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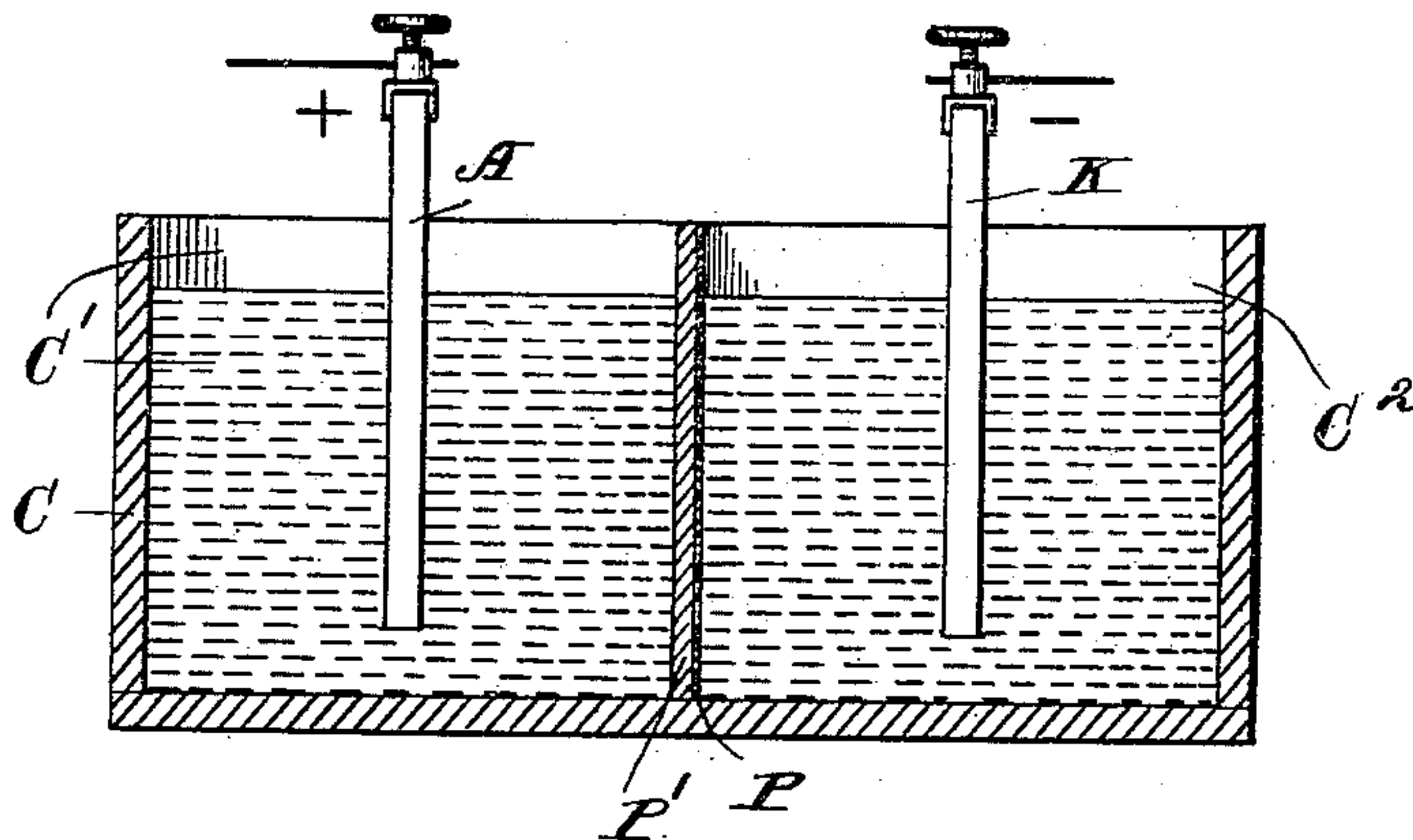
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T. A. UEHLING.

PROCESS OF AND APPARATUS FOR REDUCING AND OXIDIZING SALTS.

(Application filed Aug. 10, 1896.)

(No Model.)



WITNESSES:

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PROCESS OF AND APPARATUS FOR REDUCING AND OXIDIZING SALTS.

SPECIFICATION forming part of Letters Patent No. 620,683, dated March 7, 1899.

Application filed August 10, 1896. Serial No. 602,236. (No model.)

To all whom it may concern:

Be it known that I, THEODORE A. UEHLING, of Cleveland, Cuyahoga county, Ohio, have invented certain new and useful Improvements in Processes of and Apparatus for Reducing and Oxidizing Salts; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it pertains to make and use the same.

My invention relates to an improved process of and apparatus for reducing and oxidizing salts, whereby certain desired results hereinafter appearing are obtained.

The invention comprises, essentially, a cell divided into two compartments by a partition adapted to absorb hydrogen liberated during the process of electrolysis at one side of the partition and transfer it therethrough to combine with elements or radicals liberated at the other side of said partition and prevent the passage of all other ions from one compartment to the other compartment.

The invention relates more especially to the use in an electrolytic cell of a hydrogen-absorbing partition made of palladium or similar hydrogen-absorbing material, as hereinafter more particularly set forth.

In the accompanying drawing the figure is an elevation in vertical section of my improved cell employed in carrying out my improved process.

Referring to the drawing, C designates a cell or tank. The walls of the chamber or chambers of this tank or cell are composed of a substance or material that is non-conducting, non-corrosive, and capable of resisting and remaining unaffected by any chemical or electrolytic actions occurring or obtaining within said chamber or chambers.

Cell C in the case illustrated is divided into two compartments or chambers C' and C² by a partition P, that is built up or composed of a substance or material that is a conductor of electricity and is capable of absorbing hydrogen liberated in one of said chambers or compartments and transmit the same for combination with a radical or radicals or elements liberated by electrolysis in the other compartment or chamber.

The anode A, that is of any suitable chlorine-resisting material—such as, for instance,

platinum—and electrically connected with the positive pole of an electric source, extends into compartment C', and the cathode K, that is of any suitable alkaline-resisting material—such as, for instance, copper—and electrically connected with the negative pole of the electric source, extends into compartment C².

I will now describe the process used in connection with my improved apparatus for oxidizing salts and take, as an illustration, the formation of potassium chlorate and hydrogen from potassium chlorid.

An aqueous solution of potassium chlorid, with a small quantity of potassium carbonate or hydrate added to make the solution alkaline, is placed in compartment C'. Water containing a sufficient quantity of sodium hydrate or other suitable salt to make it a good conductor of electricity is placed in compartment C². An electric current is then passed through the cell, and the following process of oxidation takes place: The potassium chlorid contained in compartment C' is decomposed. Chlorin is evolved at the anode A and potassium liberated at partition P. Said liberated potassium immediately attacks and decomposes water, whereby potassium hydrate is formed and hydrogen set free at or on the surface of the partition. The said free hydrogen is thereupon absorbed by said partition and the chlorin and potassium hydrate combine through the continued decomposition of potassium chlorid and the formation of potassium hydrate and chlorin by a series of well-known reactions to form potassium chlorate.

Simultaneously with the above-described process in compartment C' the sodium hydrate contained in compartment C² is also decomposed. The hydrate radical is liberated at partition P and sodium at the cathode K. The said liberated radical combines with hydrogen transmitted under the influence of the electric current through the said partition to form water. The sodium meanwhile attacks the water, and the resulting products are sodium hydrate and hydrogen. However, this hydrogen being liberated at the cathode will not interfere with the extraction of the hydrogen absorbed by partition P from compartment C'.

By keeping the solution in compartment C' at a relatively high temperature the process of oxidation will continue until potassium chlorate is oxidized to potassium perchlorate.

5 By regulating the temperature potassium chlorate forms and may be easily crystallized out from a saturated solution.

I do not intend to confine myself to any particular conditions of temperature or of
10 pressure, as each class of compounds requires special treatment, according to the results desired to be obtained.

Having now described my process as applied to the oxidation of salts, it will be observed
15 that an essential feature is the complete separation of the two electrolytes contained in the different compartments, respectively, and the absorption of hydrogen from one compartment and its transference to and use in
20 the other compartment. To accomplish this result, I employ a partition consisting of palladium or similar hydrogen-absorbing material. Preferably said palladium is deposited as a thin film or sheet on the surface of an
25 ordinary porous diaphragm P' or on a fabric or netting which can withstand the chemical action of the electrolyte. The composition of said partition is immaterial so long as a sufficient quantity of palladium or other hydrogen-absorbing material is present to absorb and by the influence of electricity transmit hydrogen liberated by the decomposition of the electrolyte, and I may use a thin sheet or plate of pure palladium or an alloy of pal-
30 ladium and another metal—such, for instance, as silver or copper.

By removing the hydrogen liberated in compartment C' in the foregoing process I prevent the formation of hydrochloric acid in said
40 compartment by a combination between the free hydrogen and chlorine. The electric current not only decomposes the two electrolytes, but also promotes the transmission of the hydrogen from the one compartment through the
45 partition to the other compartment, where it is taken up and combined with the hydrate radical, thus preventing hydrogen saturation of said partition.

In practical operation I prefer to maintain
50 a constant flow of the potassium-chloride solution, which becomes oxidized during its passage through the compartment and can then be conducted away and the potassium chlorate crystallized out in the usual manner.

55 By introducing a reducible salt, such as nitrobenzol, into the cathode-compartment it will be reduced at the cathode. In this case the reduction and oxidation are carried on in alkaline electrolytes. By substituting or adding an acid the electrolyte may be made neutral or acid, as the conditions of electrolysis may require.

As the important feature of the apparatus illustrated is the palladium or hydrogen-absorbing partition attention is called to this
65 metal's peculiar property, possessed in a less

degree by platinum, of absorbing many times its volume of hydrogen and, under the influence of the electric current, transmitting it. No communication whatever is allowed between the electrolytes contained in the compartments, and in this respect my apparatus differs from the ordinary electrolytic cell, which allows of the passage through its diaphragm of both the cation and anion; but
70 hydrogen is absorbed and then so transmitted that if absorbed at one side it is available for combination at the other. By means of this hydrogen-absorbing partition hydrogen is actually extracted or removed from one compartment and introduced or transmitted into the other, thereby oxidizing the electrolyte in the compartment of the anode and reducing the electrolyte in the compartment of the cathode. A great saving of energy is also
80 accomplished, as harmful secondary reactions are completely avoided and the full force of the reactions is utilized in accomplishing the result desired.

My apparatus is not only simple and easily
90 constructed, but by its use a much larger per cent. of the theoretical yield is actually obtained than is possible with the methods now in use.

What I claim is—

1. As an improvement in the art of oxidizing and reducing substances by electrolysis, the method herein described of transferring hydrogen from one compartment of an electrolyzation vat or cell to another compartment
100 of the said vat or cell consisting in, first liberating the hydrogen from a solution by an electric current, and then transferring the hydrogen through a non-porous electrically-conducting diaphragm or partition that is capable of absorbing and transmitting hydrogen and excluding and preventing any other element, or elements, from passing there-
105 through under the influence of an electric current passed through the cell or vat, substantially as set forth.

2. The herein-described process of oxidizing and reducing two substances by electrolysis, consisting in placing aqueous solutions of said substances in the positive and negative compartments, respectively, of an electrolyzation vat or cell; subjecting said solutions to the action of an electric current, and transferring the hydrogen liberated in one of said compartments by the action of the said
120 electric current to the other of said compartments by means of a partition capable of transferring said hydrogen and impervious to all other elements or substances contained in said compartment, substantially as set forth.

3. The herein-described process of electrolyzing aqueous solutions, consisting in first dividing an electrolyzation-cell into compartments by means of a conducting, non-porous palladium partition adapted to absorb and
130 transmit hydrogen liberated during the process of electrolysis and to prevent the trans-

mission of any other element or elements, placing in the positive compartment of said cell a substance to be oxidized and into the negative compartment a substance to be reduced, electrolytically decomposing each of said substances, removing the hydrogen liberated in the positive compartment by, and transferring it through, said partition to be recombined in the negative compartment, substantially as set forth.

4. The process herein described, consisting in dividing an electrolyzation vat or cell into positive and negative compartments by means of a conducting non-porous palladium partition and placing in said positive compartment an aqueous solution of a substance to be oxidized, electrolytically decomposing said substance and removing the hydrogen evolved thereby from the said positive compartment by means of the aforesaid palladium partition, substantially as set forth.

5. The process herein described consisting in dividing an electrolyzation vat or cell into two compartments by means of a conducting non-porous palladium partition and placing an aqueous solution of a substance to be reduced in the negative compartment of said vat or cell, electrolytically decomposing said electrolyte and permitting the element or elements liberated at the said palladium partition to recombine with hydrogen transmitted therethrough under the influence of the electric current from the positive compartment of said vat or cell substantially as and for the purpose set forth.

6. In an electrolytic cell, a diaphragm consisting of a suitably-supported layer or sheet of palladium, and the anode and the cathode, said layer or sheet of palladium separating the anode from the cathode compartment, substantially as set forth.

7. An electrolyzation vat or cell having positive and negative compartments therein, an anode, a cathode, a source of electric energy, and a conducting non-porous partition impervious to all elements except hydrogen separating said compartments, substantially as and for the purpose set forth.

8. In an electrolyzation vat or cell provided with positive and negative compartments, an anode, a cathode, a source of electric energy, separate electrolytes in each compartment, and a conducting non-porous partition consisting essentially of a suitably-supported

sheet or layer of palladium, substantially as set forth.

9. For an electrolytic treatment of salts or substances in aqueous solution, the combination; with the vat or cell containing the electrolyte or electrolytes, of a partition placed between the anode and cathode of the said vat or cell and having palladium incorporated in or upon the same, substantially as and for the purpose set forth.

10. For the electrolytic treatment of two different aqueous solutions in the positive and negative compartments, respectively, of the electrolyzation vat or cell, the combination with said vat or cell of a non-porous conducting partition that will allow the passage of hydrogen from the positive to the negative compartment of said cell and prevent the passage of all ions except hydrogen from either compartment to the other, substantially as and for the purpose set forth.

11. An electrolyzation - cell divided into compartments by means of a partition, having an oxidizable salt in one of said compartments, a reducible salt in the other compartment, and electrodes projecting into or exposed in said compartments, the aforesaid partition being built up or composed of a substance or material or materials obstructing communications between the electrolyte in the different compartments but incapable of absorbing and transferring any other element than hydrogen liberated in one of said compartments and permitting said element to pass therethrough under the influence of an electric current obtaining between the electrodes, substantially as and for the purpose set forth.

12. The combination with a cell having an electropositive compartment containing a solution of the substance to be oxidized, an electronegative compartment containing a solution of a substance to be reduced, an anode in said electropositive compartment, and a cathode in said electronegative compartment, of a suitably-supported layer or film of palladium, substantially as set forth.

In testimony whereof I sign this specification, in the presence of two witnesses, this 4th day of August, 1896.

THEODORE A. UEHLING.

Witnesses:

A. M. AUSTIN,

L. WARD HOOVER.