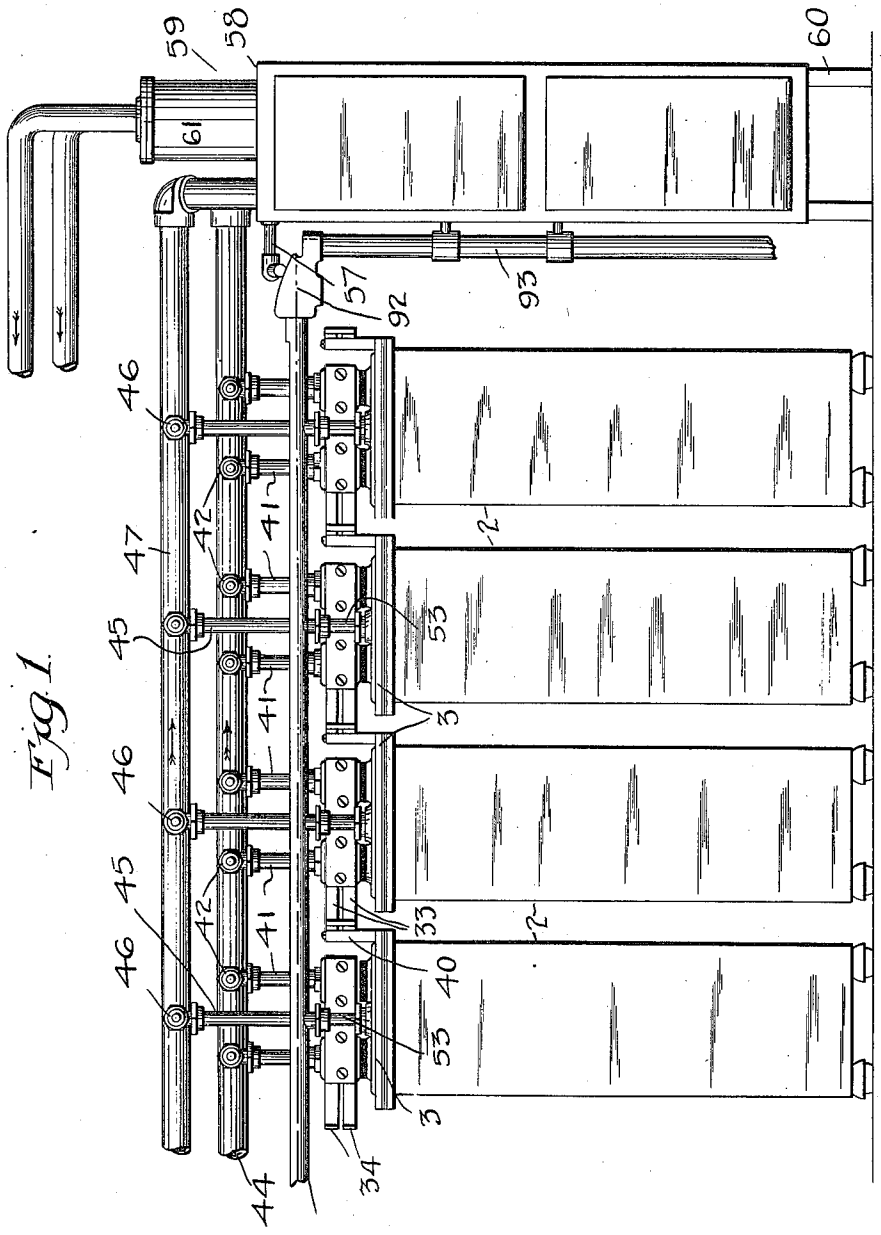


Fig. 1.

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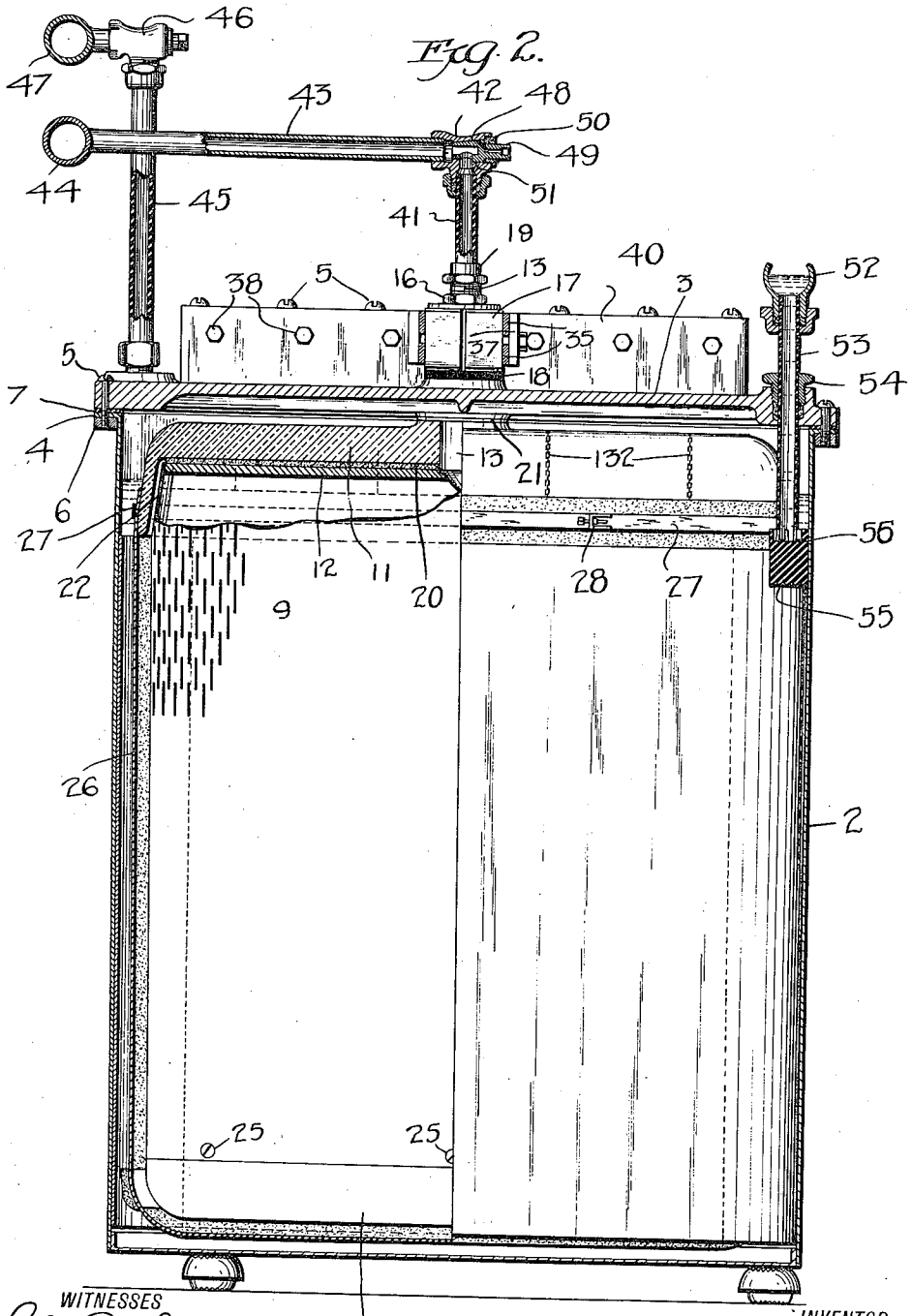
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6 SHEETS—SHEET 2.

Fig. 2.



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6 SHEETS—SHEET 3.

Fig. 3.

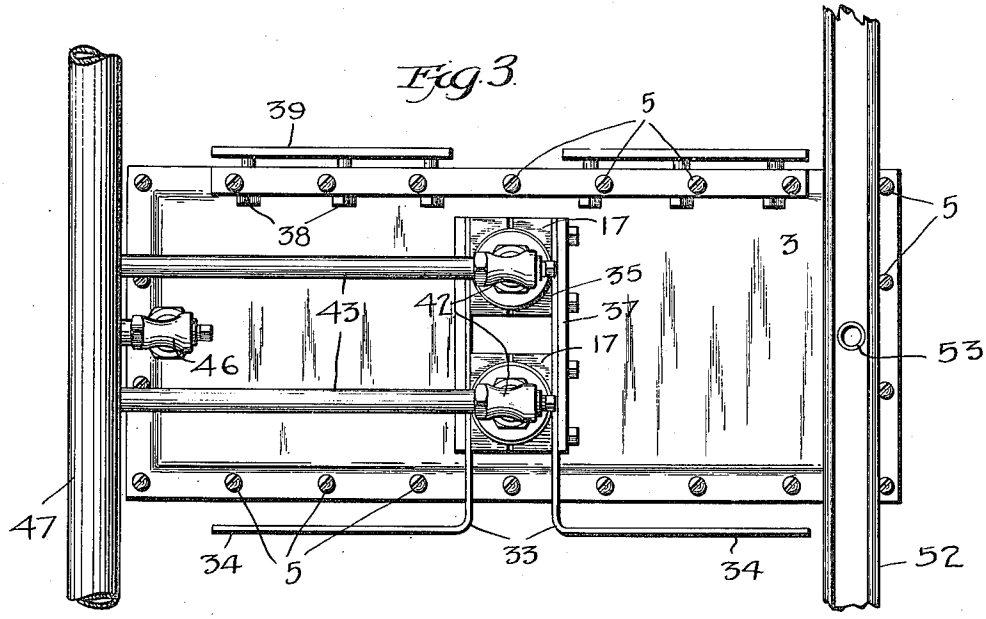


Fig. 4.

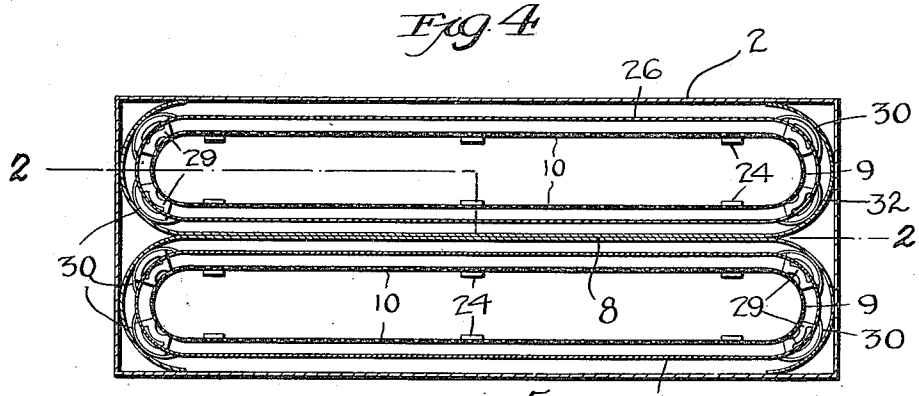
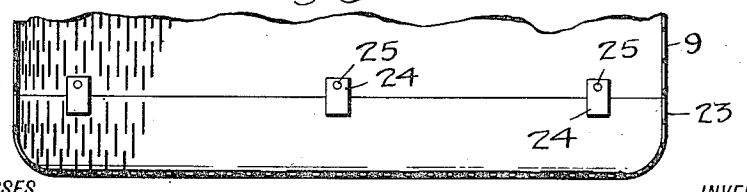


Fig. 5.



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6 SHEETS—SHEET 4.

Fig. 6.

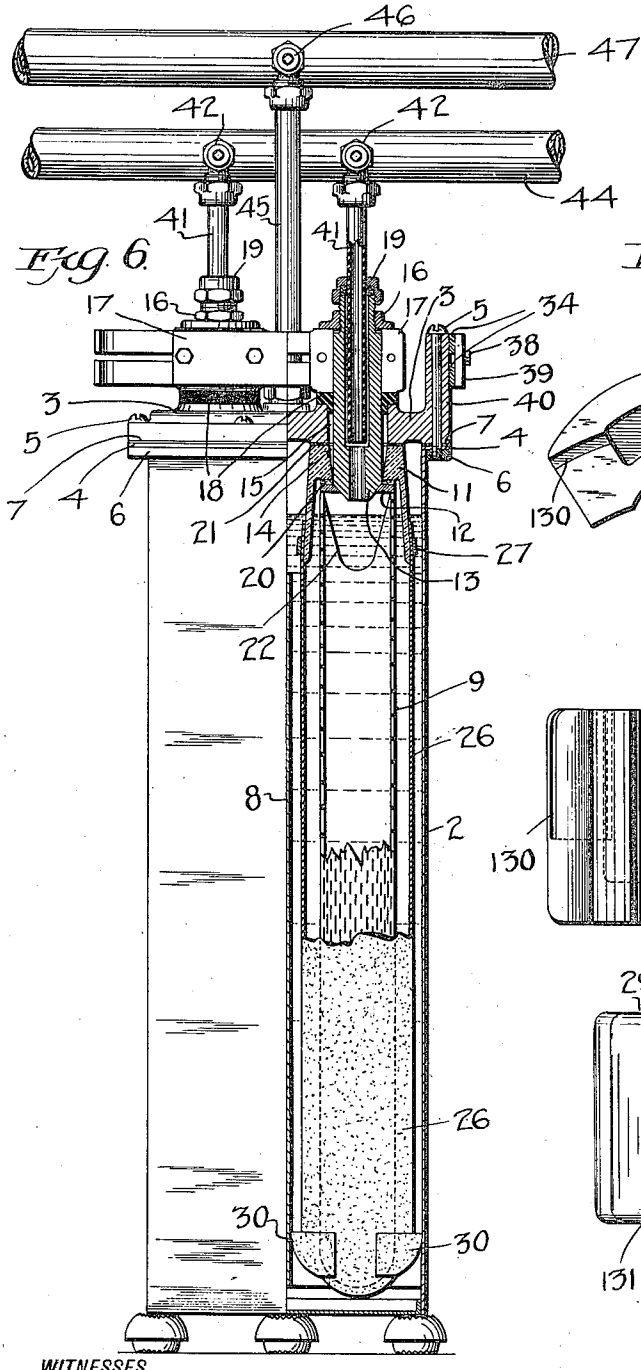


Fig. 7.

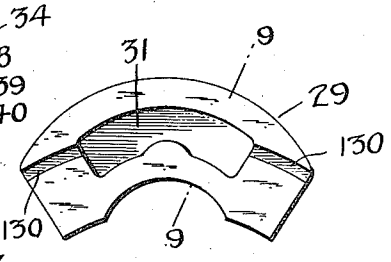


Fig. 8.

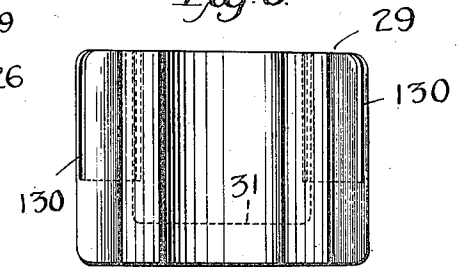
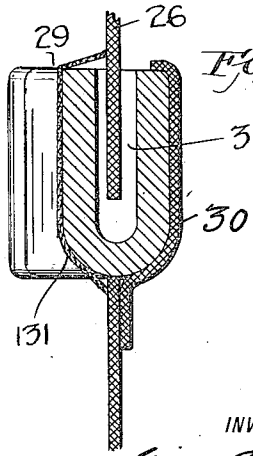


Fig. 9.



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6 SHEETS—SHEET 5.

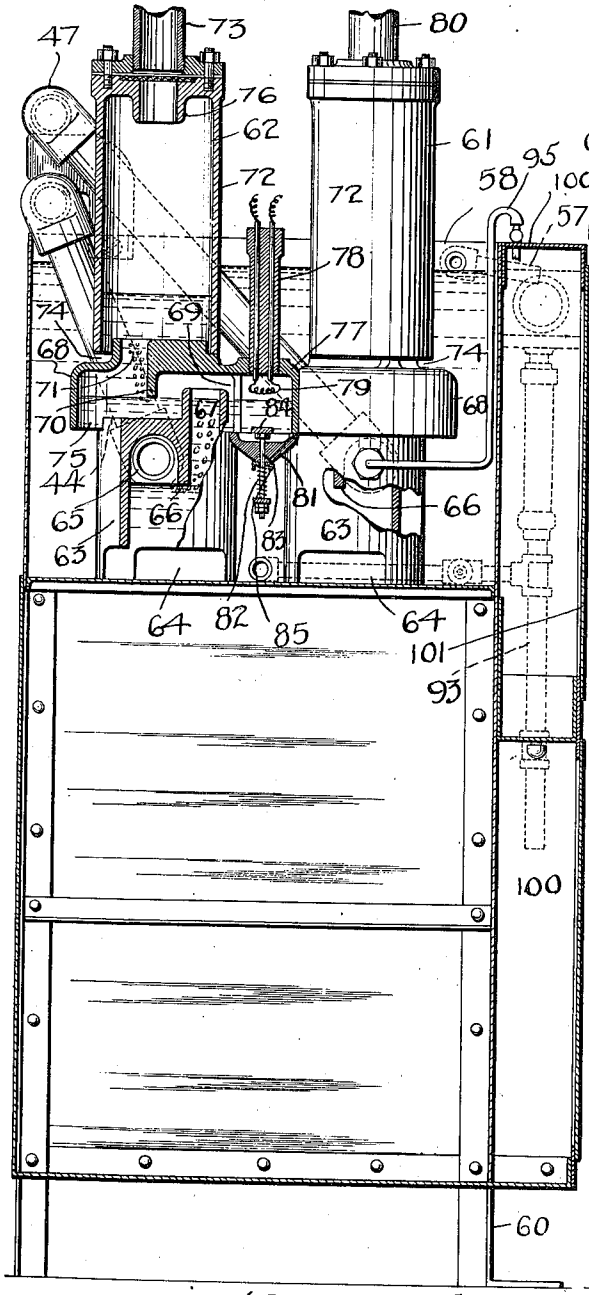


Fig. 10.

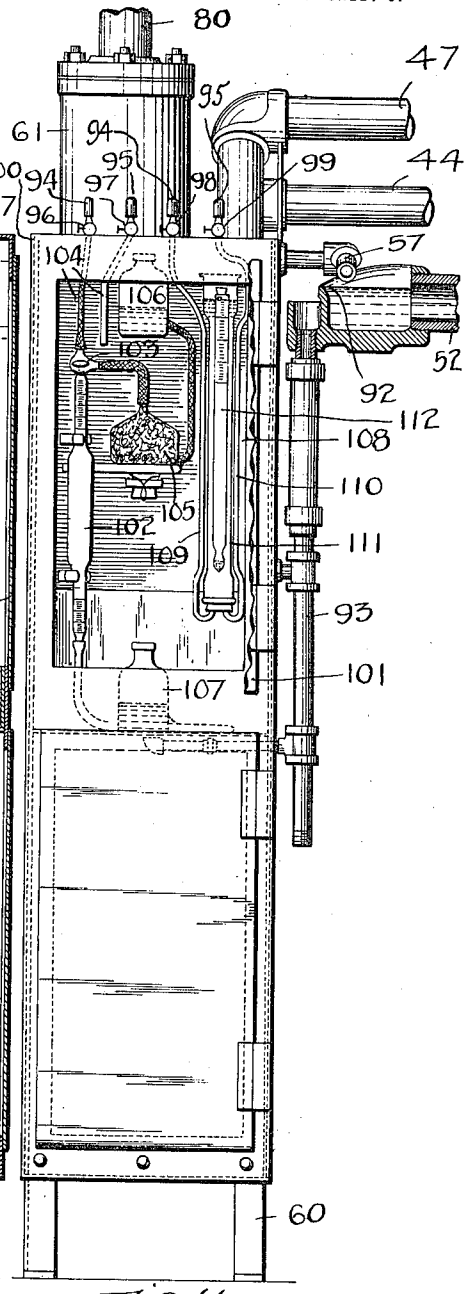


Fig. 11.

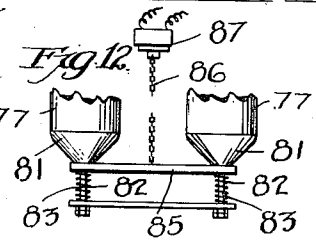


Fig. 12.

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6 SHEETS—SHEET 6.

Fig. 13.

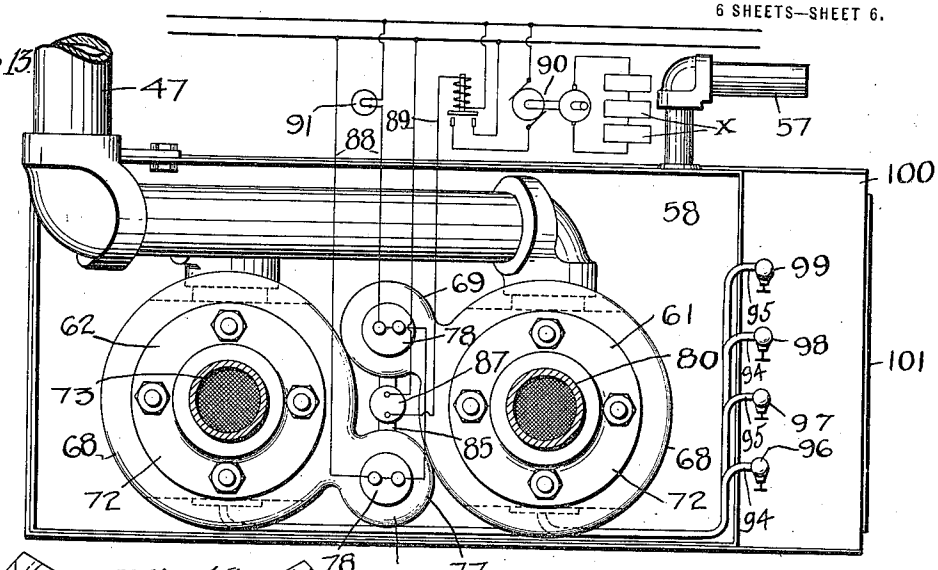


Fig. 14.

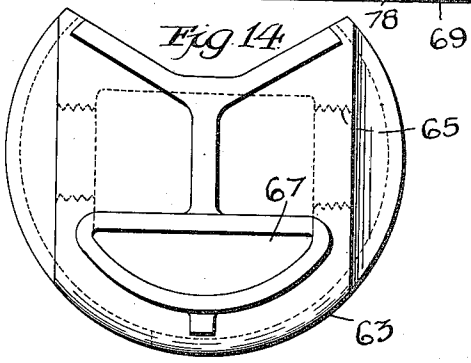


Fig. 15.

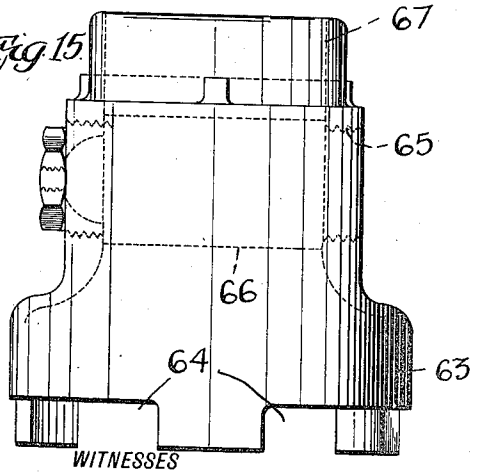


Fig. 16.

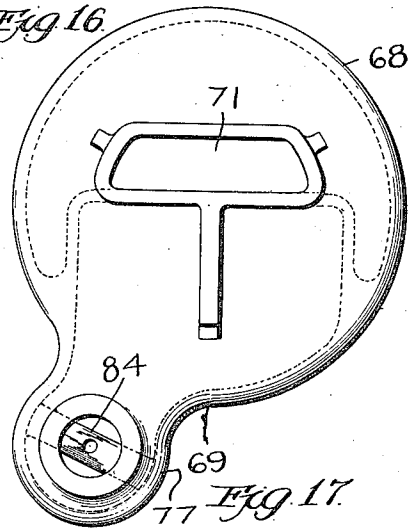
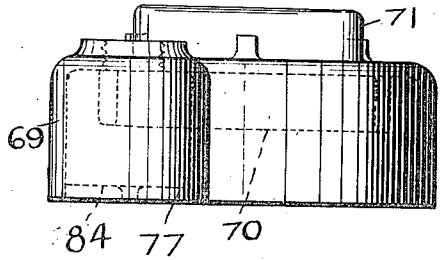


Fig. 17.



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UNITED STATES PATENT OFFICE.

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ELECTROLYTIC PLANT.

1,172,887. Specification of Letters Patent. Patented Feb. 22, 1916.

Application filed October 20, 1914. Serial No. 867,593.

To all whom it may concern:

Be it known that I, GEORGE HALTER, a citizen of the French Republic, and a resident of the borough of Manhattan, in the city, county, and State of New York, have invented certain new and useful Improvements in Electrolytic Plants, of which the following is a specification.

This invention comprises certain improvements in electrolytic plants for the production of oxygen and hydrogen and in the parts thereof.

The general object is to provide a simple and durable apparatus, of comparatively low manufacturing cost, compact and economical of floor space, possessing a high degree of efficiency, that is to say low in consumption of electrical energy for its gas output, and yielding gases of great purity, without danger of mixing.

In its broad features the cell illustrated herein resembles that disclosed in my prior application Serial No. 786,913, filed August 27, 1913, which contains claims generic to the two constructions.

Particular objects of the present invention are to provide an improved construction of the external part of the cell, to improve and simplify the construction of the electrodes, to provide advantageous means for spacing the sack or diaphragm which incloses the anode from both electrode surfaces and at the same time afford passage for liquid but not for gas between the interior and exterior of the sack, to insure equal pressures at both sides of the sack or diaphragm, to guard against injury thereto, to insure replenishment of a number of cells with liquid up to a common predetermined level through one and the same filling operation, and more especially to enable them to be filled from the overflow of the pressure-regulating means, to provide for the entire battery of cells a common filling means and a common pressure-regulating means, between which there exists a condition of hydrostatic balance, to provide an impure-gas-detecting means whereby a localized explosion is produced in the event of mixed gases passing over from the cells, and to utilize the force of this explosion to shut down the plant.

Various other features of the invention will become apparent to those skilled in the art as the specification proceeds.

In the drawings: Figure 1 is a front elevation of a battery of four cells, arranged in series, with a pressure regulator and gas-testing unit at one end thereof; Fig. 2 is an enlarged side sectional elevation taken on the line 2—2 of Fig. 4; Fig. 3 is a plan view of one of the cells; Fig. 4 is a horizontal section through the same; Fig. 5 is a fragmentary longitudinal vertical section taken through the lower portion of one of the anodes; Fig. 6 is a front view of one of the cells, partially in elevation and partially in section and broken away; Fig. 7 is a detail enlarged plan view of one of the diaphragm spacers; Fig. 8 is an elevation thereof; Fig. 9 is a vertical transverse section through the same; Fig. 10 is a side sectional elevation of the pressure regulator unit; Fig. 11 is a front elevation of the same; Fig. 12 is a detail fragmentary side elevation illustrating a mode of utilizing the force of explosions in the explosion chambers; Fig. 13 is a plan view of the pressure regulator illustrating also diagrammatically the control by the impure-gas-detector of the motor generator set supplying current to the cells; Fig. 14 is a plan view of the bottom section of one of the inclosures in the pressure regulator tank; Fig. 15 is an elevation thereof; Fig. 16 is a plan view of the mid-section of said inclosure; and Fig. 17 is an elevation of said mid-section.

The individual cells are of upright, rectangular form, and are designed to be arranged side by side in series, as illustrated in Fig. 1. Each cell comprises exteriorly a tank, consisting of a rectangular body 2 of sheet material, and a combined cover and negative connection 3 of cast metal. The cover tightly closes the top of the tank, being held against a top flange 4 thereof by means of screws 5, which are threaded into a reinforcing bar or continuous nut 6 below the flange. A gasket 7, interposed between the cover and flange, renders the joint gas-tight, and electrical connection of ample aggregate area between the top and body of the tank is afforded by the screws 5. A vertical partition 8 divides the interior of the tank into two lateral compartments, in each of which is suspended an anode 9. The partition 8, together with the walls of the tank, constitute the cathode part. Each anode is in effect double, comprising spaced

adjacent side portions 10, and the cathode element 8 between the anodes is also double, being composed of two sheets of metal placed back to back for economy of space. The two sheets are preferably welded together, and are also welded to the walls of the tank, thereby holding the partition in place and insuring electrical connection between the same and the tank constituting the remainder of the cathode part of the cell. At its upper and lower edges the partition is spaced from the cover and bottom of the tank, in order to leave a common hydrogen-collecting space beneath the cover and to afford liquid communication between the compartments.

A separator 11, of porcelain, stoneware or other material non-conductive of electricity and resistant to the action of the electrolyte and oxygen, is disposed beneath the cover 3 lengthwise over the top of each compartment. As will be apparent from Figs. 2 and 6, the said separator is of inverted trough form, closed at the top, sides and ends and open at the bottom, its walls being of such vertical depth with respect to the predetermined level of electrolyte as to project for a distance below the surface thereof and thus inclose a long and narrow oxygen-collecting chamber. The anode proper 9 is suspended from a conducting bar or plate 12, which is disposed within and directly beneath the top of the oxygen-collecting chamber, and support is afforded by conducting studs 13, which are suitably united to the bar as by welding and extend upward through openings 14 in the top of the separator and registering openings 15 in the cover of the tank to a suitable distance above the latter, where they are provided with screw-threads engaged by nuts 16. Each of said nuts is designed to be forced downward upon a terminal block 17, and the latter in turn upon a hard rubber washer 18 interposed between the blocks and the cover. A gland nut 19, screwed on the upper end of the stud, and gaskets 20 and 21, interposed, respectively, between the bar 12 and the underside of the top of the separator and between the upper side of the latter and the cover, guard against leakage. In this way both the anode and the separator are supported from the cover, from which the anode is insulated by the separator and by the insulating washer 18; and it will be observed that the bar 12 constitutes both a supporting element for the anode and the separator and a conductor of large cross-sectional area connecting the anode with the studs 13.

Each anode is a hollow body, the proportions of which correspond, on an appropriately reduced scale, to the general shape of the compartment in which it is disposed. As will be apparent from Fig. 4, it has an elongated, hollow, oblong, horizontal section rounded at the ends, and, as seen in Fig. 6, it is also rounded at the bottom. In structure the anode is made of perforated sheet-metal, preferably electro-plated as a protection against rusting. The perforations are in the form of slits, approximately 1-5/16 inches long by 1/16 of an inch wide, arranged in staggered rows as indicated. In this way an anode of open construction, of large active area and little liable to derangement, is produced in a simple and comparatively inexpensive manner. The perforations in the walls of the anode permit the electrolytic action to take place from the inner as well as from the outer surfaces, and thus increase the area available with a corresponding decrease in the surface density of the current for a given size of anode. In the preferred manner of forming the anode, a sheet of perforated metal is bent upon itself in order to form the two side portions and an integral curved end portion, and the edges are curved and brought together to form the other end portion, these edges being advantageously united by welding. The upper side edges of this body are suitably united, as by welding, to the lateral portions of the bar 12, and the upper portions of the curved ends may be cut off on a bevel, as indicated at 22, to conform to the inclination of the end walls of the separator seen in Fig. 2. The curved bottom portion of the anode is formed of a separate bottom section 23, which is also made of perforated sheet-metal and is shown secured to the bottom of the body by means of lugs 24 and screws 25.

The diaphragm, which is interposed between the positive and negative electrodes, for the purpose of preventing mixing of gases below the liquid level, consists of an oblong sack 26, which is fastened at the top to the depending walls of the separator 11 and completely incloses the anode below the separator. This sack is of porous material, unaffected by the electrolyte or the gases, a nonconductor of electricity, though offering no resistance to the passage of current, which is carried by the electrolyte within its pores, and a bar to the passage of gases when immersed and the pressures at opposite sides are equal. A fabric of woven asbestos possesses these qualities and is the material preferably employed herein. Means for insuring a balance of pressures at opposite sides of the diaphragm will be hereinafter described. The anode is thus entirely surrounded by an insulating and gas-separating inclosure, which above the liquid level consists of the impervious porcelain or stoneware separator and below the surface of the porous asbestos sack. The only parts of conducting material in contact with the electrolyte are the electrodes,

and their large surfaces are the only surfaces on which gases can be formed; and these surfaces are completely separated by a gas barrier; consequently the possibility of mixed gases is reduced to a minimum and practically eliminated. The separator projects below the level of the electrolyte to a sufficient depth, in the particular cell in question about 5 inches, to insure that its lower edges will not be uncovered by the lowering of the level during a normal or somewhat longer running period, since the effectiveness of the asbestos diaphragm to prevent mixing depends upon its being saturated with liquid, and any portion of it uncovered below the separator would become sufficiently dry to give rise to danger of the gases passing through. The projection of the separator below the surface is, however, limited to substantially the predetermined necessary degree, in order that the electrolytic action, which takes place through the diaphragm, may not be diminished.

The means for fastening the diaphragm sack to the separator 11 preferably comprises a clamping strip 27, which is located above the electrolyte and may be tightened by means of a clamp 28, the holding being rendered more secure by a downward flare of the walls of the separator.

The sack, while prohibiting the passage of gases through it as long as it hangs clear of the electrodes, may fail in performing this function if it comes in contact therewith. For this reason the sack is provided with insulating spacers 29, of porcelain or other material unaffected by the electrolyte and gases, the same being received in pockets 30 in the lower portions of the walls of the sack and projecting at opposite sides thereof, being preferably approximately as wide as the space between the electrodes. The said spacers are located at the lower portion of the sack, and preferably at the "corners" of the same, though manifestly a greater number may be provided and in different locations. In accordance with the invention these spacers are also utilized to afford passages for liquid, but not for gas, between the interior and exterior of the sack, for the purpose of preserving a uniform density of the electrolyte at both sides of the diaphragm, and also to render it unnecessary in replenishing the supply of liquid to introduce water both inside and outside of the sack. The construction of the spacers is more particularly shown in Figs. 7 to 9, wherein it will be observed that a slot 130 is formed extending downward from the top of the spacer and inward from both ends thereof, this slot widening at the middle into a well 31 of greater depth than the slot. As appears in Fig. 9, the depending wall of the sack, which is severed at the pocket to permit the insertion of the spacer, is received within and fills the slot or slots 130, but does not fill the well 31, which thus affords a diving passage downward beneath the edge of the asbestos wall. Through this passage liquid may diffuse or flow, but gases cannot pass. The spacers may be additionally held in place by asbestos cords 131, and similar cords 132 may be provided to assist in supporting the sack from the separator.

At this point it may be noted that the rounded end and bottom portions connecting the side portions 10 of the anode, besides their structural advantage, obviate the presence of any sharp corners or edges, which might rupture the asbestos fabric of the sack, besides being desirable for structural reasons.

The partition 8, heretofore described as forming part of the cathode and constituting a double sheet, is constructed with special reference to the form of the anodes. Thus, as shown more particularly in Fig. 4, the end portions 32 of the sheets forming the partition are separated and curved in reverse directions, in general conformity with the curvature of the end portions of the anodes, to a junction with the opposite side walls of the tank. By this means a uniform distance between the anode and cathode surfaces is preserved throughout the entire horizontal circuit. This distance is approximately $1\frac{1}{4}$ inches, which has been found to be the degree of proximity corresponding to the greatest efficiency, and it will be observed that the general construction of the cell is such as to permit this advantageous minimum distance, or even a less distance if desired, to be availed of without conflict with other conditions.

The cells are electrically connected in series by means of angular conductors 33, the portions 34 of which, parallel to the sides of the cells, constitute the negative terminals, while the portions 35, disposed transversely of the tops of the cells, constitute the positive terminals. The terminal blocks 17, heretofore referred to, are formed in half sections, clasping the conducting studs 13, and are held together by the same bolts 36 which clamp the terminals 35 between the blocks and clamp plates 37. The negative terminals 34 are clamped by bolts 38 and plates 39 to vertical flanges 40, one of which is formed integral with one side margin of the cover of each cell. This combination of sheet-metal tank and cast metal cover with integral negative connection affords an economical yet rigid structure, and is of particular advantage because it enables all the connections to be conveniently made above the tops of the cells and avoids the disadvantages and difficulties attendant upon welding or otherwise uniting a bus-bar to

the sheet-metal body of the tank. As already indicated, the cover and body are in full electrical connection through the medium of the bolts 5. Furthermore, both electrodes are of large electrical capacity and have large areas of contact with the alkaline solution forming the electrolyte, and consequently the cell has the least possible resistance, namely only that of the electrolyte.

The oxygen formed on the surfaces of the anode rises upward through the electrolyte inside and outside of the anode until the collecting chamber within the separator 11 is reached, where the gas at the outside passes inward through the slits. The gas thus collected passes out through the stud 13, which is made hollow for the purpose, and through an insulating tube 41, which is inserted within a counter-bore in the stud and serves to insulate the tank from the oxygen piping. The upper end of this insulating tube delivers into a valve chamber 42, whence an offtake pipe 43 extends rearward and enters a common oxygen offtake conduit 44 running lengthwise of the series of cells. The hydrogen which is collected in the general interior of the tank above the water line and outside of the chambers formed by the separators, escapes through a suitable opening in the top of the tank into an insulating tube 45, which delivers into a valve chamber 46, which in turn is connected with a common hydrogen offtake pipe 47. Within the valve chambers 42 and 46 of the individual oxygen and hydrogen offtake pipes are two-way valves 48, one of which is illustrated in Fig. 2. The said valve is provided with a projecting stem 49, by means of which it may be turned, and has passages which in the position shown in Fig. 2 connect the pipes 41 and 43 and thus permit the gas to flow to the common offtake. When, however, the valve is given a half turn, a small passage 50 therein, which is normally blanked, is brought into registry with a corresponding passage 51 in the valve chamber, and simultaneously the communication with the common offtake is cut off. In this way a small amount of the oxygen or hydrogen produced by any of the cells may be tapped off for testing purposes independently of the other cells.

Filling of the cells is effected from a common recipient or trough 52, running lengthwise of the series above their tops. Downtakes 53 of insulating material extend from the bottom of the recipient through openings in the covers of the several tanks made tight by glands 54, and rest at their lower ends at a suitable distance below the level of the electrolyte on blocks 55, of insulating material, secured at a predetermined height to the walls of the tank. As shown in Fig. 2, the top of this block is recessed to receive the lower end of the tube, which is provided with openings 56 in such manner that a tortuous entrance is provided for the liquid, which cannot be followed in the reverse direction by the gas rising in the neighborhood. The recipient 52 preferably receives its supply of water from an overflow pipe 57 of the tank 58 of a pressure regulator and flash-back 59. The said pressure regulator is mounted on a suitable stand 60 at one end of the series of cells and comprises, in addition to the tank 58, separate inclosures 61 and 62 for confining the two gases as they pass upward through the water. The common offtake pipes 44 and 47 are connected at their lower ends with the lower portions of these inclosures, the interiors of which are in open communication with the body of liquid in the tank 58. The offtake conduits being of ample cross-sectional area and the liquid in the pressure regulator tank being open to atmospheric pressure, the pressures of the gases in all the cells are determined by the height of the columns of water displaced by the gases in passing through the pressure regulator, and, since the inlets from the conduits 44 and 47 are arranged to permit the two gases to escape upward at the same level, the pressures of the gases on the two sides of the diaphragm are equal in each cell and equal to the pressures in all of the other cells. By the provision of means for holding a body of water into which both gases are delivered, or, which amounts to the same thing, communicating bodies open to the pressure of the atmosphere, a common liquid level at the regulator is insured for both gases, and consequently a balance of pressures in the cells is insured. Predetermined liquid levels are established both in the pressure regulator tank 58 and in the filling recipient 52. In the former the maximum height of the liquid is determined by the overflow 57, and in the latter by an overflow 92, from which water may escape into a waste pipe 93. From time to time, as the levels are lowered by evaporation and by electrolytic action, water is supplied to the tank 58 and from this tank, after the predetermined level therein has been reached, to the recipient 52, from which it enters the cells.

A condition of hydrostatic balance exists between the pressure regulator and the filling means for the cells, that is to say, the height of the column of water from the level in the recipient 52 to the liquid level in the cells is the same as and determined by the height of the water columns represented by the distance from the level in the pressure regulator tank 58 to the inlets from the offtake pipes 44 and 47. Consequently, the pressures in the cells having been determined by the distances of the inlets from the offtake pipes 44 and 47 below the liquid level

in the tank 58 of the pressure regulator, the level of the electrolyte in the cells may be fixed at the height desired (which will not expose the diaphragm below the separator) by the height at which the recipient 52 is located, or, to be more exact, by the height of the overflow 92 therefrom. Whether the recipient 52 receives its water from the pressure regulator tank or is independently supplied with water, as of course it might be, the common hydrostatic filling system, in coöperation with the common hydrostatic pressure regulator, enables all of the cells to be replenished with liquid up to the same predetermined level by one and the same filling operation. In this way the maintenance of the proper height of electrolyte in the cells, which is very important, is greatly facilitated, and it is impossible to fill any of the cells improperly or to omit to fill any of them while filling the rest. The feature of supplying the filling recipient from the overflow of the pressure regulating tank is desirable because it insures that all parts of the system requiring water will be kept properly replenished, a single place of filling sufficing for all.

The lower ends of the filling tubes 53 are located approximately at the level of the lower edge of the separator or somewhat above, so that in event of the electrolyte lowering to such a degree as to endanger the exposure of the sacks below the separators, with consequent liability of mixing of gases, the exits of the filling tubes are uncovered, thus permitting the hydrogen to escape through the filling recipient and thereby giving warning of the condition of the cells.

The inclosures 61 and 62 are preferably duplicates and are constructed in a simple and inexpensive manner of superposed hollow castings, which may simply rest one upon the other or be bolted if preferred. The lowest section 63 of each rests on the bottom of the tank 58 and is provided with openings 64 for the admission of water and with an inlet 65, to which the pipe 44 or 47, as the case may be, is connected. The said inlet opens into a recess in the top of the section behind a depending baffle wall 66, the lower edge of which determines the depth of the column of water to be displaced, and is located at the same height in both inclosures. From the bottom section the gases pass upward through a passage 67 into the interior of the mid-section 68. An important part of the mid-section is an explosion chamber 69, into which the passage 67 projects. This chamber is formed by walls arranged in such manner that the gas entering the same is trapped and collects until it lowers the water in the chamber sufficiently to permit it to escape beneath a depending baffle wall 70. The gas then rises through a passage 71 in the mid-section into the top section 72, which constitutes a collecting chamber connected at its upper end with the delivery pipe 73. The formation of the adjoining portions of the superposed sections is such that openings 74 are afforded between the mid and top sections, placing the interior of the section 72 in communication with the liquid in the tank, these openings constituting safety vents permitting any accumulated pressure in the delivery system to blow out through the water in the tank of the pressure regulator rather than to force its way back into the cells. In like manner, openings 75 are left between the mid and bottom sections, serving as additional vents and also to guard against any upward rush of gas driving the water out of the upper portion of the inclosure. The outlet in the top of the collecting section 72 is surrounded by a depending flange or nozzle 76, which is provided for the purpose of causing any condensed moisture or caustic, which might otherwise be carried into the delivery pipe, to drop back into the liquid in the tank.

The explosion chamber 69 of each inclosure is formed with a lateral extension 77, and as shown in Fig. 13 these extensions are preferably arranged between the two inclosures. Into the top of each of these extensions there is tapped a plug 78, carrying a platinum wire 79 exposed to the gas in the explosion chamber. This wire is of suitable cross-sectional area to be rendered incandescent by the passage of electric current of appropriate strength, and thus constitutes a continuous impure-gas-detector, which has no effect as long as the gas is pure but will produce an explosion in event of even a small proportion of the other gas being admixed therewith. The explosion thus produced being water-sealed both from the oxygen and hydrogen delivery pipes 80 and 73 and from the offtake pipes 44 and 47, cannot be propagated in either direction. The occurrence of the explosion may be relied upon as an indicator, but preferably means are provided for utilizing its force to effect an automatic function, such as the shutting down of the motor generator set supplying current to the cells. This is illustrated partly by diagram. A movable part or piston 81 is disposed at the bottom of each of the explosion chamber extensions 77, where it is normally held in place by a spring 82 encircling a rod 83 which passes loosely through the piston and is secured at its upper end to a stationary part 84. Upon the occurrence of an explosion, the piston is forced downward against the action of its spring, and in so doing carries downward a bar 85, the end portions of which underlie the pistons of both chambers. The arrangement is such that when one of the pistons is forced downward, this bar fulcrums on the rod 82 of the other piston, while if

both of the pistons descend it is carried down bodily. To its center is secured a flexible connection 86, which extends to a pull switch 87 of ordinary construction. The electrical connections are shown diagrammatically in Fig. 13, where 88 represents the circuit for supplying current to the igniter wires 79, and 89 a circuit controlled by the switch 87 and in turn controlling the starting device of the motor generator set 90, which supplies current to the cells represented diagrammatically at X. A lamp 91 in the igniter circuit 88 is provided for the purpose of indicating whether the igniters are in operative condition. From the foregoing it will be understood that an explosion, due to impure gas entering one or other of the explosion chambers, interrupts the control circuit 89 and thereby stops the motor generator, shutting down the entire plant.

From the inlet chambers 65 of the inclosures 61 and 62 small pipes 94 and 95 are led to valved connections 96, 97, or 98, 99 at the top of a cabinet 100 which is supported by the stand 60 in front of the pressure regulator tank and serves to house certain gas-testing apparatus. The front of this cabinet is normally closed by a door 101, which is shown open in Fig. 11 to reveal the contents. Testing apparatus of this character and its mode of use for determining the purity of oxygen or hydrogen are known and do not, therefore, require detailed explanation. 102 is a graduated burette, which is provided at the top with a valve 103 and may be connected with either the oxygen fitting 96 or the hydrogen fitting 97 by means of a flexible tube 104.

105 is a pipette containing fine copper gauze and connected with the valve 103, which is a two-way cock adapted to admit gas to the burette 102, the pipette being cut off or in another position to permit gas to be transferred from the burette to the pipette, the supply tube 104 being cut off. The pipette is connected by tubing with a flask 106, which constitutes a water seal and also affords pressure to drive the gas residue from the pipette into the burette. The lower end of the burette is connected by a suitable length of tubing with an aspirator bottle 107, which may be raised and lowered. The cabinet also contains a novel form of pressure indicator 108, the same comprising two glass tubes 109 and 110, which may be connected with the oxygen and hydrogen eduction systems and communicate at their lower ends with the interior of a common tube 111. Within the latter is a float 112, in the nature of a hydrometer. Zero on the scale of this hydrometer float is located on the water level line in the common tube 111, and it follows that the pressures on the two gases, as also the difference between their pressures, may be read directly by comparing the levels of the liquid in the tubes 109 and 110 with the graduations on the float.

The pressure regulator and explosion chambers are not claimed specifically in this application, such subject-matter being reserved for my copending application, Serial Number 867,592, filed October 20, 1914.

What I claim as new is:

1. An electrolytic cell for the production of oxygen and hydrogen having a narrow upright chamber inclosed by cathode surfaces, a top therefor, a separator of non-conducting material and inverted trough form disposed lengthwise of said chamber with its top beneath said top for the chamber, an anode beneath said separator composed of slitted sheet-metal and of hollow oblong form in horizontal section, and a sack fastened to said separator and inclosing the anode.

2. In a cell for electrolytic dissociation of water, a tank having a suitable top, a substantially horizontal conducting bar supported from said top, and a perforated sheet-metal anode secured at its upper edges to said bar, said anode being of hollow oblong form in horizontal section with curved ends and a curved bottom.

3. A cell for electrolytic dissociation of water, comprising a tank, a partition dividing the interior of said tank into narrow vertically-arranged compartments and together with the walls of the tank constituting the cathode part, and anodes in said compartments of hollow oblong horizontal section with curved ends, the partition comprising at each end two separated portions curved in substantial conformity to the ends of the anodes.

4. A cell for electrolytic dissociation of water, comprising a tank, a partition dividing the interior of the tank into narrow vertically-arranged compartments and together with the walls of the tank constituting the cathode part, and anodes in said compartment of hollow oblong horizontal section with curved ends, said partition comprising two plates assembled back to back with their end portions curved apart and around the ends of the anodes.

5. A cell for electrolytic dissociation of water, comprising a substantially rectangular tank having anodes and cathodes disposed in parallelism, the anodes being double, comprising spaced perforated plates, and a cathode between double anodes comprising two plates placed back to back.

6. In a cell for electrolytic dissociation of water, the combination with positive and negative electrodes, of a diaphragm comprising an asbestos sack inclosing the positive electrode, and insulating members carried by the diaphragm sack, to space the walls of the same between the electrodes.

7. In a cell for electrolytic dissociation of water, the combination with an anode, and cathode members at opposite sides thereof, of a diaphragm comprising an asbestos sack inclosing the anode, said sack being provided with pockets, and insulating members mounted in said pockets to space the walls of the sack between the electrodes.

8. In a cell for electrolytic dissociation of water, the combination with positive and negative electrodes, of an asbestos diaphragm therebetween, and insulating spacers carried by the diaphragm and affording diving passages permitting circulation of water but preventing mixing of gases.

9. In a cell for electrolytic dissociation of water, the combination with positive and negative electrodes, of an asbestos diaphragm having pockets, members of insulating material mounted therein, each having a slot for the reception of the upper edge of the pocket widened centrally into a well deeper than the end portions of the slot and affording a diving passage beneath said edge.

10. In a cell for electrolytic dissociation of water, the combination with an anode, of a sack inclosing the same and having members of insulating material inserted in its lower portion and projecting at opposite sides thereof, said members having recesses receiving curtains formed by severed portions of the sack and affording diving passages beneath said curtains.

11. In a cell for electrolytic dissociation of water, the combination with positive and negative electrodes occupying substantially parallel adjacent planes, a separator of non-conducting material over the positive electrode inclosing an oxygen-collecting chamber the walls of which project below the normal electrolyte level, a sack fastened to said separator and inclosing the positive electrode below the level of the electrolyte, and spacers of insulating material inserted in the lower part of said sack to hold the sack substantially mid-way between the electrodes.

12. In an electrolytic cell for the production of oxygen and hydrogen, the combination of a tank constituting a cathode, a cover for the tank bearing an integral vertical flange, means for attaching a negative terminal to said flange, means tightly attaching the cover to the body of the tank and electrically connecting the same, and an anode suspended from the cover and insulated therefrom.

13. In a plant for the electrolytic production of oxygen and hydrogen, a battery of electrolytic cells comprising tanks having anodes and cathodes and means for separating and collecting the gases, individual oxygen and hydrogen take-off conduits leading from the gas spaces of said cells, main take-off pipes into which said individual conduits deliver, and valved means in the several individual conduits movable alternately to open outlets from one or more of said conduits while shutting off communication between the same and the main pipes and to re-open said communication at the same time closing said outlets.

14. The combination with a battery of electrolytic cells for the production of oxygen and hydrogen, the same comprising closed tanks having anodes and cathodes and means for separating and collecting the gases, common off-take pipes communicating with the gas spaces of the cells, pressure-regulating means comprising a liquid holder open to atmospheric pressure and having inlets from said pipes permitting the gases to escape upward at equal distances below the surface, and means for separately collecting and carrying off the rising gases, said liquid holder having an overflow determining the height of liquid therein, and hydrostatic filling means for the cells including a common recipient in receiving relation to said overflow.

15. The combination with electrolytic means for producing oxygen and hydrogen by decomposition of water and separate gas eduction systems, of means in one or both of the eduction systems forming an explosion chamber water-sealed at both inlet and outlet, an igniter in said explosion chamber, and suitable means for utilizing the force of the explosion produced in said chamber in event of impure gases to interrupt the operation of the plant.

16. The combination with electrolytic apparatus for the production of oxygen and hydrogen, and separate gas eduction systems leading therefrom, of an explosion chamber in one or each of said eduction systems, means isolating said chamber from the remainder of the system against propagation of explosions produced in the chamber, an igniter therein, and means affected by an explosion in the chamber for shutting down the apparatus.

17. The combination with electrolytic apparatus for the production of oxygen and hydrogen, and separate gas eduction systems leading therefrom, of an isolated explosion chamber in one or each of said eduction systems through which the gas is compelled to pass, a movable part arranged to be displaced by an explosion in said chamber, and a switch connected with said movable part so as to be operated thereby.

18. The combination with electrolytic apparatus for the production of oxygen and hydrogen, a motor generator with starting device for supplying the same with current, and separate gas eduction systems leading from the apparatus, of an isolated explosion

chamber in one or each of said eduction systems through which the gas is compelled to pass, a movable part arranged to be displaced by an explosion in said chamber, a circuit controlling the starting device of the motor generator, and a switch in said circuit connected with said movable part so as to be operated thereby.

In testimony whereof I have signed my name in the presence of two subscribing witnesses.

GEORGE HALTER.

Witnesses:
J. F. BRANDENBURG,
E. GREENBERGER.