Oct. 23, 1923. 1,471,641

C. F. ADAMS

ELECTROLYTIC GAS CELL

Filed March 9, 1922 2 Sheets-Sheet 1

FIG. 1.

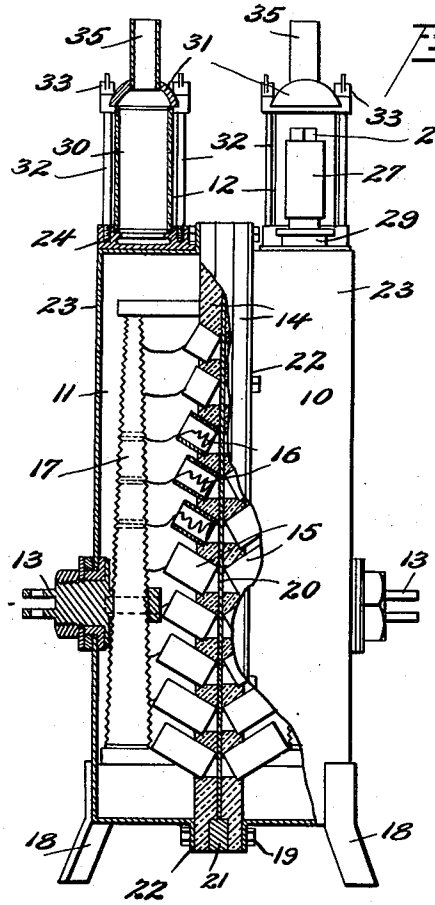
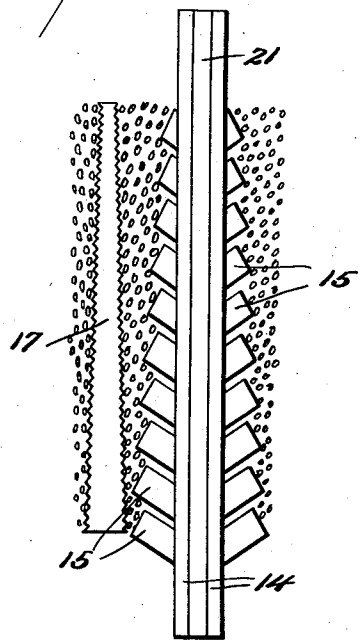


FIG. 5.



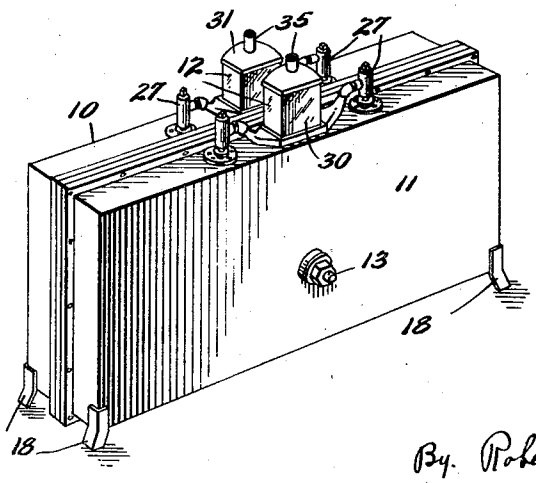


FIG. 4.

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FIG. 2.

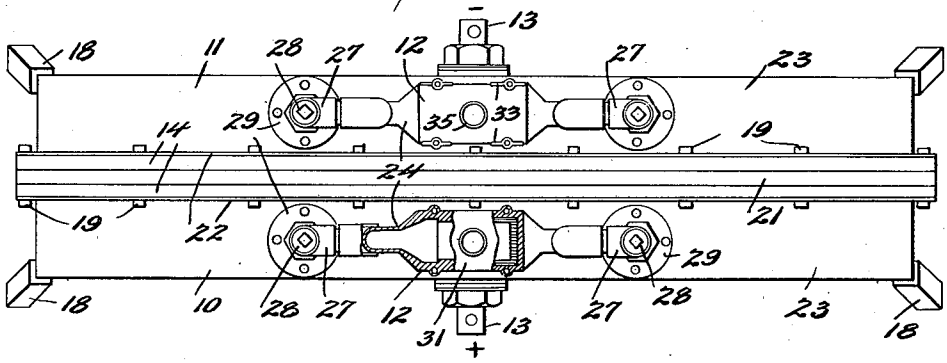
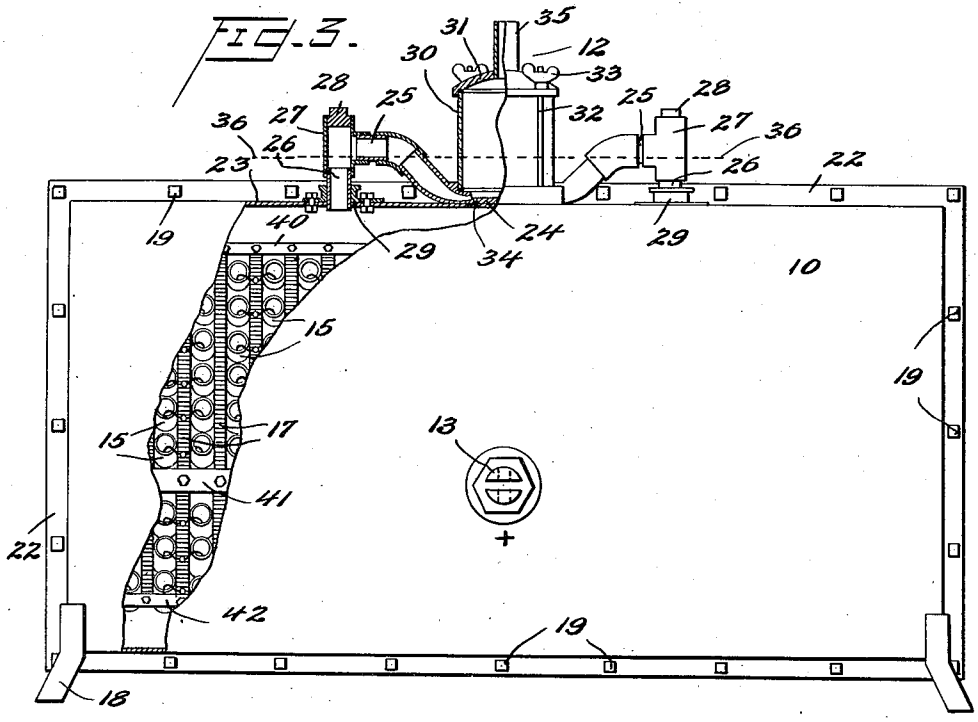


FIG. 3.



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UNITED STATES PATENT OFFICE.

CLARENCE F. ADAMS, OF DAYTON, OHIO.

ELECTROLYTIC GAS CELL.

Application filed March 9, 1922. Serial No. 542,348.

To all whom it may concern:

Be it known that I, CLARENCE F. ADAMS, a citizen of the United States, residing at Dayton, in the county of Montgomery and State of Ohio, have invented certain new and useful Improvements in Electrolytic Gas Cells, of which the following is a specification.

My invention relates to improvements in electrolytic gas cells, where a solution is broken up into its component parts and certain parts in the form of gases liberated on metallic collectors and conducted separately or collectively to a suitable storage reservoir and wherein electricity is the chief agent employed in this operation; and the objects of my improvements are, first to produce a cell of light weight construction and of minimum size for economy of space and for portability; second, to give a greater efficiency in production by lowering the resistance to the passage of current through the solution and the resistance to the release of gas from the metallic collectors; third, to overcome difficulties in the way of internal insulation to the leakage of electricity; and fourth, to provide an automatic back pressure equalizer that will also serve as an indicator in quickly giving some idea of comparative volumes of gas being generated by each compartment. The form and type of this indicator is likewise included within the scope of the invention.

I attain the objects above enumerated by the devices illustrated in the accompanying drawings which constitute a part of this specification and in which Figure 1 is an end view of the assembly showing an exposed end view of the interior of the left side; Figure 2 is a top view of the assembly; Figure 3 is a side view of the assembly showing an exposed side view of a part of the interior construction; and Figure 4 is a perspective view of a complete cell; and Figure 5 is a sectional view through the diaphragm with parts of the adjoining boards broken away.

A considerable portion of the electrical energy required for the operation of an electrolytic cell is dissipated in the form of heat due to two principal causes; first, ohmic resistance of the elements and the electrolyte through which the current passes; and second, resistance due to a polarization of the elements. In overcoming the resistances due to the two above mentioned factors, energy is expended in the form of heat, but it is true that a part of this heat energy is utilized for a useful purpose, principally in aiding the chemical association and dissociation that takes place in the electrolyte. This is only carried, however, to a certain point and beyond that point the heat energy generated is wasted and lost as far as the efficiency of the operation of the cell is concerned.

Working on the theory that the polarization of the elements is due principally to the surface tension of the gas bubbles formed on the face of the elements and that this tension increases with the size of the bubble from the time of its inception until the time of its actual release from the element, it was decided to construct a form of element that would give sufficient surface for collecting ions from the solution but present a small surface for adhesion as the ions grew into bubbles thereby releasing the bubbles before any considerable size could be attained and likewise after the bubbles had been released, provide a clear path through the solution to the upper surface of the electrolyte. This problem was viewed from many angles and finally after a number of attempts had been made resulting in various degrees of success and failure, the form and combination illustrated in this specification was adopted.

The cell is built in two principal parts, 10 and 11, Figure 1. Each part consists of a back pressure regulator and indicator 12, an electrical terminal 13, a transite wood board 14, transite wood tubes 15, wire coils 16, grid bars 17 and legs 18. The last detail of assembly consists of putting the two parts together with bolts 19 as shown in Figure 1, but more distinctly defined as in Fig. 2. Just before this assembly is made, however, an asbestos diaphragm 20 and a rubber gasket 21 (see Fig. 1) are placed in position as shown. The bolts 19 are then run through the holes traversing the outer border of the transite boards, through the diaphragm 20, the packing 21 and the flanges 22 of the sheet metal shells 23 composing the outer casing. The bolts are then drawn up with nuts which are held in place by lock washers.

In Figure 3 is shown a more detailed view of the back pressure regulator and indicator. The lower casting 24 thereof carries integral with itself two nipples and two 45° elbows which have attached to the opposite

ends, the combination consisting of nipples 25 and 26, T's 27 and plugs 28. Two holes are provided in the sheet metal shell 23 for the accommodations of the nipples 26 as shown and a non-leakable but flexible joint is made between the nipple and shell by the packing combination 29. A cubical glass dome 30 is placed between castings 24 and 31. Rectangular rubber gaskets are placed at the top and bottom ends of the globe. The globe with upper and lower castings is then clamped together by means of studs 32 and wing nuts 33. The casting 24 is secured to the sheet metal shell 23 by means of machine screws 34 as shown. In the upper casting 31 is fitted a nipple 35.

The functioning of the back pressure regulator and indicator is substantially as follows: Water is first introduced through nipple 35 until the level indicated by line 36 is reached. Any further water introduced would simply overflow through the pipe combination into the cell. The water thus introduced and retained in the combination including the dome 30 is to act as a seal for the gas coming from that part of the cell to which it is attached. Gas is conveyed from the cell through the pipe combinations on both sides of the dome and through the water seal up into the dome from which it is then released through nipple 35 to any suitable conveying system leading to storage or otherwise. Gas invariably carries some moisture as it is conveyed from the cell. This moisture would tend to increase the water level in the pipe and dome combination but this cannot occur for the reason that any surplus created above the line 36 is caused to fall back by virtue of its own weight into the cell from whence it came and where it should remain. This arrangement, therefore, automatically provides against any increase in the depth of the water seal and consequently any increase in the back pressure on the cell due to the action of this seal. Evaporation of the water contained in the dome and pipe combination is more than compensated for by moisture carried over with the gas and consequently the level of the water seal remains at the same point under all conditions and exerts a constant value in back pressure at all times. Water may be introduced to the cell as needed by removing either one or both of the plugs 28, or by removing either one or both of these plugs, permanent connections may be made from T's 27 to an overhead water system through a nipple, hose and regulating valve (not shown), the rubber hose interposed for electrical insulation purposes and the valve for the purpose of regulating the flow of water as needed. By using a glass dome in this combination here referred to as a part of the back pressure regulator and indicator, a means is provided for inspecting at a glance the size and quantity of the gas bubbles as they pass through the water seal into the globe. The size and quantity of the gas bubbles is a visual indicator of the internal working conditions of the cell at all times. The size and capacity of this dome and pipe combination is the same on each side of the cell and the gases coming through each combination is subjected to the same back pressure from the water seals, making a balance of pressure internally of the gases generated on both sides.

In operation direct current electricity is used in connection with two metallic elements immersed in the solution and between the elements is placed an asbestos diaphragm to keep the gases formed on each of the elements separated. As was stated before, the cell that represents the subject-matter of this invention, is divided into two principal parts and each part contains separately its own element combination.

The electrode elements in this cell constitute one of the chief novel features of the invention and their construction is substantially as follows: Each electrode element is made up of one transite board, a number of transite tubes, a number of coils of wire, a metallic grid and an electrical terminal. In the place of using transite board, vulcanized rubber of the proper consistency or any other substance possessing fairly good electrical resisting qualities together with chemical resisting qualities can be used. The transite tubes can also be replaced with glass tubes or tubes of other material that posesses good electrical and chemical resisiting qualities. On the inner face of each transite board are inserted a number of transite tubes varying in length from top to bottom, the shortest tubes being at the top and the longest tubes at the bottom as illustrated in Figs. 1 and 5. Each tube carries a coil made into the form of a conical spring with its base at the bottom of each tube. The apex end of each of these wire cones is extended in a straight piece protruding some distance out of the free end of each tube and connects to the grid assembly which is placed in front of the board and tubes as shown in Fig. 1. The grid assembly is made up of taper bars that set in a vertical position in front of the board and tubes. There is an interval between each grid bar as shown in Fig. 3 and these bars are held in place by cross tie bars 40, 41 and 42, Fig. 3. To cross bar 41 is attached the electrical terminal 13. Each grid bar 17 tapers from its base to its top on two of its opposite sides as shown in Fig. 1. These tapered surfaces are saw toothed as is also shown in Fig. 1. The grid assembly is attached to the board by means of studs projecting out

from and at right angles to the board holding the grid parallel to the board throughout as shown in Fig. 1. Each tube inserted in the board is at an angle to the board, pointing upward. The holes that are drilled in the board 14 to accommodate the tubes are drilled just far enough to leave a thin wall at the bottom of each hole and then a hole somewhat smaller in diameter is drilled through from the opposite side of the board but at right angles thereto. This allows a wedge shape shoulder for the bottom of each tube to rest against.

The operation of the cell is substantially as follows: After the cell has been assembled as shown in the accompanying drawings, an ionized solution, we will say for example, sodium hydrate, is introduced to the two parts of the cell 10 and 11 to a level just covering the upper parts of the grids. The solution must be introduced to the two parts simultaneously to keep a static balance on both sides of the asbestos diaphragm 20, to prevent any possible rupture in the diaphragm. Circulation of the electrolyte from one part of the cell to the other can only take place through the tubes 15 and the asbestos diaphragm. After the electrolyte has been introduced and water placed in the back pressure regulator and indicator, a source of direct current electricity is connected to the terminals 13. As the terminals themselves and all the internal conducting parts of the cell are insulated from the two sheet metal shells 23 of the casing, the current has but one path to follow and that is through the terminals, the grids, the coils, the asbestos curtain, and the space on each side of the curtain between the curtain and the bottom of each tube. The positive ions (assuming that the ionic theory is correct) collect on the coils and grids of the negative element combination and the negative ions collect on the coils and grids of the positive element combination. Hydrogen gas results on the negative side and oxygen gas on the positive in the proportion of H_2O. The two gases are kept from mixing inside the cell by the asbestos curtain which is firmly clamped between the two boards 14 of the element combinations. Gas is released from the coils in small bubbles but from the tubes in various sizes as a result of the accumulation of the smaller bubbles before release from the tubes. The surface tension of the larger bubbles thus formed do not appear to affect the polarization resistance of the coils even though they touch the coils in their release from the tubes. Owing to the arrangement of the tubes varying in length from the top to the bottom of the cell as illustrated in Figures 1 and 4, gas released from any particular tube has a clear path upward, thus avoiding a back pressure due to released bubbles striking other bubbles still in a state of formation on the elements. Only about one third of the gas, however, is released from the tubes, approximately two thirds of the total amount being released from the grid bars. The grid bars being tapered upward and having two opposite surfaces saw toothed as shown in Fig. 1, release the gas in very small bubbles and give each bubble of gas so released a chance to travel upward without interfering to any considerable extent with bubbles above still in the state of formation, thus making this arrangement similar to that of the tubes. The coils in the tubes are constructed of the same size wire throughout each element combination but these coils vary in the length of the wire used, the variation depending upon the length of tube in which any particular coil is placed.

The electrode element construction throughout including the gird bars, as can be seen in Fig. 1, provides a tapering cross sectional area from base to top and since the terminals are connected below the center of the grids, the point of greatest intensity of the decomposing current is therefore through the bottom coils and the lower part of the grid bars, this intensity diminishing at any point upward either in the coils or on the grid bars. This provision causes the internal heat generated due to internal resistance to likewise vary in intensity upward, diminishing as the intensity of the current. This effect not only materially aids in the release of the gas bubbles from the element combinations but aids the rise of the bubbles through the electrolyte after they have been released. The gas accumulated above the upper surface of the electrolyte being subjected to the same back pressure on each side of the cell due to the action of the back pressure regulators, brings very little stress to bear on the asbestos diaphragm in keeping the two gases separated.

With the arrangement as herein described, the asbestos diaphragm clamped as it is between two substantial boards and exposed to stress only at the holes connecting the opposite tubes, is in a position to withstand a far greater strain than with any arrangement heretofore used in electrolytic cells and should the diaphragm break down at any particular hole the leak may be simply remedied by plugging that hole and dispensing with the coil unit in that part of the electrode element.

I claim:

1. In an electrolytic cell for the manufacture of gases, the combination with a casing consisting of two parts detachably secured together, of an electrode element in each of said parts, and a diaphragm permeable to the electrolyte mounted between the two parts of said casing.

2. In an electrolytic cell for the manufac-

ture of gases, the combination with a casing consisting of two parts detachably secured together, of an electrode element in each of said parts including spaced grid bars and a plurality of coils of wire connected to said grids, and a diaphragm permeable to the electrolyte mounted between the two parts of said casing.

3. In an electrolytic cell for the manufacture of gases, the combination of electrode elements each consisting of grid bars and a plurality of coils of wire connected to said bars, corresponding coils of opposing electrodes being placed in proximity, and a diaphragm permeable to the electrolyte interposed between said coils.

4. In an electrolytic cell for the manufacture of gases, electrode elements, each consisting of grid bars and a plurality of coils of wire arranged so as to minimize resistance due to polarization.

5. In an electrolytic cell for the manufacture of gases, electrode elements, each consisting of grid bars and a plurality of coils of wire so arranged that gas bubbles released therefrom have a clear path upward through the electrolyte.

6. In an electrolytic cell for the manufacture of gases, electrode elements, each consisting of grid bars and a plurality of coils of wires of different lengths connected thereto.

7. In an electrolytic cell for the manufacture of gases, an electrode element, consisting of grid bars and a plurality of coils of wire of different lengths, the latter being graduated from the top to the bottom of the cell in accordance with the length thereof.

8. In an electrolytic cell for the manufacture of gases, an electrode element consisting of grid bars of tapering cross sectional area, and a plurality of coils of wire connected thereto, and an electric terminal connected to said grid bars below the center thereof.

9. In an electrolytic cell for the manufacture of gases, the combination with a casing consisting of two parts detachably connected together, of an electrode element in each of said parts, a diaphragm permeable to the electrolyte mounted between the two parts of said casing, and a back pressure regulator having a constant level liquid seal associated with each of said parts.

In testimony whereof I affix my signature.

CLARENCE F. ADAMS.