O. H. JEWELL.

ELECTROLYTIC CELL.

APPLICATION FILED MAR. 4, 1920.

1,357,400. Patented Nov. 2, 1920.

Fig. 1.

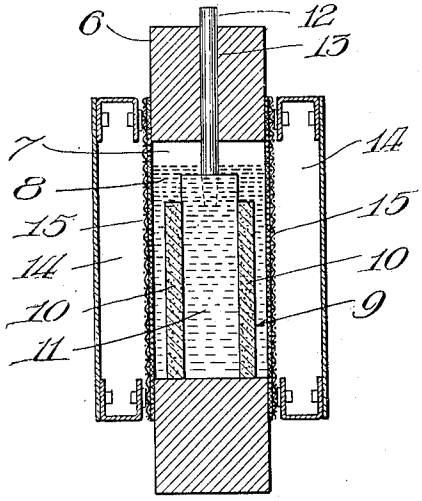


Fig. 2.

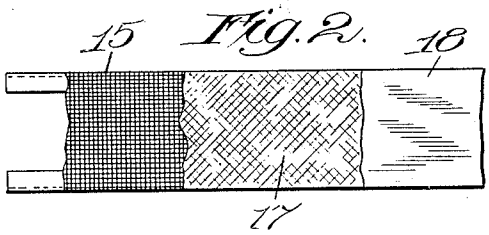


Fig. 3.

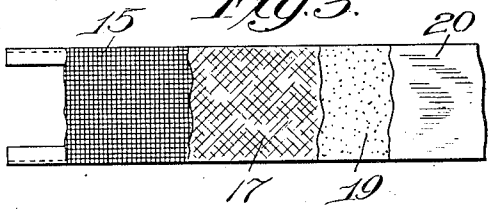
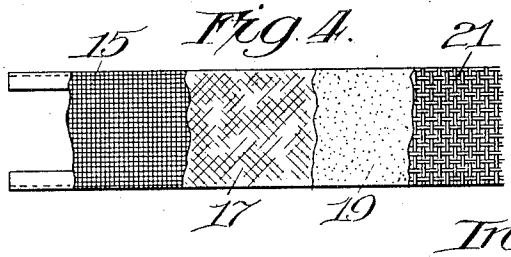


Fig. 4.



Inventor:
Omar H. Jewell
by Dyrenforth, Lee, Chritton and Wiles
Attys

UNITED STATES PATENT OFFICE.

OMAR H. JEWELL, OF CHICAGO, ILLINOIS, ASSIGNOR TO CHLORINE PRODUCTS COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

ELECTROLYTIC CELL.

1,357,400. Specification of Letters Patent. Patented Nov. 2, 1920.

Application filed March 4, 1920. Serial No. 363,268.

To all whom it may concern:

Be it known that I, OMAR H. JEWELL, a citizen of the United States, residing at 1728 Kenilworth avenue, Chicago, in the county of Cook and State of Illinois, have invented a new and useful Improvement in Electrolytic Cells, of which the following is a specification.

My invention relates more particularly to electrolytic cells employed for the production of caustic soda and chlorin from salt brine by the electrolytic action produced by electric current, such cells in accordance with common practice being formed with porous walls, or diaphragms, through which the liquid being subjected to the electrolytic action percolates; and my primary objects, generally stated, are to provide for the production of a more durable and efficient construction of cathode-diaphragm to the end that the renewals of the diaphragms shall be required less frequently, the efficiency of the cells augmented and the cost of operating the same materially reduced.

The best practice, according to methods and apparatus heretofore employed, is to use one or more layers of asbestos paper usually about .025 inch in thickness which overlies the perforated metal portion of the cathode and which is either wire fabric or plates with openings provided therein. Such construction, however, presents great disadvantages in practice, the paper becoming rapidly affected by the caustic alkali and chlorin which destroys the bonding material of the paper bonding the asbestos fibers together, with the result that the paper soon becomes reduced to a pulpy mass, which not only retards the outflow of caustic liquor from the cell, but results oftentimes in the gradual working of the paper through the interstices of the perforated metal backing, the paper oftentimes tearing to such an extent as to render it inoperative at such impaired portions, such conditions rendering vary uncertain the length of time a cell will remain in normal operating condition, and such impairment oftentimes occurring within the relatively brief length of time of 24 hours or so, after the cell has begun operation. It will be apparent that such conditions require the maintaining of several extra cells for replacement purposes, in order that the system used be out of commission the minimum length of time, the employment of extra labor for rehabilitating the impaired cells as well as the incurring of relatively large expense for frequent asbestos replacements, and generally the increase of cost for labor in the maintaining and operating of a plant.

It may be further stated that in the operation of an electrolytic cell an erosive effect is produced on the asbestos paper in accordance with prior practices, probably due to the agitation of the salt brine by the evolution of chlorin gas, this erosive action oftentimes resulting in the separation from the body of the paper of those portions of the paper which have become reduced to pulpy condition, which separated portions are carried up with the chlorin gas to the top of the cells, causing the porous diaphragms to be less resistant to the percolation of the liquid therethrough at these portions thereof, thereby resulting in non-uniform filtration and the formation at the impaired portions of the diaphragms of chlorin compounds intermediate of pure chlorin and sodium chlorid, such for example as chlorites and chlorates, and hereinafter referred to as chlorin intermediates, which is very objectionable and reduces the efficiency of the cell as well as the life of the anodes and the metal of the cathodes.

Furthermore, in cells employing asbestos cloth or paper alone in the usual manner, chlorin filters through the diaphragm portion and chemically unites with the sodium hydroxid in close proximity to the metal of the cathode, producing chlorin intermediates which attack the metal of the cathode, decomposing the latter, oftentimes very rapidly and in spots where the flow of brine cathodewise is the strongest, thus impairing the cathode. Furthermore, under such conditions, puncturing of the diaphragm frequently results, rendering the cells inoperative. Again, the conditions are such that chlorin intermediates often occur in the anolyte, which is an objection as their presence rapidly oxidizes, and thus destroys, the anodes which are usually of graphite and relatively expensive. In the case of asbestos-diaphragm cells referred to, the chlorin intermediates have little or no effect on asbestos, and thus these extraneous foreign compounds passing through the diaphragms disintegrate the metal of the cathodes and charge the caustic cell liquor with impuri-

ties which are objectionable. One of the reasons for this condition being objectionable is that the tubes employed in the evaporation of the cell liquor outflow, and which are usually made of soft charcoal iron and are readily attacked by such impurities, are damaged and cause the evaporated caustic liquor to contain metallic compounds produced by the reaction of the cell liquor on the metal of the evaporators, which causes the cell liquor to present an objectionable blue or purple color and is otherwise objectionable.

Furthermore, the brine usually contains some impurities such as calcium and magnesia, even if previously treated for purification, which are precipitated by the sodium hydroxid as hydrates, these tending to build up on the cathode side of the diaphragm and clog it, the use of material as heretofore commonly provided for diaphragms being such that this clogging occurs relatively quickly, the cathodes often becoming coated with a heavy white scaly deposit after the cells have been in operation for a short time, with the result of reducing the cell efficiency.

Again in the case of the cells employing asbestos paper or cloth, the sodium-hydroxid produced for the first two or three weeks after starting the operation of a cell with new diaphragm material is usually of such low per cent. that it is not commercially practical to recover the sodium hydroxid therefrom, it being customary to dispose of the hydroxid produced during such period, as waste.

My objects, generally stated, are to overcome the objections presented by cells as hitherto provided and provide a diaphragm which shall operate with maximum efficiency, be of relatively long life, capable of being produced at minimum cost, result in the production of the maximum quantity of sodium hydroxid from the brine treated, where this is one of the products produced by the material being operated on, and minimize impairment of the other parts of the apparatus with which the cell is used.

Referring to the accompanying drawing:—

Figure 1 is a sectional view, with certain parts omitted, of an electrolytic cell, the general arrangement of the parts of which corresponds with a type of cell in common use, the structure being shown as formed of two cathode elements, the diaphragms, or porous partitions of which, and through which the liquid being treated to the electrolytic action percolates, being shown as embodying my invention. Fig. 2 is a fragmentary face view of the diaphragm of Fig. 1, with parts broken away to disclose the construction of the same, this construction constituting one embodiment of my invention. Fig. 3 is a view like Fig. 2 showing another embodiment of my invention; and Fig. 4, a view like Fig. 2 showing still another embodiment of my invention.

My invention relates to the constructing of porous cathode-diaphragms in general, regardless of the particular construction or arrangement of the elements of the electrolytic cell, but for the purpose of illustration I have chosen to represent a common type of cell, such being represented in Fig. 1 and as shown involving a wall-structure 6, as for example of concrete, containing an opening 7 therein into which the liquid to be acted on by the electric current to effect electrolytic action, is introduced, the liquid being represented at 8. The opening 7 contains the anode element 9 formed of the plates 10 extending side by side and secured to uprights 11 connected with the lower ends of rods 12, one only of which is shown, which extend into openings, one of which is shown at 13, in the upper portion of the wall 6. The cathode elements, two of which are provided in the particular arrangement shown, are represented at 14, these elements being shown as of hollow construction with perforated side-walls 15, provided with porous diaphragms, at which the elements 14 extend across the ends of the openings 7, means (not shown) being provided for conducting out of the cathodes 14, the liquid percolating through the diaphragms and side-walls 15 from the liquid-containing space 7.

In accordance with the showing in Fig. 2 the diaphragm referred to is formed of a layer 17 of any suitable organic substance of such character that caustic alkali of a concentration occurring in electrolytic cells will not rapidly decompose it, as for example cotton, preferably provided in the form of a fabric, linen, jute or wood-pulp, the latter preferably provided as paper sheets. The diaphragm layer 17 of this construction (Fig. 2) has a layer 18 of Portland cement applied to its outer face, the diaphragm extending across the perforated member 15 of current-conducting material of a character not affected by the cathode liquid. The perforated member 15 may be of any suitable material for performing the function of a cathode as, for example, steel, nickel, Monel metal, or nickel-plated copper; and it may be of any desired form as, for example of wire mesh, as illustrated, or a plate containing apertures. The portions 15, 17 and 18 would extend entirely across the open side of the cathode and the opening 7 which the cathode opposes. The Portland cement is applied to the layer 17 in the form of a fluid solution of about the same consistency as relatively thick paint, this coating of cement being preferably applied in three superposed layers applied in

succession, each layer being permitted to become partially set before the next layer is applied, it being preferred that each layer be made somewhat more dense than the preceding one and the second and third layers graduated in thickness from the top to the bottom of the coating, being thicker at the bottom, the combined thickness of the layers of cement coating being by preference, about .05 of an inch thick at the top.

The cement coating by preference permeates the layer 17 and forms a relatively hard, yet somewhat flexible, diaphragm which is not subject to disintegration by erosion and will remain in operative condition to properly perform its function, for a relatively great length of time. The material of the layer 17 is very slowly affected by the caustic alkali contacting therewith and by employing the cement coating the material of the layer 17 is protected against access thereto of the chlorin gas in suspension evolved in the cell by the electrolytic action, and which if it did contact with the layer 17 would cause it to rapidly disintegrate.

In the construction shown in Fig. 3 the porous diaphragm is constructed of the layer 17 as in the case of the construction shown in Fig. 2, but instead of coating the layer 17 with the cement layer 18, a coating of asbestos paper 19 is applied to the outer surface of the layer 17 and a thin coating of relatively thin Portland cement, represented at 20 is applied to the outer surface of the paper 19. In this particular construction the porous barrier between the layer 17 and the chlorin gas evolved by the action of the cell, is presented by the paper 19 and cement coating 20, the coating 20 also serving to portect the paper against any action of erosion in the operation of the cell which would disintegrate the paper and produce the objections above pointed out. Furthermore the layer 17 in the construction shown in Fig. 3 operates to prevent the paper from working through the perforations in the member 15, retaining the paper in place, even after the paper has become a mass of soft pulp. The formation of chlorin intermediates in the paper layer 19 tends in time to destroy the layer 17, but this action is comparatively slow and may be largely controlled by limiting the outflow of the cathode liquor, or increasing the current density to a point where only alkali is contained within the layer 17, the formation of chlorin intermediates being proportioned to the amount of chlorin permeating the asbestos paper overlying the layer 17.

The construction illustrated in Fig. 4 is the same as that shown in Fig. 3, except that instead of employing the cement coating 20, the outer face of the paper 19 is covered with asbestos cloth represented at 21. This construction affords the advantages as above explained in connection with the layer 17, and the provision of the asbestos cloth 21 serves as a means of protecting the asbestos paper against the erosive action due to the evolving of the chlorin gas in the operation of the cell, and prevents displacement of the paper in the event of its becoming of pulpy condition.

The purpose of providing the cement coating according to Fig. 2 of graduated thickness as explained, is to cause the percolation of the liquid through the vertical diaphragm to be substantially uniform throughout the area of the latter.

It may be further stated that a diaphragm for this purpose to be perfect must be one which is not appreciably reacted upon by the products of the electrolysis at the cathode, does not become rapidly clogged and therefore does not rapidly reduce the outflow of the liquid, and offers the minimum resistance to the electric current, results which are substantially attained in a diaphragm constructed in accordance with my invention, and especially when provided according to Fig. 2.

By constructing a diaphragm in accordance with my invention, employing an organic substance as stated, and especially cotton, and providing a protection covering therefor at the anode side of any desirable material to protect the organic substance from the action of the chlorin, the chlorin either free or as chlorin intermediates, is prevented from reaching the cathode, thereby avoiding the corroding and impairment of the same, and these foreign substances will not occur to any appreciable extent in the anolyte and thus impairment of the anodes from this cause is prevented. The organic substance, by reason of its absorbent property, becomes readily saturated with the caustic brine to substantially the outer surface of the layer of the organic substance, and by reason of this body of caustic brine held in suspension in this substance, chlorin which might pass through the protective covering referred to for the organic substance, is neutralized at points remote from the metal cathode and thereby prevented from attacking the cathode.

Applicant has found in the use of an organic substance for the diaphragm that the metal of the cathode is not eaten away and the cell liquor is substantially free of chlorin intermediates, and this is probably accounted for in part by the fact that chlorin intermediates will attack organic substances, such as cotton, the organic substance becoming oxidized and thereby changing the chlorin intermediates into salts which will not attack metal. In this connection it may be stated that it is far better that the organic substance, which is relatively inexpensive, be reacted upon than have the

metal of the cathode and the evaporator tubes eaten away, these tubes being usually made of soft charcoal iron and readily attackable by the chlorin intermediates usually found in cell liquors as hitherto produced and not present in appreciable quantities in the cell liquor of cells employing a diaphragm in accordance with the present invention.

Furthermore the brine contains some impurities such as calcium and magnesia even when previously treated for purification, which are precipitated by the sodium hydroxid as hydrates. These tend to build up on the cathode side of the diaphragm and clog it. By employing an organic substance as the diaphragm material, it may be used as a relatively thick layer and when so employed, the deposition of the impurities referred to takes place within the diaphragm and remote from the cathode, the organic substance serving to filter out these impurities, but by reason of its relatively porous condition preventing rapid clogging thereof. The result is that these impurities are prevented from becoming plated on the cathode and it therefore remains clean and in the most desirable condition for effective operation as distinguished from becoming coated with a heavy white scaly deposit which reduces the cell efficiency and occurs where the cathodes are not protected from these impurities.

A cell having a diaphragm comprising an organic substance enables it to produce practically pure strong caustic from the beginning of the operation of the cells, the caustic produced being from 4% to 5% caustic liquor from the beginning of the operation of the cells and the liquor being substantially free of alumina, iron, lime, magnesia, silicates, or other impurities which require special treatment to remove. Furthermore the diaphragm material is inexpensive and readily replaceable and the metal of the cathode is unimpaired.

While I have illustrated and described particular constructions embodying my invention, I do not wish to be understood as intending to limit it thereto, as the same may be variously modified and altered without departing from the spirit of my invention.

What I claim as new and desire to secure by Letters Patent is:

1. A cathode of an electrolytic cell having a member of current-conducting material with a diaphragm portion comprising an organic substance of such character that caustic alkali of a concentration occurring in electrolytic cells will not rapidly decompose it, and porous material extending over the exposed face of said substance for protecting the latter from the anolyte.

2. A cathode for an electrolytic cell having a member of current-conducting material with a diaphragm portion comprising an organic substance of such character that caustic alkali of a concentration occurring in electrolytic cells will not rapidly decompose it, and porous asbestos material extending over the exposed face of said substance and protecting the latter from the anolyte.

3. A cathode for an electrolytic cell having a member of current-conducting material with a diaphragm portion comprising an organic substance of such character that caustic alkali of a concentration occurring in electrolytic cells will not rapidly decompose it, and Portland cement extending over the exposed face of said substance.

4. A cathode for an electrolytic cell having a member of current-conducting material with a diaphragm portion comprising an organic substance of such character that caustic alkali of a concentration occurring in electrolytic cells will not rapidly decompose it, and asbestos material extending over the exposed face of said substance and coated with Portland cement and protecting the organic substance from the anolyte.

5. A cathode for an electrolytic cell having a member of current-conducting material with a diaphragm portion comprising an organic substance of such character that caustic alkali of a concentration occurring in electrolytic cells will not rapidly decompose it, a sheet of asbestos paper applied to said substance, and a sheet of asbestos fabric applied to said paper, said asbestos paper and asbestos fabric protecting said organic substance from the anolyte.

6. A cathode for an electrolytic cell having a member of current-conducting material with a diaphragm portion comprising a layer of cotton, and a porous material extending from the exposed face of said layer and protecting the latter from the anolyte.

7. A cathode for an electrolytic cell having a member of current-conducting material with a diaphragm portion comprising a sheet of cotton fabric, and a porous material extending over the exposed face of said fabric and protecting the latter from the anolyte.

8. A cathode for an electrolytic cell having a member of current-conducting material with a diaphragm portion comprising a layer of cotton, a porous asbestos material extending over the exposed face of said layer and protecting the latter from the anolyte.

9. A cathode for an electrolytic cell having a member of current-conducting material, with a diaphragm portion comprising a sheet of cotton fabric, and porous asbestos material extending over the exposed face of said cotton fabric and protecting the latter from the anolyte.

10. A cathode for an electrolytic cell hav-

ing a member of current-conducting material, with a diaphragm portion comprising a layer of cotton and Portland cement extending over the exposed face of said layer and protecting the latter from the anolyte.

11. A cathode for an electrolytic cell having a member of current-conducting material, with a diaphragm portion comprising a sheet of cotton fabric and Portland cement extending over the exposed face of said fabric and protecting the latter from the anolyte.

12. A cathode for an electrolytic cell having a member of current-conducting material, with a diaphragm portion comprising a layer of cotton, and asbestos material extending over the exposed face of said layer and coated with Portland cement and protecting the said layer of cotton from the anolyte.

13. A cathode for an electrolytic cell having a member of current-conducting material, with a diaphragm portion comprising a sheet of cotton fabric, and asbestos material extending over the exposed face of said cotton fabric and coated with Portland cement and protecting the said fabric from the anolyte.

14. A cathode for an electrolytic cell having a member of current-conducting material, with a diaphragm portion comprising a layer of cotton, and means for protecting said layer against access thereto of the chlorin gas evolved during the operation of the cell.

15. A cathode for an electrolytic cell having a member of current-condutcting material, with a diaphragm portion comprising a sheet of cotton fabric, and means for protecting said fabric against access thereto of the chlorin gas evolved during the operation of the cell.

16. A cathode for an electrolytic cell having a member of current-conducting material, with a diaphragm portion comprising a layer of cotton, a sheet of asbestos paper applied to said layer, and a sheet of asbestos fabric applied to said paper, said asbestos paper and asbestos fiber protecting said cotton layer from the anolyte.

17. A cathode for an electrolytic cell having a member of current-conducting material, with a diaphragm portion comprising a sheet of cotton fabric, a sheet of asbestos paper applied to said fabric, and a sheet of asbestos fabric applied to said paper, said asbestos paper and asbestos fabric protecting said cotton fabric from the anolyte.

OMAR H. JEWELL.