(No Model.)

E. ANDREOLI.
ELECTROLYTIC APPARATUS.

No. 525,732. Patented Sept. 11, 1894.

Fig. 1.

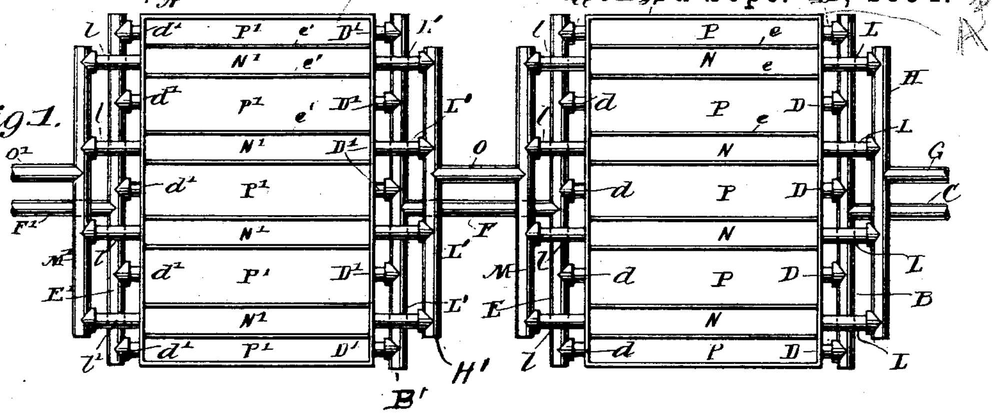


Fig. 2.

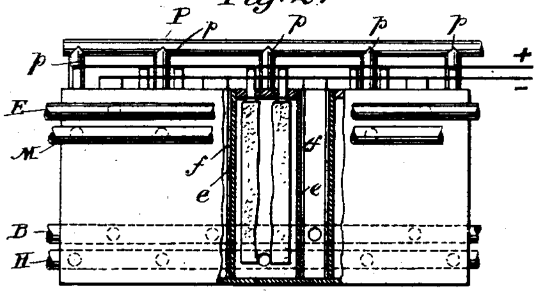


Fig. 3.

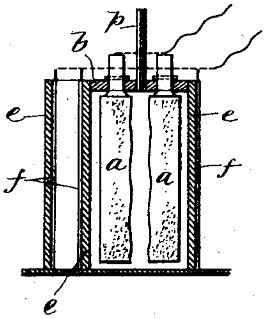


Fig. 4.

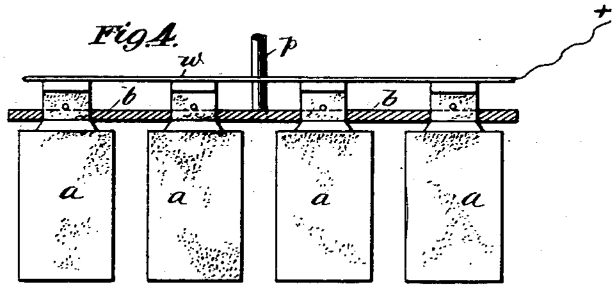
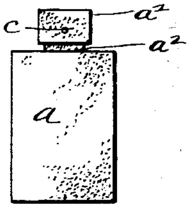


Fig. 5.



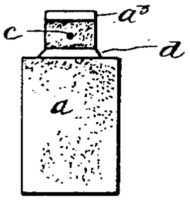
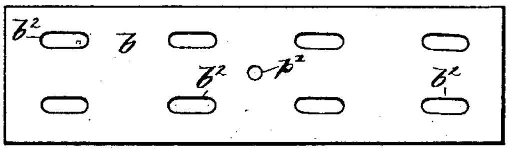


Fig. 6.

Fig. 7.



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ELECTROLYTIC APPARATUS.

SPECIFICATION forming part of Letters Patent No. 525,732, dated September 11, 1894.

Application filed August 4, 1893. Serial No. 482,333. (No model.)

To all whom it may concern:

Be it known that I, EMILE ANDREOLI, a citizen of the French Republic, residing at 18 Somerleyton Road, Brixton, London, England, have invented certain new and useful Improvements in Electrolysis, of which the following is a full, clear, and exact description.

This invention relates to electrolytic apparatus, its object being to provide an apparatus in which a solution may be decomposed into its constituent parts while circulating through positive and negative compartments formed by suitable partitions closely situated between metallic or carbon cathodes and retort carbon anodes, the whole being constructed in a simple, cheap and efficient manner.

In the following description of my invention I describe the decomposition of a solution of chloride of sodium, but it is obvious that any other solution may be used instead.

In the accompanying drawings: Figure 1 represents a plan of the tanks. Fig. 2 is an end view of the same with parts broken away. Fig. 3 is a transverse section of a negative and a positive compartment. Fig. 4 represents a side view of the carbon anodes. Figs. 5 and 6 are two side views of the carbon anode, and Fig. 7 is a plan of the cover of one of the anode compartments.

Referring to the accompanying drawings by letter: Fig. 1 shows two similar tanks, A and A′, divided into positive compartments P P′ and negative compartments N N′ by porous partitions *e e′* which will be hereinafter described. B is a main pipe connected with the front part of the tank A, which receives the solution to be electrolyzed from a feeding cistern (not shown in the drawings) through a pipe C. The solution passes by means of the branch pipes D D into the positive compartments P P, which it fills up, then flows through the outlet branch pipes *d d* and the main pipe E at the rear of the first tank A, then traverses the conduit F and enters the main pipe B′ of the second tank and its inlet branch pipes D D′, whence it fills up the positive compartments P′ P′. The solution passes more or less rapidly between the anodes according to the rate at which it is desired to have the liquid aspirated by the pump. (The pump is not shown in the drawings.) The electrolyte escapes through *d′ d′* and, after it has traveled through a series of tanks, is sent back to its reservoir and returns to the first tank as before stated and so on to all the positive compartments, in which chlorine is generated and collected as hereinafter described and illustrated.

The circulation in the negative compartments, where caustic soda is formed, takes place in an identical manner. The solution arrives from a feeding tank (not shown in the drawings) through the conduit G into the main pipe H and its branch pipes L L, passes through the negative compartments N N, flows out through the outlet branch pipes *l l* and the main pipe M situated at the rear of the tank A, then traverses the conduit O and enters the main pipe H′ and its inlet pipes L′ L′, passes through the negative compartments and so on until it is pumped back to its feeding tank and forced through the main pipe G into the negative compartments N N of the first tank, &c.

Fig. 2 is an end view of the tank, with part of the end removed, showing the inside of the tank, the carbon anodes, diaphragms and cathode. *p p* are the small pipes leading the chlorine gas from the positive compartments into the main pipe P. B and H are the inlet pipes. E and M are the outlet pipes. In order to simplify the construction of my tanks I can dispense with one of the main pipes and with the pipe which connects them; so that on one side the liquids will arrive by means of the branch pipes D D and L L, and on the other it will escape through the branch pipes *d d* and *l l* and flow direct into the positive and negative compartments of the next tank, but I prefer to use the construction shown in the drawings. The chlorine gas is collected from each positive compartment by means of pipes *p p* (Fig. 2) which are fixed on the lid of each positive compartment, and it is aspirated by a convenient apparatus at the end of the last tank.

The inlet and outlet main pipes which respectively communicate with the anode and cathode compartments are disposed either in the upper or in the lower or central part of the tanks, as I find it more suitable according to the arrangement of the tanks, which may be in one or two, or more, rows on the same level, or which may be disposed "in cascade" in series of four or five tanks each row slightly one above the other. In order to control the regularity of the flow of the positive and negative electrolytes glass gages may be placed in the upper part of each positive and negative compartment. My compartments are narrow. The electrolytic action is therefore at its maximum, since between the two carbon anodes in each positive compartment and two metallic plates in each negative compartment the layer of circulating liquid is very thin, and thus the resistance is at its minimum. The cathodes not being as thick as the anodes I may have the negative compartments narrower than the positive ones, so that about the same quantity of liquid is electrolyzed while traveling through the positive and negative compartments. The above arrangement allows me to have a much greater surface of electrodes than is usual in ordinary electrolytic apparatus.

Parallel to the chlorine pipe P runs a metallic or other convenient pipe of a larger size than the chlorine pipe which serves to carry off the hydrogen which is evolved in the negative compartment and which is aspirated at a proper speed by a convenient apparatus in an opposite direction to that of the current of the chlorine gas. In order to make the drawings less complicated, the negative compartments are shown without lids, and the pipes for leading off the hydrogen are not shown.

Each compartment may be provided at one end with a cock for withdrawing the liquid, with a view to taking samples and of ascertaining whether there is any chlorine in the alkaline lye or hypochlorite or chlorate in the positive compartments; but, the porosity of the diaphragm being very great, the cocks of the positive compartment are not situated on the same side as those of the negative compartments, and thus the flow of the liquids being in an opposite direction there is no possibility of infiltration or percolation between the chlorinated and alkaline solutions.

My anodes vary according to the purpose for which I use the electrolytic tank. For instance, in the production of oxygen from a sulphuric acid solution the positive plates will be made of lead or peroxide of lead; they will be made of iron or steel in a solution of soda or caustic potash. In other cases they will be made of platinum, or in electro-plating operations they will be made of the metals to be deposited. In the present example of the electrolysis of chloride of sodium solution my anodes will consist of slabs of retort carbon. The best and perhaps the only material which can serve as anodes in the electrolysis of halogens is the well known gas retort carbon, and I could not claim its use in an electrolytic tank if it were not that I utilize in a new and efficient manner, retort carbon, which otherwise cannot be obtained in large slabs, owing to which fact it is practically unavailable for use as an anode.

Another difficulty is to connect the carbon anodes together and with the dynamo without exposing the metallic contacts to corrosion by chlorine and oxygen. My device, however, which I will hereinafter describe, allows me to utilize retort carbon as anodes in the most efficient manner. My invention does not consist in the use of retort carbon, but in a novel mode of construction which allows me to utilize it at the positive pole in the commercial production of chlorine and caustic soda by electrolysis or in similar electrolytic operations. My tank being shallow, I can easily find pieces of carbon long enough to be used as anodes, and even to touch the bottom of the tank. The mode of construction is as follows: Out of the raw pieces of scurf I cut slabs of a convenient size, as shown in Figs. 5 and 6, which at the top corners show two shoulders, leaving a head a' which, being rounded off or not, fits into a hole cut into the slate lid as shown in Fig. 7. Fig. 7 shows the lid of a positive compartment with holes b^2 cut in it, through which holes the heads of the anodes will pass. p' is the opening through which the pipe *p*, which conducts the chlorine, passes. These holes are first internally coated with cement made of litharge, powdered asbestos, porous porcelain and a convenient agglutinating material, or with any other convenient cement to keep the anodes firmly in position. It will be understood by reference to Fig. 4, in which *a a* represent the carbon anodes; *b b*, the top of the anode compartments; *p*, the pipe through which the chlorine passes, and *w* the wire connecting the anodes with the source of electricity, that whatever may be the length of my anode compartments it is easy to make anodes of a sufficiently large surface. The carbon pieces are carefully ground on the side which faces the cathodes, from which they are separated only by a thin asbestos or porous porcelain diaphragm, but the other side does not require to be carefully planed. In the upper part of the carbon anodes, Figs. 5 and 6, are cut grooves *g* and the top of the carbon anode a^3 is coppered and tinned, so that contact bars of a convenient size may be fixed on it. *c* shows a small hole through which a hard wood peg boiled in paraffine is forced. Around the groove a^2, made in the neck of the anode, I wind a paraffined string or cord *d*, so as to prevent the carbon from being loose and also to prevent gas from escaping from the positive compartment. When this collar made of paraffined string has been firmly tied, I coat it with a layer of paraffine or other insulating material to make it quite an impervious mass through which no gas can escape.

Fig. 3 shows two anodes *a a* in cross section, each in presence of a porous partition *e e*, close to the other side of which is the corresponding cathode *f f*. Owing to the close proximity of the electrodes presenting a large active surface the thinness of the porous diaphragm and of the intervening layers of rapidly flowing electrolyte, resistance is reduced to a minimum. The porous diaphragms which are generally used in electrolytic operations are made of clay, asbestos, cardboard or cloth, nitrocellulose or vegetable parchment. I replace such porous diaphragms by some others which oppose but little resistance and which from the point of view of cheapness, durability and efficiency are excellent in electrolytic installations. The new diaphragms which I adopt for my electrolytic tanks are made of porous porcelain, or pumice stone porous porcelain; or they may be made of a porcelain consisting of pulverized pumice stone mixed with powdered asbestos, infusorial earth or other substances which resist gases, alkalis or acids. These porous porcelain plates, being made of nearly unattackable substances and baked at a high temperature resist acids, alkalis, and even chlorine, oxygen and caustic soda incomparably better than the best ordinary porous clay or porcelain, which very rapidly disintegrate and allows the diffusion of the liquids.

The cathodes *f* are preferably made of metallic wire gauze or perforated metal. In some instances it is advisable to construct them of carbon, but, as stated, I prefer to construct them of wire gauze or netting and dispose a single cathode opposite each series of anodes. It is obvious, however, that any number of cathodes may be united and disposed opposite the anodes.

The closeness of the electrodes is very favorable to the good yield of the electrolysis. As may be seen in Fig. 3, the result of this disposition of electrodes and of the diaphragms is that there are two similar electrodes in each compartment, *i. e.*, two carbons in each positive and two cathodes in each negative compartment, working much more satisfactorily than if one anode and one cathode only were in each compartment. The electrodes and porous porcelain partitions are therefore in the following order in the tanks: carbon anode, diaphragm, cathode, cathode, diaphragm, carbon anode, carbon anode, and so on.

Having thus described my invention, what I claim is—

1. In an electrolytic apparatus, the combination of a plurality of tanks, each divided into a number of anode and cathode compartments, and a system of circulation consisting of a main pipe and branch inlet pipes therefrom leading to each of the anode compartments and corresponding branch outlet pipes leading from the anode compartments, the outlet pipes being joined together into a single main pipe and then branching again to the anode compartments of the next tank, and so on throughout the system of tanks, and a similar arrangement of pipes connected with the cathode compartments, all for the purpose set forth.

2. In an electrolytic apparatus, the combination of a plurality of tanks, each divided into a number of anode and cathode compartments, and a system of circulation consisting of a main pipe and branch inlet pipes therefrom leading to each of the compartments of one polarity in the same tank and corresponding outlet pipes leading from the same compartments, the outlet pipes being joined together onto a single main pipe and then branching again to the corresponding compartments of the next tank, and so on throughout the system of tanks, for the purpose set forth.

3. In an electrolytic apparatus, the combination of an anode composed of a plurality of single pieces of retort carbon presenting on one side smooth, flat surfaces, and a cathode placed opposite the smooth surfaces of the anode, substantially as described.

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

EMILE ANDREOLI.

Witnesses:

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U. S. Vice and Deputy Consul-General, London.

FRANCIS W. FRIGOUT,
Deputy Consul-General of the United States of America at London, England.