Jan. 11, 1938. H. HARTMAN 2,105,438

PROCESS AND APPARATUS FOR PRODUCING PERCOMPOUNDS

Filed July 2, 1935

Fig. 2.

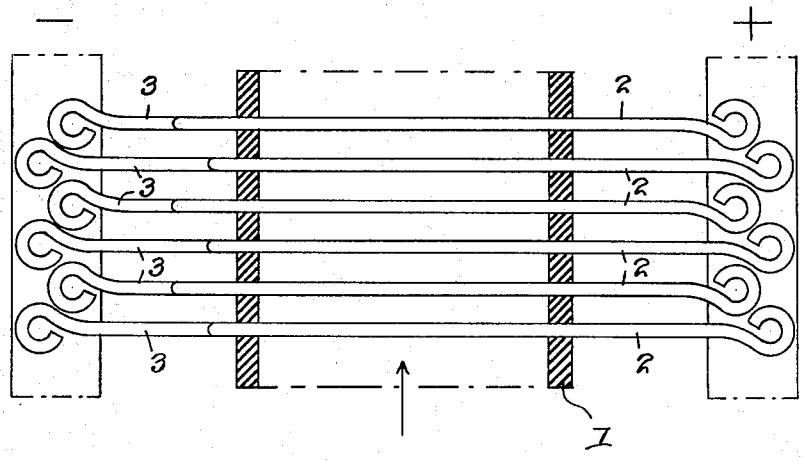
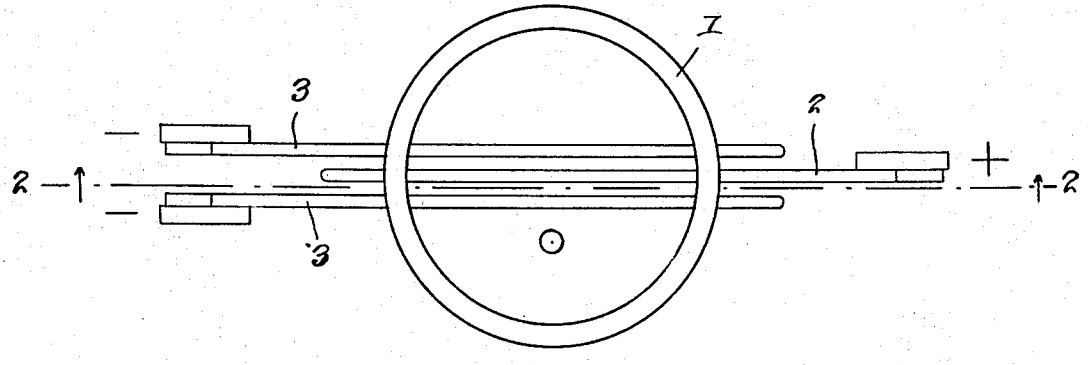


Fig. 1.



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PROCESS AND APPARATUS FOR PRODUCING PERCOMPOUNDS

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7 Claims. (Cl. 204—9)

The present invention relates to process and apparatus for producing chemical compounds by electrolysis. More particularly the invention relates to process and apparatus for producing persalts such as percarbonates and perborates.

In carrying out electrolyses in aqueous solution, especially in electrolytically manufacturing active oxygen containing compounds, such as percarbonates or perborates, the electrolyzers, or electrolyte containers, are usually manufactured from acid proof earthenware, vitreous stoneware, sheet iron covered with ebonite, enamelled cast iron, or other material resistant to the action of chemicals. According to the present practice, the electrolyzers prepared from these materials are only partially filled with electrolyte in order to allow the gases produced during the electrolysis to escape immediately from the electrolyte. However, this practice of the prior art has the disadvantage or inconvenience that very often compounds or salts resulting from the electrolysis crystallize out against the walls of the electrolyzers or between the electrodes, whereby stoppages or short circuits between the electrodes arise. The objectionable conditions arise most frequently when difficultly soluble compounds or salts are formed as products of the electrolysis. The avoidance of these objectionable conditions forms one of the objects of the present invention.

I have found that the above mentioned drawbacks are not encountered or do not arise if the electrolyte is pumped through an electrolyzer that is completely filled with the electrolyte to be electrolyzed, the walls of the electrolyzer being wholly or partly manufactured from rubber or from another material that does not conduct the electric current and that guarantees a gas tight obturation of the electrodes that pass through the walls of the electrolyzer. The electrolytically developed gases which are taken along with the moving or pumped electrolyte appear to exercise either a mechanical or a physical chemical action that prevents the formation of crystals against the walls of the electrolyzer or between the electrodes.

Among the further objects of the present invention is the provision of electrolytic apparatus in which the distance between the anodes and cathodes can be made very small, which decreases the resistance to the flow of the electric current through the electrolytic bath.

A further object of the invention is the provision of process and apparatus by the use of which greater yields of products, such as persalts, per unit of electrical energy employed are obtained.

Referring to the accompanying drawing illustrating one embodiment of electrolytic apparatus in which the process of the present invention may be practiced.

Figure 1 represents a plan or end view of the electrolyzer; and Figure 2 represents a section on the line II—II of Figure 1, looking in the direction of the arrows.

In the said views, the numeral 1 represents a rubber hose through which the electrolyte is pumped or caused to flow; and the numerals 2 and 3 indicate respectively anodes and cathodes. A plurality of anodes and cathodes are preferably employed, as shown in the drawing. It is to be understood that the distances between each of the electrodes may be varied, and that the number and arrangement of the electrodes may also be varied. The anodes and cathodes may be placed in separate rows or circles, or the anodes and cathodes can be arranged alternately in rows or circles; and the number of anodes and cathodes may be varied in each row or circle.

In the embodiment of the apparatus illustrated in the drawing, six rows of electrodes are shown, each row consisting of two cathodes between which is positioned an anode. Each anode 2 is pushed or passed through the hose 1 along a diameter of the rubber hose 1; and two cathodes 3 are pushed or passed through the hose 1 at the side of each anode 2, so that one cathode lies on one side of each anode 2 and another cathode lies on the other side of each anode 2. The connections between the walls of the rubber hose 1 and the anodes and cathodes are gas and liquid tight.

The electrolyzing chamber which is shown in the drawing as formed of rubber hose, or a section of rubber hose, may have any other suitable shape or cross section. The electrolyzer may also be constructed in such a way that the wall portions through which the electrodes penetrate are manufactured from weak or soft rubber, while the other wall portions are made from

a different material, for example iron covered with ebonite, in order to strength the whole thing.

The material for the walls of an electrolyzer according to the invention must possess the property that it does not conduct the electric current, and those parts in which or through which the electrodes are introduced are advantageously manufactured from a material which possesses sufficient elasticity to guarantee a gas-tight obturation of the electrodes. Materials such as India rubber, chlorinated rubber, balata and the like meet such requirements. Preferably the whole electrolyzer is manufactured from an elastic material that does not conduct the electric current, for example, a soft rubber hose or hose section 1, as shown in the drawing, and the electrodes are preferably passed across the electrolyzer so as to be approximately at right angles to the direction of flow of the electrolyte. The electrodes are preferably passed through the electrolyzer so as to be gripped or held at two points. The elastic material of which the electrolyzer may be formed effectively grips the electrodes in gas and fluid tight relationship when the electrodes are pushed or inserted through the electrolyzer to occupy the positions described above. However, this gas and liquid tight connection may be obtained in any other suitable manner.

In practicing the present invention the electrolyzer chamber 1 may have its axis horizontally or vertically disposed or even inclined to the horizontal. The electrolyte to be electrolyzed may be pumped in at either end. However, when the tube 1 in the drawing is used with its axis vertically disposed or inclined to the horizontal, it is preferable to pump the liquid upwardly through the tube 1 as indicated by the arrow shown in Figure 2 of the drawing.

If one passage of the electrolyte through the electrolyzer does not accomplish all the electrolytic action or production of compound or salt desired, the electrolyte may be passed repeatedly or continuously through the electrolyzer until the desired amount of electrolytic action in the electrolyte is attained. To this end a pump is caused to withdraw electrolyte to be electrolyzed from a vessel and deliver it to one end of the tube 1, whereupon the electrolyte, after being subjected to the action of the electric current in the electrolyzer, is conducted from the other end of the tube 1 back again to the said vessel, and circulated repeatedly or continuously through the electrolyzer. Interposed between the said vessel and pump may be placed a cooler to bring the temperature of the electrolyte to the desired conditions, or the said vessel may be provided with cooling coils. After the electrolytic action is conducted to the desired extent, the electrolyte may be treated in any suitable manner to separate the products produced. For example, in the production of perborates or percarbonates, these compounds may be separated from the electrolyte by crystallization accompanied by cooling if necessary.

The gases that are produced during the electrolysis are taken along with the electrolyte, that is pumped around with efficient rapidity, to prevent the formation of crystals against the wall of the electrodes, or between them, in electrolysis in which a difficultly soluble product or compound is formed, for example, sodium perborate. It is a surprising feature that the gases taken along, which accordingly have stayed in the electrolyte for some time, do not exercise a detrimental influence on the result of the electrolysis, and that, for example, no reduction of the alkali perborate takes place, owing to the cathodically developed hydrogen, when alkali perborate is produced according to an example hereinafter given.

Example 1

Manufacture of sodium perborate.

A saturated solution of sodium carbonate and borax in water is pumped one or more times, as described above, through the apparatus shown in the drawing having a rubber hose 1 having an internal diameter of 75 mm. and with a rapidity of 2M³ per hour. Through the wall of this hose are passed platinum anodes having a diameter of 3 mm. and V2A steel cathodes having a diameter of 3 mm., the distance between the electrodes being 5 to 6 mm. from center to center. V2A steel is a well known product manufactured by Krupp (the well known German works), and its approximate composition is carbon 0.25%, chromium 20%, nickel 7%, the remainder being iron.

At an anodic and cathodic current density of 0.45 ampere per square centimeter and 250 amperes current strength, electrolysis takes place at 10–12° C. and 5–6 volts bath tension.

After leaving the rubber hose, the electrolyte is conducted to a cooling and depositing vessel in which the sodium perborate formed separates out.

Example 2

Manufacture of potassium percarbonate.

Water saturated with potassium carbonate is electrolyzed according to Example 1 instead of water saturated with sodium carbonate and borax, except that the electrolysis is preferably conducted at a temperature not over 0° C. The potassium percarbonate is separated by crystallization from the electrolyte.

What is claimed is:

1. Process for preparing a persalt by electrolysis of an aqueous solution which yields a persalt on electrolysis, which process comprises introducing a flowing stream of the said solution into a chamber having inlet means and outlet means for said solution but which is otherwise closed and which has electrode means in the path of said solution as it flows from the said inlet means to the said outlet means, said solution in its flow from the said inlet means to the said outlet means entirely filling the said chamber and carrying with it substantially all the products of the electrolysis, and applying a difference of electrical potential to said electrodes for producing the said electrolysis as the solution flows through the said chamber.

2. Process for producing persalts by electrolysis which comprises subjecting an aqueous solution which yields a persalt on electrolysis to electrolysis while it is flowing through an electrolyzing zone, and moving out of the electrolyzing zone, in the flowing solution, substantially all products, including gas, produced as the solution flows through the electrolyzing zone.

3. Apparatus for electrolyzing a solution comprising in combination a tubular chamber, the walls of said chamber being formed of a soft elastic rubber-like non-conductor of electricity, electrodes extending into said chamber through the walls of said chamber and held by said walls in fluid tight connection, means for introducing the solution to be electrolyzed into one end of

said tubular chamber, and means for conducting electrolyzed solution away from the other end of said tubular chamber.

4. An electrolyzing cell comprising a tubular chamber, the wall of said chamber being formed of a soft elastic rubber-like material which is a non-conductor of electricity, and electrode means in said chamber extending out of said chamber through said elastic material and in fluid tight relationship therewith.

5. An electrolyzing cell comprising a tubular chamber, the wall of said chamber being formed of a material which is a non-conductor of electricity and having at least a portion thereof formed of a soft elastic rubber-like material which is a non-conductor of electricity, and electrode means in said chamber extending out of said chamber though said elastic material and in fluid tight relationship therewith.

6. Process for preparing a perborate which comprises subjecting an aqueous solution containing a compound of boron, which yields a perborate on electrolysis, to electrolysis while it is flowing through an electrolyzing zone, and moving out of the electrolyzing zone, in the flowing solution, substantially all products, including gas, produced as the solution flows through the electrolyzing zone.

7. Process for preparing a perborate which comprises subjecting an aqueous solution containing a borate, which yields a perborate on electrolysis, to electrolysis while it is flowing through a tubular electrolyzing chamber, and moving out of the electrolyzing chamber, in the flowing solution, substantially all products, including gas, produced as the solution flows through said tubular electrolyzing chamber.

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