

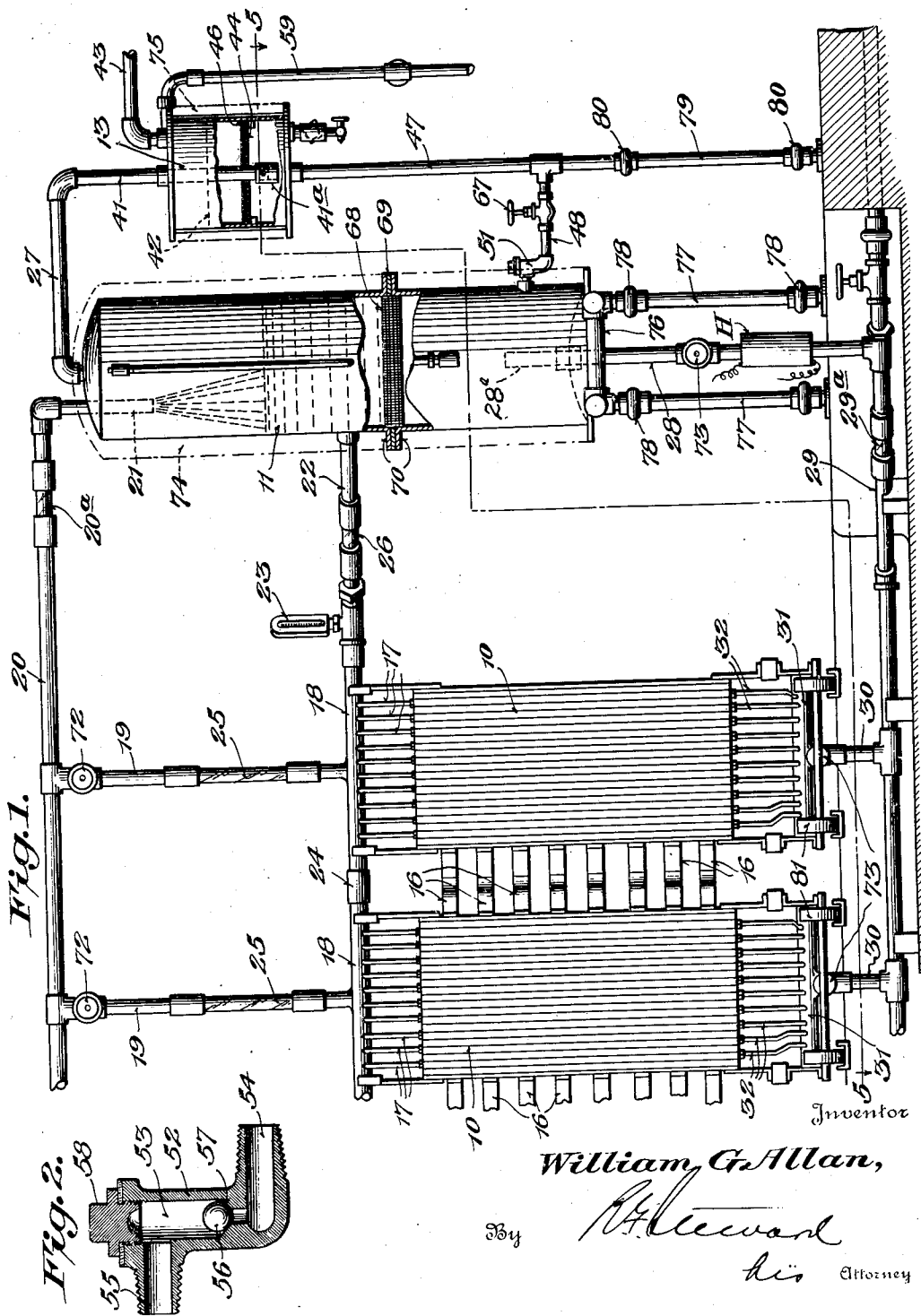
Feb. 21, 1928.

1,660,147

W. G. ALLAN

ELECTROLYTIC GAS GENERATING SYSTEM

Original Filed Oct. 1, 1920 4 Sheets-Sheet 1



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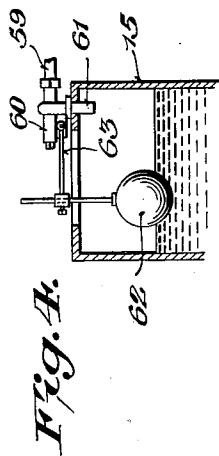
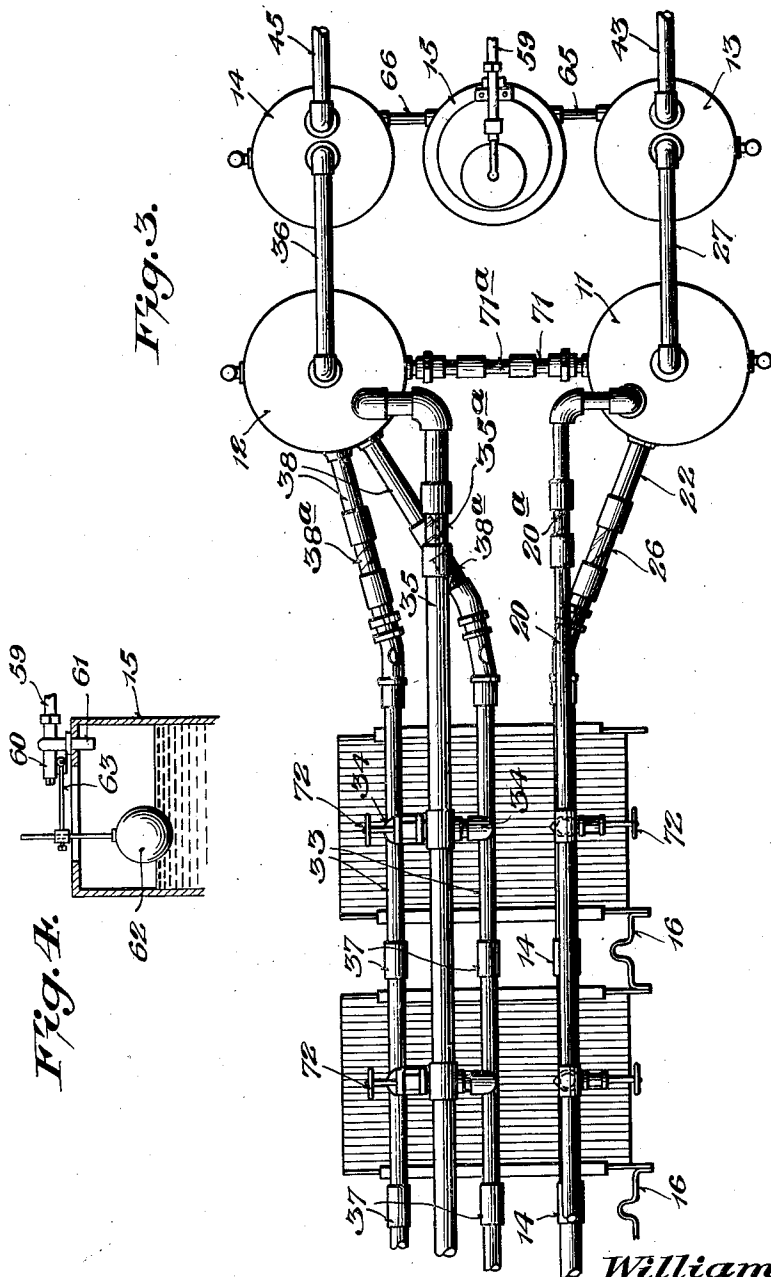
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ELECTROLYTIC GAS GENERATING SYSTEM

Original Filed Oct. 1, 1920 4 Sheets-Sheet 2



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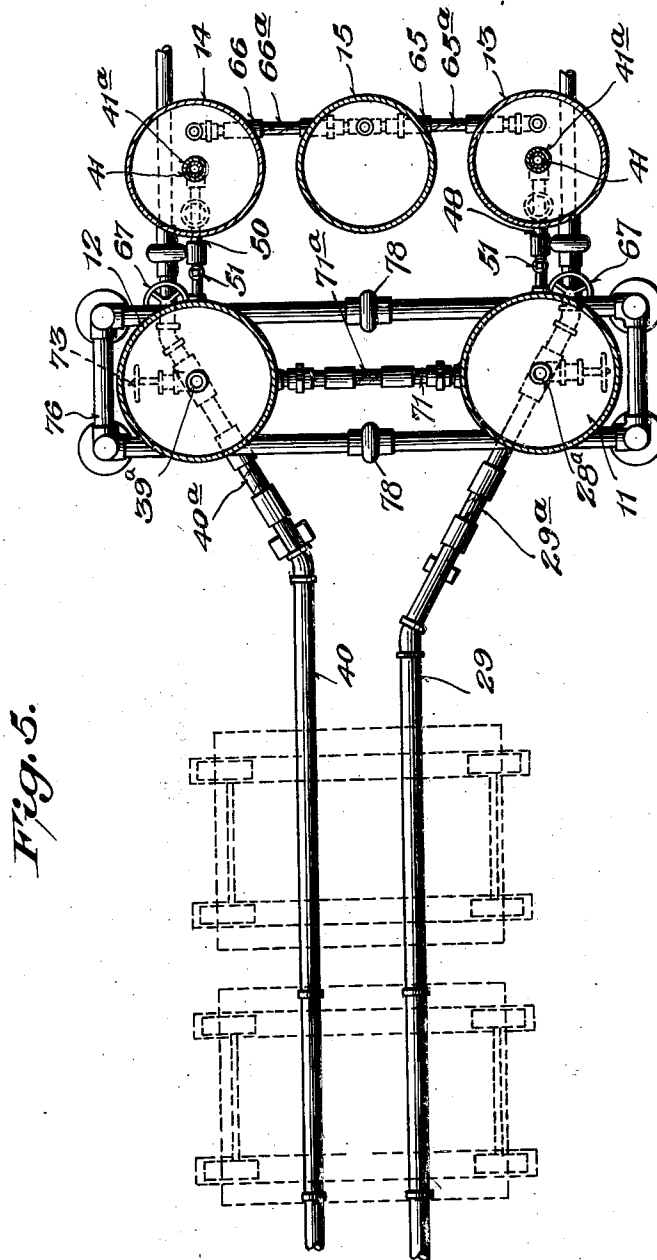
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ELECTROLYTIC GAS GENERATING SYSTEM

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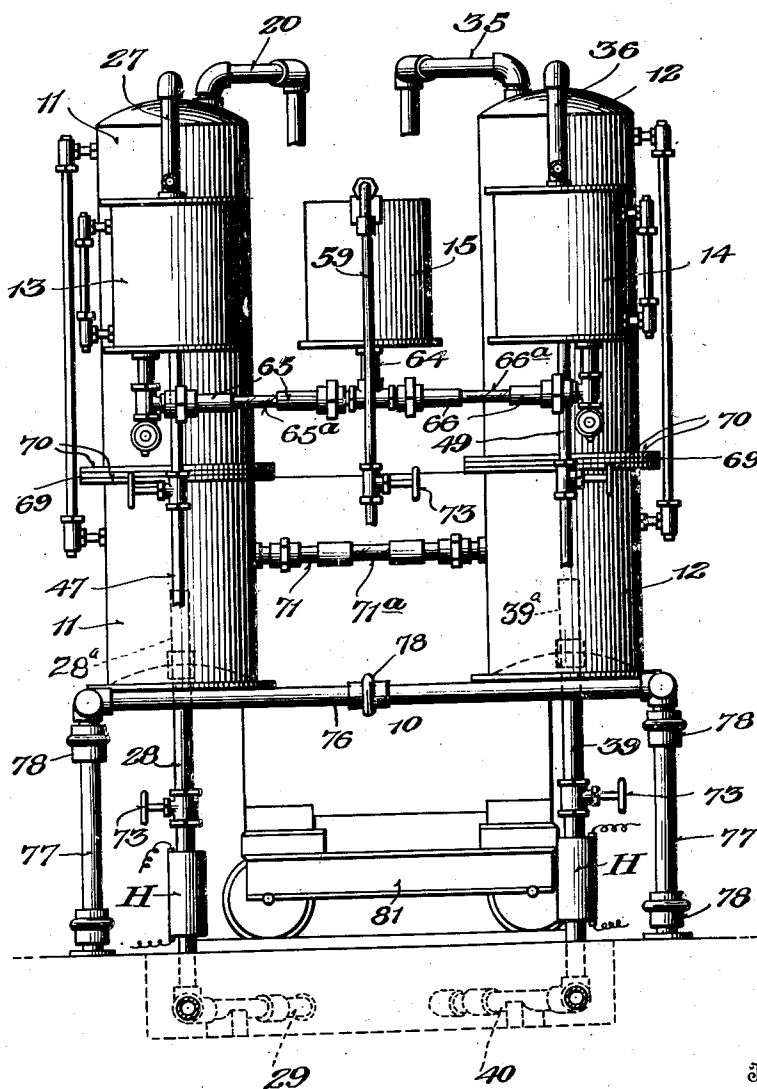
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Fig. 6.



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UNITED STATES PATENT OFFICE.

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ELECTROLYTIC GAS-GENERATING SYSTEM.

Application filed October 1, 1920, Serial No. 413,971. Renewed February 19, 1927.

This invention relates to electrolytic gas generating systems, and particularly to systems adapted for the generation of oxygen and hydrogen electrolytically.

5 In general, the system forming the subject-matter of the present invention is of a type in which the electrolyte, a solution of caustic alkali and water, for example, is caused to circulate systematically in a closed
10 piping system, the electrolyte passing over the surfaces of the electrodes and being conducted from the cells or generating units, in company with the gas evolved from the anode and cathode compartments respectively, and being returned for re-passage
15 through the generating units after being freed from the generated gas. Systems of this general type are well known in the art, and the present improvements relate to novel
20 features of construction and arrangement of apparatus parts, whereby circulation of the anolyte and catholyte respectively, as well as separation and subsequent treatment of the generated gases, are rendered more systematic and dependably controllable than has
25 been the case heretofore; and also whereby other novel and advantageous results are obtained, as will more fully hereinafter appear.

30 One of the principal objects of the invention is to provide improved means operative to effect automatic regulation and adjustment of gas pressure and hydrostatic head of electrolyte to attain proper balance of said
35 pressure and head between the hydrogen and oxygen sides of the generator cells. Another object of the invention is to provide means, most desirably operating in conjunction with and forming a part of the aforesaid automatic regulating and adjusting means,
40 whereby make-up water may be supplied to the electrolyte circulating system automatically whenever and wherever required to replenish and maintain the supply in predetermined amount. Still another object of the
45 invention is to provide a system of the character in question operative to extract from the evolved gases any caustic soda or caustic potash or other solute used in the electrolyte that may be entrained or mechanically carried over with the gases and return the same
50 to the electrolyte by way of the feed water supply. Other and further objects of the invention are to conserve and utilize the
55 heat resulting from the electrolytic action

in the cells, to provide improved safeguards against the transmission of explosions from the cells themselves to gasometers or other containers to which the gases may be conducted therefrom, and to provide improved
60 means for effecting more thorough and complete separation of fine bubbles of gas from the electrolyte after it has left the cells and before it is returned thereto.

With the above general objects in view and
65 some others which will appear from the description hereinafter, the invention consists in the features, details of construction, and combinations of parts, which will first be described in connection with the accompanying
70 drawings, illustrating a typical practical construction embodying the principles of the invention, and will then be more particularly pointed out.

In the accompanying drawings,

75 Fig. 1 is a side elevation of a system embodying the invention, parts being shown broken away and in section;

Fig. 2 is a sectional view in detail of a valve construction desirable to employ in
80 said system;

Fig. 3 is a plan view of the system illustrated in Fig. 1;

Fig. 4 is a detailed sectional view of the float controlled water feed;

85 Fig. 5 is a plan, partly in section on the line 5-5 of Fig. 1 illustrating the lower pipe connections;

Fig. 6 is an end elevation of the apparatus of Fig. 1 viewed from the right.

90 Referring to the drawings, 10 designates generally a generator unit of any suitable type, of which there may be one or a plurality, as desired; 11 and 12 are separating
95 and supply tanks for anolyte and catholyte respectively, connected to the generator units in a manner to be explained later; while chambers 13 and 14, for regulating the pressure of oxygen and hydrogen respectively,
100 together with feed water supply chamber 15, constitute a gas washing, pressure regulating, and feed water control system connected to and cooperating with said anolyte and catholyte tanks as will appear herein-
105 after.

The generator unit 10, of which a plurality are employed in the present example, may be of any suitable type. In this instance each unit comprises a plurality of flat substantially rectangular cells held together
110

by suitable means to constitute a unit of the so-called filter press type. One or more such units may be employed; and when a plurality of units are used they may be electrically connected in series by suitable connectors 16, said connectors being advantageously of an expansible loop form, as best seen in Fig. 3. Each generator unit is connected by suitable piping to the anolyte and catholyte tanks 11 and 12 in such manner that anolyte and evolved oxygen are conducted from the anode chambers of the unit to the anolyte separating tank 11, and separated anolyte is returned to said anode chambers; while catholyte and hydrogen are conducted from the cathode chambers of said unit to the catholyte separating tank 12, from which separated catholyte is returned to said cathode chambers; a systematic circulation of the electrolyte being thus maintained in two distinct circuits, with concomitant removal of oxygen and hydrogen separately. In the construction illustrated in the drawings, anolyte and oxygen leave the upper portion of the anode compartments of the cells of each unit through offtakes 17 leading into manifold 18, connected by riser 19 to the anolyte and oxygen header 20 which enters the upper portion or gas space of the anolyte separating tank 11, discharging downwardly therein above the level of the liquid as indicated at 21. The manifold 18 may also be connected to the separating tank 11 by a pipe connection 22, leading horizontally from the manifold 18 to the anolyte tank and entering the latter below the normal level of anolyte contained therein. This connection 22 while found to have some advantages in practice, is not indispensable. A thermometer 23 may be provided in connection 22 for observation of the anolyte temperature. Where a plurality of generator units are employed, the manifolds 18 thereof may be coupled end to end by detachable connections 24 of rubber hose or the like, to form in effect a continuous offtake manifold. Each riser 19 may include a section of glass tubing 25 for observing the electrolyte level and for insulating the manifolds from the riser 20. The connection 22 may similarly include an insulating section 26. The oxygen header 20 may also have a short section 20^a of insulating material. Oxygen going over into the anolyte tank collects in the gas space and is conducted away through pipe 27, while anolyte leaves the lower part of the separating tank through pipe 28 and is returned to the lower side of the anode compartments of the cells by way of return header 29, branches 30, manifolds 31, and intakes 32. Said header 29 desirably includes a section 29^a of insulating material.

The described piping provides a complete system for circulation of anolyte over the

anodes in the anode compartments, with removal of evolved oxygen. The system for circulation of catholyte through the cathode compartments of the cells and removal of evolved hydrogen is similar in all essential respects to that described for anolyte circulation. In the construction here illustrated, the catholyte and hydrogen offtakes (not shown) lead from the cathode compartments into the catholyte and hydrogen manifolds 33 which in this instance are the same size as the anolyte manifolds 18, two manifolds 33 being provided for each unit in order to accommodate the double volume of hydrogen generated as compared to oxygen. A single manifold of larger diameter might obviously replace the two parallel manifolds. Said manifolds 33 are connected by risers 34 to the catholyte and hydrogen header 35, which enters the top of catholyte separating tank 12 and discharges downwardly into the gas space thereof in a manner similar in all respects to the described arrangement of the anolyte header 20. Hydrogen gas separated in the gas space of the catholyte tank passes out through outlet pipe 36. The manifolds 33 of successive generator units may be coupled together at 37 as indicated, and each set of the manifolds may be provided with a direct horizontal connection 38 to the catholyte tank, similar to connection 22 for the anolyte manifolds. Catholyte free from hydrogen is returned from the catholyte separating tank to the cathode compartments of the cells by way of bottom outlet 39, header 40, and manifolds and intakes, not shown, but similar to the corresponding manifolds and intakes 31, 32, for anolyte. The pipes 35, 38 and 40, include insulating sections 35^a, 38^a and 40^a, respectively. By extending the outlet pipes 28 and 39 up into their respective separating tanks 11 and 12 for some distance above the bottoms thereof, as indicated at 28^a and 39^a, an annular sludge-collecting space is provided in each of said tanks around the upward extension of the outlet pipe, while comparatively clear electrolyte is returned to the cells.

The oxygen leaving the gas collecting space of the anolyte tank through pipe 27 is led through a dip pipe 41 and discharged below the level 42 of water contained in the gas washer and pressure regulator 13. After bubbling through the water contained in this chamber, the oxygen is led away through pipe 43 to a gasometer or other place of storage or use. In order to ensure effective washing and cooling of the gas, the chamber 13 is provided with a transversely extending baffle device 44 located below the level of the water, and separating the chamber into upper and lower portions. The dip pipe 41 extends through and projects somewhat below this baffle device, which is fo-

raminous in character and consists preferably of one or more layers of metal wire gauze or screen, the layers either being placed close together or spaced apart. The bubbles of gas are thus broken up in passing upwardly through the baffle device, with the result that they are exposed thoroughly to the wash water. In this way a very complete extraction of any entrained impurities is effected, and the gas will be efficiently cooled.

The baffle device 44 is most desirably composed of a plurality of superposed plies of metallic mesh or screen having their edges consolidated and united by welding or otherwise to a supporting ring 46 which may be secured in any appropriate manner at the desired level in the chambers 13 and 14. For the chamber 13, in which the oxygen gas is handled, the baffle device is preferably made of nickel or Monel metal wire cloth which is not readily oxidized; while for the hydrogen washer 14, iron wire mesh may be used, if desired, in place of nickel or Monel metal.

The construction and operation of the chamber 14 into which hydrogen is led through pipe 36 is similar in all essential respects to the corresponding chamber 13 for oxygen, so that the description above given for the chamber 13 will suffice also for 14. Hydrogen gas, after thorough washing, and cooling in chamber 14 leaves the latter through outlet pipe 45.

The water employed in the chambers 13 and 14 to wash the oxygen and the hydrogen, respectively, free of alkali and also to absorb heat units therefrom, is employed to replenish the supply of electrolyte in the system which is constantly being depleted by electrolytic action in the cells and by evaporation. In this way the feed water or make-up water supplied to the system is preheated and is also made to carry back into the system the entrained caustic soda or caustic potash that would otherwise pass off with the generated gases. Thus, warm wash water passes from the oxygen washing and pressure regulating chamber 13 down through pipes 47 and 48 into the lower part of the anolyte separating chamber 11. In a similar manner wash water passes from the hydrogen washing and pressure regulating chamber 14 through pipes 49 and 50 into the lower part of the catholyte separating tank 12. In order to prevent diffusion of alkali back up into the wash chambers 13 and 14 through the described connecting pipes, each of the pipes 48 and 50 may be provided, where it enters the corresponding separating tank, with a non-return or check valve device indicated generally at 51 in Fig. 1. While this device may assume various forms, one especially desirable construction is illustrated in Fig. 2 where 52

valve chamber 53 having an inlet 54 and an outlet 55 discharging into the anolyte or catholyte separating tank as the case may be. A spherical or other suitably shaped valve member 56 is adapted to engage conical valve seat 57 to control passage of liquid through the valve device. The upper end of the valve chamber 53 may be closed by a threaded plug 58, the interior of the valve chamber and the valve seat being thus rendered readily accessible.

The level of the wash water in the chambers 13 and 14 is maintained at such a point that the column of relatively pure wash water substantially balances the column of electrolyte in the corresponding separating tank 11 or 12. Since the concentration of alkali in the electrolyte and separating tank is much greater than that in the wash water, the height of the balancing column of wash water is necessarily substantially greater than that of the column of electrolyte balanced thereby. Since the amount of electrolyte in the system tends to diminish as the electrolytic action goes on, the electrolyte level in the separating tanks tends to fall, thus reducing the pressure on that side of the valve device 51, permitting valve member 56 to lift and allowing make-up water to pass into the separating tank through the corresponding inlet pipe 48 or 50. When equilibrium has been restored, the valve member 56 seats and shuts off the connection between the separating tank and its corresponding washing and regulating chamber. However, feed of water from the regulating chamber to the separating tank tends to lower the level of the water in the regulating chamber; so that in order to keep this level constant, and thereby also to keep the supply of electrolyte in the generator system constant, provision should be made for automatically supplying water to the washing and pressure regulating chambers as rapidly as is necessary to maintain the liquid levels therein constant. To this end, the present apparatus includes feed water supply chamber 15 before mentioned, into which fresh water from any suitable source of supply may pass through pipe 59 by way of a valve 60 which controls flow from pipe 59 into inlet 61 discharging into the chamber 15. Operation of the valve 60 is controlled by means of a float 62, which is adjustable on lever 63 to close the inlet 61 at any predetermined level of liquid in chamber 15 and to open said inlet whenever the liquid level falls below the predetermined point. The chamber 15 is connected by pipe 64 and oppositely extending branches 65 and 66, including insulating sections 65^a, 66^a with the aforesaid chambers 13 and 14, so that any lowering of the liquid level in either chamber 13, 14, produces a corresponding lowering of level in chamber 15, thereupon caus-

ing the float to open the inlet valve to admit enough water to restore equilibrium. In actual operation the continual drain of liquid from the washing and pressure regulating chambers to replenish the supply in the gas generating system results in more or less constant inflow of fresh water into the chamber 15 and distribution thereof to the chambers 13 and 14 as required.

It will be seen that the described arrangement permits regulation of gas pressure by allowing the gas from the cells to discharge or bubble under a given head of water which may be adjusted to equal a column of water of any desired height. The pressure may be the same for the oxygen discharge as for the hydrogen discharge, or the discharge heads may be different. The connection 65, 66 between the washing and pressure regulating tanks has the effect of an equalizer connection to prevent any change in the respective pressure on the hydrogen and oxygen sides. The rate of discharge or bubbling of the hydrogen being at twice the rate of the oxygen by volume, the cubical capacity of the piping systems including gas holders, etc., beyond the pressure regulating chambers 13, 14, may be double that provided for the oxygen in order to further prevent unbalancing of the pressures of the two gases in the system.

Hand controlled valves 67 may be provided in the feed water connections to the electrolyte separating tanks in case it should be necessary to close off one or the other of the feeds entirely or to throttle either one to any extent requisite to secure proper operation under given conditions.

It has also been found desirable in practice to place in each of the separating tanks 11, 12, a foraminous baffle device or screen 68 similar in character to the baffle device 44 above described. When placed below the level at which the offtake connections from the cells enter the separating tanks in the manner illustrated in Fig. 1, each diaphragm 68 serves to prevent passage of fine gas bubbles with the electrolyte down into the lower part of the separating tank and the return of such fine bubbles to the corresponding cell compartments from which they originally came. The action of the screen is to cause fine gas bubbles to coalesce on its upper side and to form larger bubbles which pass upward into the gas collecting space and thence through the gas outlet to the associated washer device. The gas filtering screens or baffle devices 68 are also useful in catching any solid matter such as iron oxid etc., formed or loosened in the cells and carried over by the gas and electrolyte into the separating tanks, such material being prevented from returning to the cells and clogging up the passages, ducts, etc., therein. Furthermore the material thus collecting on the up-

per side of the screen as a sludge or the like itself serves as an efficient filtering medium. Said screens or baffles also function as means for steadying or damping surges of the electrolyte caused by variations in gas pressure during operation, and violent fluctuations in the hydrostatic head are thus largely prevented. The screens or baffles 68 are most desirably arranged so as to be easily removable from the separating tanks for disposal of excess of sludge or other material collected thereon. To this end, the several plies of metal cloth or gauze, of which the screen device is preferably constructed as already explained in connection with the baffle devices 44, are welded or otherwise marginally secured to a flat ring or flange 69 which can be readily clamped between the flanges 70 of the upper and lower sections into which each separating tank is most desirably divided. By means of this novel arrangement removal of the screen devices 68 for cleansing, repairing, or replacement, is readily effected.

An equalizing connection 71, having an insulating section 71^a may be provided between the lower parts of the separating tanks 11 and 12 to balance the hydrostatic head of the electrolyte columns contained in said tanks.

The risers 19 and 34 are of such diameter as to permit utilization of the gas bubbles passing therethrough to produce a "gas lift" or pumping effect whereby an effective circulation of the electrolyte through the cells of the generator unit or units is maintained. These pipes may also be provided with valves 72 whereby the flow of electrolyte and gas may be controlled and regulated as may be necessary or desirable to secure certain results in the operation of a system comprising a plurality of generator units, or to entirely close the riser pipe when it is desired to disconnect the corresponding unit from the rest of the system. Other valves 73 may also be provided in other parts of the piping wherever desired, as indicated.

In operating at high current densities it is especially desirable to maintain the electrolyte at the highest temperature consistent with practical operation in order to keep the internal resistance of the cells low. It is therefore desirable to conserve in the system, so far as is practicable, the heat units evolved by the electrolytic action in the cells. This is accomplished in part by the described system for using the feed water for washing the hot gases, but it is desirable also to keep down the losses due to radiation and conduction by encasing some or all parts of the system, including the piping, in suitable heat insulation. Insulation of the separating tanks and pressure regulating and washing tanks as indicated in dotted lines at 74 and 75, respectively, is especially

effective in conserving heat units that would otherwise be lost. The piping and other parts of the system including the cell group, may be similarly encased in heat insulation although, in order to avoid complicating the drawings, this is not indicated therein. Effective heat insulation of all parts of the system is also of practical importance where the apparatus is to provide an off-peak load for a central power station, such as a street railway power station, for example. When used in this way, the apparatus may be idle during the peak load period, but should operate for the full off-peak period. Proper insulation aids in keeping the electrolyte up to proper temperature during idle periods and reduces loss of time in heating up the electrolyte after starting. In some cases it is desirable to use heaters H at any convenient point or points in the system to further ensure full utilization of the off-peak period by the electrolyzer. Such heaters may take either direct or alternating current, and may be operated during the on-peak period to keep the electrolyte fully up to its normal temperature, thus enabling an immediate start of the electrolyzer at full efficiency.

The described apparatus should be electrically insulated from ground by suitable means. In this connection the construction shown in the drawings embodies a convenient method of insulating the frame work 76 supporting the separating tanks. The means here shown comprise supporting pipe struts 77 provided with blind couplings 78 of porcelain or other insulating material, such couplings being also provided in the horizontal members of the framework, as shown. Similar supporting pipe struts and insulating blind couplings for other parts of the system are illustrated at 79 and 80 respectively.

The described arrangement effects a further result of considerable practical importance. In the normal operation of an electrolytic cell, there is a tendency for the electrolyte to become stronger or more concentrated in the cathode compartments of the cells, and weaker in the anode compartments. In systems where the circulation of anolyte and catholyte is maintained substantially separate and distinct, the concentrations of anolyte and catholyte may therefore differ considerably, which is undesirable. In the present arrangement, however, this difficulty is overcome, because the piping connections are such that the balancing hydrostatic heads, in conjunction with the automatic feed of make-up water into the system, constantly tend to direct a larger proportion of water into the catholyte than into the anolyte. It will be seen that, by virtue of the cross-connection 65-66, the level of wash water is substantially identical in both the washing tanks 13, 14, and it is

maintained constant by the float-controlled feed valve in tank 15. Any increase in concentration of the catholyte in tank 12 would result in the catholyte standing at a somewhat lower level than the anolyte, because the tanks have the balancing connection 71. Now the consumption of water in the cells depletes the aqueous constituent of the anolyte and catholyte equally, and therefore tends to lower the liquid level in tanks 11 and 12 equally. But the tendency to increased concentration of catholyte and decreased concentration of anolyte disturbs this equal lowering of liquid levels, resulting in an exaggerated lowering of the catholyte level and a diminished lowering of the anolyte level. Since the liquid level is maintained constant and identical in tanks 13 and 14, more wash water therefore tends to flow from tank 14 into tank 12, than from tank 13 into tank 11; and consequently the tendency to different concentrations of anolyte and catholyte is counteracted. It is to be noted, moreover, that the make-up water is introduced into large bodies of anolyte and catholyte and therefore has ample opportunity for thorough mixture therewith, instead of being introduced into the cell compartments.

The described tendency for more make-up water to be fed into the catholyte tank 12 may also be affected and regulated by adjusting the depth at which the gas offtake pipes 27 and 36 discharge below the liquid level in the washers 13 and 14, respectively. Thus, each dip pipe may be provided with a vertically adjustable terminal section indicated at 41^a, as illustrated in the case of the oxygen dip pipe 41 (Fig. 1). By increasing the depth of the hydrogen discharge, the pressure of hydrogen in the separating tank 12 is increased, thus lowering the level of the catholyte in said tank and increasing the tendency for greater flow of make-up water into tank 12. The optimum conditions for distribution of make-up water to the separating tanks may thus be attained by adjustment of one or both of the adjustable dip pipes.

Each of the several generator units may be mounted on a wheeled truck 81 to facilitate moving any unit into or out of its place in the series whenever this is necessary.

What I claim is:

1. In electrolytic apparatus, the combination, with electrolytic cell means and a conduit system for circulation of electrolyte through the latter, of feed water supply means, conduit means whereby water may flow from said supply means into said system, and gas offtake means arranged to conduct gas from said system into and below the level of water contained in said water supply means.

2. In electrolytic apparatus, the combina-

tion, with electrolytic cell means and a conduit system for circulation of electrolyte through the latter, of feed water supply means, conduit means whereby water may flow from said supply means into said system, means opposing diffusion of electrolyte from said system into said water supply means, and gas offtake means arranged to conduct gas from said system into and below the level of water contained in said water supply means.

3. In electrolytic apparatus, the combination, with electrolytic cell means and a conduit system for circulation of electrolyte through the latter, of feed water supply means, conduit means whereby water may flow from said supply means into said system, gas offtake means arranged to conduct gas from said system into and below the level of water contained in said water supply means, and baffle means interposed between the terminus of said gas offtake means and the surface of the water.

4. In electrolytic apparatus, the combination, with electrolytic cell means, of main reservoir means for separating gas from electrolyte, conduit means for leading gas and electrolyte from said cell means and discharging the same into said reservoir means, auxiliary reservoir means adapted to contain feed water and having a feed connection to the main reservoir means, gas offtake means arranged to conduct gas from said main reservoir means and to discharge the same into and below the level of water in said auxiliary reservoir means, a water supply pipe discharging into said auxiliary reservoir means, and valve-mechanism responsive to fluctuations of water level in said auxiliary reservoir means to control discharge of water from said water supply pipe.

5. In electrolytic apparatus of the character described, the combination with electrolytic cell means comprising an anode compartment and a cathode compartment, of an anolyte separating tank in communication with the anode compartment, a catholyte separating tank in communication with the cathode compartment, an auxiliary water tank in communication with each separating tank, means for balancing the hydrostatic heads in the separating tanks, and means for returning electrolyte from the separating tanks to the cell compartments.

6. In electrolytic apparatus of the character described, the combination with electrolytic cell means comprising an anode compartment and a cathode compartment, of an anolyte separating tank in communication with the anode compartment, a catholyte separating tank in communication with the cathode compartment, an auxiliary water tank in communication with each separating tank, means for automatically balancing the

hydrostatic heads in the separating tanks, and means for returning electrolyte from the separating tanks to the cell compartments.

7. In electrolytic apparatus of the character described, the combination with electrolytic cell means comprising an anode compartment and a cathode compartment, of an anolyte separating tank in communication with the anode compartment, a catholyte separating tank in communication with the cathode compartment, an auxiliary water tank in communication with each separating tank, a feed water supply tank in communication with the auxiliary tanks, means for admitting water to the supply tank, means for balancing the hydrostatic heads in the separating tanks, and means for returning electrolyte from the separating tanks to the cell compartments.

8. In electrolytic apparatus, the combination, with a plurality of cells each comprising an anode compartment, a cathode compartment, an anolyte and oxygen offtake, a catholyte and hydrogen offtake, and separate intakes for anolyte and catholyte, respectively, of an anolyte separating tank, a catholyte separating tank, and pipes connecting said tanks, respectively, with the corresponding offtakes and intakes of the cells, a pair of auxiliary tanks, one cooperating with each separating tank, each auxiliary tank adapted to contain water of which the level is higher than the liquid level in its cooperating separating tank, a gas offtake leading from each separating tank and discharging into its cooperating auxiliary tank below the water level therein, a pipe for conducting feed water from each auxiliary tank into its cooperating separating tank, a water supply tank having pipe connections supplying water to both auxiliary tanks, a water supply pipe discharging into said water supply tank, and adjustable float-controlled means for regulating discharge of water thereinto in accordance with the liquid level therein.

9. In electrolytic apparatus for production of hydrogen and oxygen, the combination, with a plurality of cells assembled in a unitary structure, of an anolyte and oxygen separating chamber, a catholyte and hydrogen separating chamber, piping for conducting electrolyte and gas from each of said cells to the proper corresponding separating chamber and for returning electrolyte from said chambers to the cells, said piping and chambers constituting an electrolyte-circulating system, washer means for washing the gases separated in said separating chambers, and means for conducting wash liquid from said washer means into said circulating system.

10. In electrolytic apparatus for the production of hydrogen and oxygen, the com-

5 bination, with cell means, of gas and electrolyte separating chambers, and piping connections for leading gases and electrolyte from said cell means into said separating chambers and for returning electrolyte therefrom to said cell means, of separate washers, one for each separating chamber, a gas conduit leading from each separating chamber into the corresponding washer and dipping below the normal liquid level therein, means operative to maintain said liquid level substantially constant in said washers, and means for conducting wash liquid from said washers into said separating chambers.

10 11. Apparatus as set forth in claim 10, in which the depth at which at least one of the said gas conduits dips below the liquid level in its corresponding washer is adjustable.

15 12. In electrolytic apparatus, the combination with cell means comprising anode and cathode compartments, of separating chambers into which anolyte and catholyte, together with generated gases are discharged and from which electrolyte is returned to said cell means, and make-up water supply means adapted and arranged automatically to deliver a greater proportion of make-up water to the catholyte than to the anolyte at a location outside said compartments.

20 13. Electrolytic apparatus comprising, electrolytic cell means, main reservoir means for separating gas from electrolyte, said reservoir being normally partially filled with electrolyte the gas collecting above the electrolyte, conduit means for conveying gas

and electrolyte from the cell means to the reservoir, means for returning substantially gas-free electrolyte to the cell means, auxiliary reservoir means adapted to contain feed water and having a feed connection with the main reservoir, said connection being below the level of the electrolyte in the main reservoir, and valve mechanism for preventing the passage of electrolyte from the main to the auxiliary reservoir.

45 14. Electrolytic apparatus comprising, electrolytic cell means, main reservoir means for separating gas from electrolyte, said reservoir being normally partially filled with electrolyte the gas collecting above the electrolyte, conduit means for conveying gas and electrolyte from the cell means to the reservoir, means for returning substantially gas-free electrolyte to the cell means, auxiliary reservoir means adapted to contain feed water and having a feed connection with the main reservoir, said connection being below the level of the electrolyte in the main reservoir a water supply pipe discharging into the auxiliary reservoir, and valve mechanism responsive to fluctuations of water level in said reservoir to control the discharge of water from said supply pipe, and valve mechanism for preventing the passage of electrolyte from the main to the auxiliary reservoir.

60 65 In testimony whereof I hereunto affix my signature.

WILLIAM G. ALLAN.