

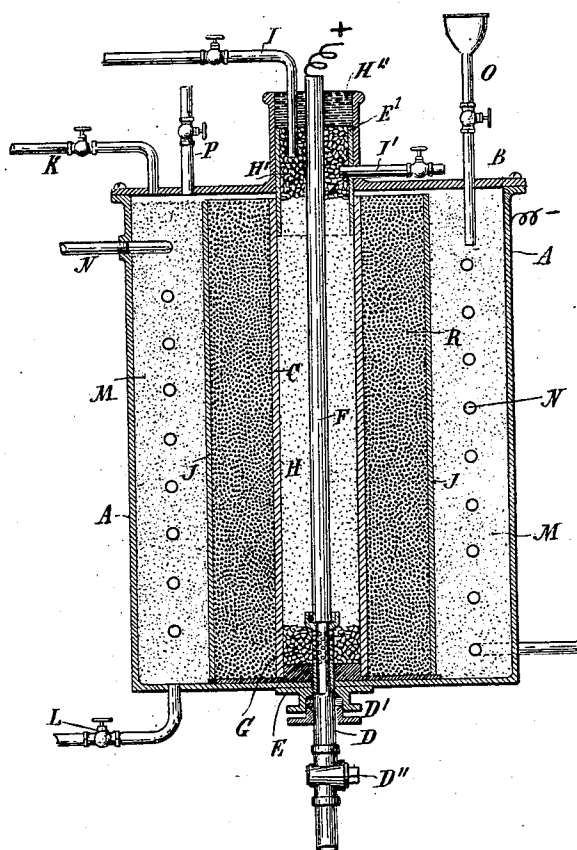
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Patented May 7, 1901.

I. L. ROBERTS.
ELECTROLYTIC APPARATUS.

(Application filed Jan. 21, 1892.)

(No Model.)



Witnesses:

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UNITED STATES PATENT OFFICE.

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ELECTROLYTIC APPARATUS.

SPECIFICATION forming part of Letters Patent No. 673,452, dated May 7, 1901.

Application filed January 21, 1892. Serial No. 418,785. (No model.)

To all whom it may concern:

Be it known that I, ISAIAH L. ROBERTS, a citizen of the United States, residing at Brooklyn, in the county of Kings and State of New York, have invented certain new and useful
5 Improvements in Electrolytic Apparatus, of which the following is a specification, reference being had to the drawing accompanying and forming a part of the same.

10 This invention consists in a new and improved apparatus or means for electrolysis, especially of salts and acids, organic or inorganic, or for the substitution of radicals and bases.

15 I shall first describe the plan of construction of my improved apparatus and then point out the general uses to which the same may be applied and the nature of the results which are or may be secured thereby.

20 The figure is a vertical central section of the apparatus provided with the various appliances that are required in the different uses of the same.

A is a containing tank or receptacle, which
25 I make, preferably, of iron in order that it may serve as a cathode. This tank is provided with a cover B, by means of which it may be hermetically sealed or closed.

C is an earthenware cylinder centrally located in the tank. This cylinder is prepared according to a process invented by me for rendering it substantially non-porous without destroying its capacity for electrolytic work—that is to say, it is soaked for a considerable
30 time in an aqueous solution of silicate of soda.

35 It is then immersed in a solution of an acid, such as sulfuric acid, until by the action of the same upon the silicate of soda the pores of the porous material of which the cylinder is composed are filled with a gelatinous mass.
40 There are other ways now well known in which a like result may be obtained, and it may be stated in general that the cylinder as thus prepared constitutes merely one form of
45 what is now well known in the art as a non-porous electrolytic diaphragm or partition for which without departure from the invention any other of a like character may be substituted. Such form of cylinder separating the
50 anode and cathode compartments by a dia-

phragm sufficiently non-porous to prevent filtration, but permeable to electrolytic action, is described in United States patents granted to me December 9, 1890, Nos. 442,332 and 442,334.

In the bottom of the tank A is an opening through which projects a glazed-iron or vitrified-tile pipe D, the flaring end of which is near the bottom of the cylinder C. A suitable stuffing-box D' surrounds the pipe D, and a cock or like device D'' is provided therein.

In the bottom of the cylinder C is a mass of comminuted asbestos and wax or ozocerite E, that insulates the contents of the cylinder from the cathode-tank. A glass or glazed-earthenware cylinder E' is fitted into the upper end of the cylinder C and projects above the plane of the cover B.

F is a carbon anode stick or cylinder that is placed centrally in the jar C, extending down to the opening of the pipe D, which it closes wholly or partially. A number of perforations are formed in the end of pipe D within the jar C, and around it is placed a layer of coarse carbon grains G to permit free drainage. The jar C is then filled with comparatively fine grains or particles of conductive carbon H or a similar material to nearly the top of the jar. A layer of coarse carbon grains, broken glass, or pebbles H' is then placed in the cylinder E', and over this a luting or seal of wax or tar H''. Two ducts or tubes extend from the mass of coarse grains H—one a pipe I for the introduction of fluids, and the other a pipe I' for the escape of gas.

The jar C is surrounded by an ordinary porous cylinder or holder J, of any proper character, that leaves an annular space around the jar which is filled in with a substance R, such as very finely pulverized anthracite coal or other pulverized amorphous material that will not prevent electrolytic action, but will prevent the substantial transfusion of liquids.

An outer chamber or space is left between the partition J and the tank A, and this is provided with an inlet pipe or duct K at the top and a draw-off pipe L at the bottom. For some uses of the apparatus this chamber or

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space is filled with crushed carbon M, and a coiled pipe N is contained in it through which steam or hot water may be passed.

O is a stand-pipe entering the outer or cathode chamber, and P is a pipe from the upper part of the same for the escape of gas.

Examples of the uses for which this apparatus is adapted are: the purification of water, the manufacture of caustic alkalies and acids, or the oxidation of any substance in a fluid state. In such cases the apparatus may be used without the crushed carbon M in the outer compartment. For illustration, suppose that water is to be purified. It is admitted through the pipe I and falls on the top of the column of comminuted conductive carbon H, which must be fine enough to retard the movement or flow of the water for a sufficient time for it to be acted on by the electric current, which is passed through the apparatus by connecting the anode and cathode to a suitable generator and filling the outer compartment or chamber with a conducting medium, such as a solution of caustic soda.

The action of the apparatus is as follows: The current passes through the anode and conducting carbon and through the treated jar C and the amorphous anthracite coal, the holder J, and the caustic soda to the cathode-tank. The water percolating through the crushed carbon or coke comes in contact with the nascent electrolytic oxygen, which oxidizes all the organic matter held in suspension and kills all the germs contained in it. It is drawn off through the pipe D. The solution of caustic soda is used, primarily, as an assistance to conductivity; but the main purpose is to furnish a means of producing pure oxygen throughout the mass of crushed carbon. Caustic potash might be used for the same purpose.

If it is desired to use a small amount of chlorin with the oxygen, then some chlorid of sodium or any other alkaline chlorid may be added to the caustic soda.

I have found that this apparatus is better adapted for the manufacture of caustic alkalies than those heretofore invented by me, and the reason for this I attribute to the discovery that a metallic base can be transferred through my impervious partitions as well as an acid radical.

It is a fact that in the electrolysis of chlorid of sodium or potash in solution through a non-porous electrolytic diaphragm as heretofore practiced by me there is a constant decrease in the output of chlorin and alkali as the strength of the chlorid decreases and the alkali increases. I have found that this is largely due to the fact that in the tanks where no solution is carried next the anode no base was present. In my present process I keep a continuous supply of sodium chlorid or other solution in the anode-chamber, so that the bases may be supplied as fast as

they are transferred to the outer compartment. On starting up the apparatus the outer compartment must contain some brine to make the water a conductor; but only a small proportion, or about five to ten per cent., is required for this. Any incidental acids formed in this process will be drawn off at the bottom of the anode compartment or jar, while the oxygen and chlorin will escape through the tube at the top. In the treatment of chlorid of sodium (or other substances in which the base is transferred to the outer compartment) the sodium base combining with the water forms sodic hydrate, which at proper intervals may be drawn off through the tube L.

I have found that this apparatus can be used as a reducing as well as an oxidizing device. Thus it is possible to refine sugar, rectify ardent spirits and impure wines, and compose synthetically many chemical substances under conditions which will be briefly described.

When treating such substances as sugar, where it is desirable to remove the acids as well as to bleach, I first pass the ordinary brown filtrate through the reducing or hydrogen side next the cathode, which is in such cases to be filled with crushed conducting-carbon, such as comes from gas-retorts. The operation I have also found is very much facilitated by passing steam or hot water through the coil N for warming the contents of the compartment. When the sugar solution is passed through and a proper amount of current employed, practically all of its acid will be transferred to the anode-compartment or decomposed and converted into water. This will generally refine it sufficiently; but some sugars will require passing through a second tank similar to the one it has passed, but on the anode or bleaching side. In the first treatment dilute sulfuric acid of 4° Baumé should be placed in the anode-compartment, and this will yield hydrogen in the cathode-chamber. In the second treatment pure caustic soda or potash solution will answer for the cathode or hydrogen chamber. This will yield pure oxygen in the anode-compartment.

I have selected sugar as a representation of the organic types; but wine when containing too much acid can be passed through the reducing side and have as much removed as necessary. Alcohols and essential oils may be either reduced or oxidized, as may be desired, by passing them through one or the other compartment, as above described. Resins may be deoxidized by passing them through the cathode-chamber and using sufficient heat and pressure. In the case of such substances as resins or oils, which are liquid only at temperatures above the normal, they should be treated in water and allowed to flow through the proper chamber with the water, so that a mixture of the two is continually passing

down through the tank by gravity. If they are restricted by the lower cocks the oils will separate from the water and will not be acted on properly. They must flow in a small stream or by drops, according to the current used.

I have found that pressure materially aids the action above described when it is desired to oxidize any substance, since it brings the particles of the substance into more intimate contact with the oxygen; but when reduction is desired a suction is advantageous, and this may be maintained by connecting the stand-pipe O with a pressure-reducing apparatus or by any other suitable means.

The amount of current, the temperature, pressure, or time of treatment will of course vary with different substances and the character of the results to be obtained; but these are matters easily ascertainable from experiment.

The action of the electric current, at least so far as its efficiency is concerned in the treatment of the various substances named, I think, is attributable to the nascent gases coming in contact with the substance to be treated. It is obvious also that the mass of divided carbon R and the partition J can be dispensed with without interfering with the operation of my process. They are beneficial principally as a protection and aid in the production of caustic alkalies, but are not of material consequence in the treatment of alcohols or the refining of sugar.

I do not limit myself in the practice of the processes herein described and claimed to the apparatus above described, as other apparatuses might be employed to produce similar results.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. In an electrolytic apparatus the combination of the anode and cathode compartments separated by a diaphragm or partition sufficiently non-porous to prevent filtration but permeable to electrolytic action, a mass of comminuted conductive substance filling one of said compartments, means for maintaining the flow through the same of the solution to be treated, and means for maintaining a pressure in said compartments, substantially as described.

2. The combination of the conducting-tank A, a partition within said tank sufficiently non-porous to prevent filtration but permeable to electrolytic action for forming an anode-compartment, an anode within said compartment, an insulating layer between the bottom of the tank A and the lower end of said partition and anode, an inlet I and drain-pipe D for said anode-compartment.

3. The combination of the iron tank A, the electrolytic partition, the anode F, a mass of divided contacting carbon surrounding the same, the drain-pipe D at the bottom of the anode-compartment, the inlet I and insulating layer E between the bottom of the tank A and lower ends of the electrolytic partition, the anode F and the divided mass of contacting carbon.

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

ISAIAH L. ROBERTS.

Witnesses:

ANTHONY GREF,
WM. A. POLLOCK.