V. GERBER.

DEVICE FOR CARRYING OUT CHEMICAL PROCESSES BY ELECTROLYSIS.

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1,301,832. Patented Apr. 29, 1919.

Fig. 2

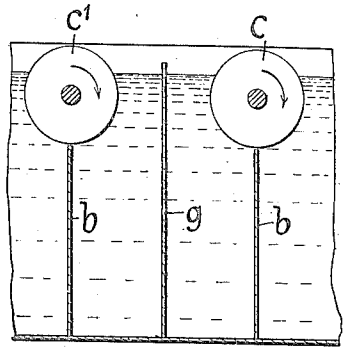
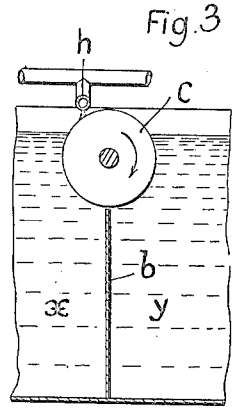


Fig. 3



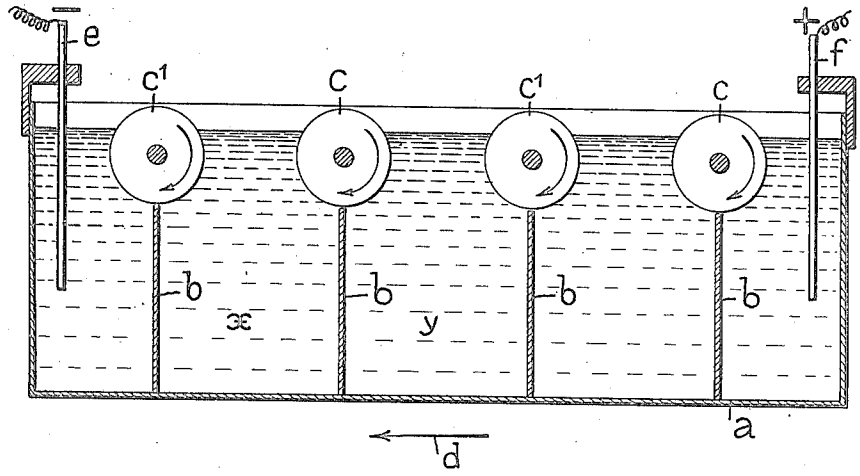


Fig. 1

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DEVICE FOR CARRYING OUT CHEMICAL PROCESSES BY ELECTROLYSIS.

1,301,832. Specification of Letters Patent. Patented Apr. 29, 1919.

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To all whom it may concern:

Be it known, that I, VIKTOR GERBER, a citizen of the Republic of Switzerland, residing at Baden, Bruggerstrasse 31, Switzerland, have invented certain new and useful Improvements in Devices for Carrying Out Chemical Processes by Electrolysis; and I do hereby declare the following to be a clear, full, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawing, and to letters or figures of reference marked thereon, which form a part of this specification.

This invention has reference to improvements in a device for carrying out in a simple manner such chemical processes by electrolysis that can be carried into effect by a pure chemical process only in a complicated and imperfect manner. The device according to this invention is particularly adapted for carrying out chemical processes of the kind in which an electrolyte has to be used as starting substance.

This invention will now be more particularly described with reference to the accompanying drawing illustrating by way of example several embodiments of the invention. In this drawing:

Figure 1 shows partly in a vertical longitudinal section and partly in front view a first construction according to this invention.

Fig. 2 is a vertical section through a cell subdivided into two parts by a diaphragm, and

Fig. 3 shows a spraying device for washing the parts adhering to a roll back into a cell.

Referring at first to Fig. 1, *a* denotes a long trough of non-conducting material subdivided into a plurality of cells by transverse walls *b* of non-conducting material. The partition walls *b* do not extend up to the upper edge of the trough *a*. Near to the upper end of each transverse wall *b* is mounted rotary metallic rolls *c*, and *c'* respectively. The metallic rolls *c*, *c'* constitute therefore the upper inclosing members of the cells. Instead of using solid metallic rolls, also rollers of any suitable material covered with a layer of metal may be provided above the walls *b*. Into the two cells provided at both ends of the trough *a* project electrodes *e* and *f* respectively of known type. For instance an iron plate may be used as the cathode *e* and a plate of carbon as the anode *f*. The speed of rotation that has to be imparted to the rolls *c* and *c'* depends chiefly upon the current density.

When the cells are filled with electrolytes, preferably concentrated solutions, and when a current is supplied to the two electrodes, the metallic rolls act as carriers, *i. e.* as means of transport for the substances adhering thereto.

For the purpose of explaining the phenomena taking place let us consider for instance two adjacent cells *x* and *y*. Between these cells is arranged a roll *c*. When it is assumed, that the electric current passes in the direction of the arrow *d* through the cells, and when it is further assumed, that the rolls are yet stationary, then the part of the roll *c* dipping into the electrolyte of the cell *x* acts as anode, while the part of the same roll which dips into the electrolyte of the cell *y* acts as cathode. Upon a rotation of the rolls, for instance in a clockwise direction, as shown in Fig. 1, the parts of the rolls exchange their rôles, *i. e.* the parts which were just acting as anodes act now as cathodes and vice versa. Should the current pass in the opposite direction with regard to the arrow *d* through the cells, then the sense of rotation of the rolls would have preferably also to be changed. The electrolyte in cell *y* now contains the cathion α', while the electrolyte in the cell *x* contains the anion β'. Further, the metal *Me* of the roll *c* constitutes together with the discharged or deposited β' an insoluble combination $Me\beta$. The latter is transported by the rotating roll *c* into the cell *y*, where β forms again an ion, the combination $\alpha\beta$ with the ions α' and β' being thus obtained in said cell *y*, whereby the metal *Me* of the roll is regenerated. The whole process hereinbefore described consists therefore in a transport of the anion from the cell *x* into the cell *y* by means of the metal *Me* of the roll acting as carrier. For the purpose of transporting in the manner referred to, for instance ion of chlorin or ion of sulfate (in cold solution) it is advisable to use silver, and for the transport of ion of hydrogen and ion of oxygen respectively, in alkaline solution, copper, nickel or iron may be used, while, when dissolved in an acid solution, rolls of lead may be used. Sulfur-ion can be conveyed by any one of the metals above

mentioned. In the same manner the rolls are also adapted to act as conveyers or carriers for the cathions, the discharged cathion α' depositing in the cell y on the roll and forming in the cell x—while it passes electrolytically again into the solution—with the anion β' the combination $\alpha\beta$ with the ions α' and β'.

With the exception of the cells provided at both ends of the device hereinbefore described no generation of gas takes place in any other cell of such a battery during its normal working. Consequently, the differences in concentrations to be observed on the conveying or transporting rolls are not effaced with regard to the remaining electrolyte; the newly formed combinations consequently sink, in case they appear in concentrated solution, and are in this manner withdrawn to further electrolysis.

In order to take advantage from these differences in the concentration present in the electrolyte, it is advisable to use solutions having a temperature of about 15° C., as higher temperatures would also have the effect to cause a mixing. When requisite, the cells may be subdivided into two parts by means of diaphragms g parallel to the axis of the rolls (see Fig. 2). When the electrolytes of the cells are sufficiently enriched with the new-formed combinations, the cells are emptied and filled with fresh electrolytes.

The just described working of the device corresponds to an intermittent manner of operation. It will be understood, however, that it is also possible to work with flowing electrolytes, the electrolyte being caused to pass through each cell apart. In such a case it is advisable to electrolyze warm solutions and to make the space of the cell narrow in the direction of the stream, *i. e.* to make the distance between the rolls small. Further, in order to prevent, in such a case, a stronger intermixing of the solutions of two adjacent cells, for instance of the cells x and y, in consequence of the rotation imparted to the roll lying between said two cells, *i. e.* in the present instance to the roll c, the parts of the electrolyte of x adhering to the roll may be washed back into the cell x by means of a spray device h (Fig. 3). When requisite, the concentration of the electrolyte flowing through the cell x may be maintained of the required density by means of a suitable substance.

As it will be seen from the following examples, the device described admits of carrying out chemical conversions in aqueous solutions. In connection with these examples it is assumed, that the direction of rotation of the rolls and the direction of flow take place in the direction above mentioned. The signs or symbols $\oplus$ and $\odot$ signify 96540 coulombs (electro-chemical equivalent-charge) of positive and negative electricity respectively.

Example 1.

It is assumed that the metal of c' is silver and that of c for instance copper. It is further assumed, that the solutions on the left of the rolls c' are solutions of common salt and those on the right solutions of milk of lime.

The phenomena taking place are on the whole the following:

$$(2NaCl \rightarrow 2Na' + 2Cl';\ Ca(OH)_2 \rightarrow Ca'' + H_2O + O'').$$

Side of the anode.	*Side of the cathode.*
$2Cl' + 2Ag + 2\oplus = 2AgCl.$ $O'' + Cu + 2\oplus = CuO.$	$2AgCl + Ca'' = CaCl_2 + 2Ag + 2\oplus.$ $CuO + 2Na' + H_2O = 2NaOH + Cu + 2\oplus.$

The resulting phenomenon is:

$$2NaCl + Ca(OH)_2 = 2NaOH + CaCl_2.$$

Example 2.

It is assumed, that the metal of c' is silver and that of c lead. It is further assumed, that the solutions on the left of the rolls c' are solutions of common salt and that the liquid on the right is water acidulated with sulfuric acid. The phenomena taking place are the following:

$$(2NaCl \rightarrow 2Na' + 2Cl';\ H_2SO_4 \rightarrow 2H' + SO_4''.)$$

Side of the anode.	*Side of the cathode.*
$2Cl' + 2Ag + 2\oplus = 2AgCl.$ $SO_4'' + H_2O + \frac{1}{2}Pb + 2\oplus = \frac{1}{2}PbO_2 + H_2SO_4.$	$2AgCl + 2H' = 2HCl + 2Ag + 2\oplus.$ $\frac{1}{2}PbO_2 + 2Na' + H_2O = 2NaOH + \frac{1}{2}Pb + 2\oplus.$

The resulting phenomenon is therefore:

$$NaCl + H_2O = NaOH + HCl.$$

Example 3.

It is assumed, that the metal of c' is again silver and that of c lead. It is further assumed, that the solutions on the left of c' are alternatively solutions of common salt and gypsum and that the liquid on the right of the rolls c' is water acidulated with sulfuric acid. Thus, the arrangement in the opposite direction of the current is the following: solution of common salt—roll of silver—acidulated water—roll of lead—solution of gypsum—roll of silver—acidulated water—roll of lead—solution of common salt.

The occurring phenomena are:

$$(2NaCl \rightarrow 2Na' + 2Cl';\ H_2SO_4 \rightarrow 2H' + SO_4'';\ CaSO_4 \rightarrow Ca'' + SO_4''.)$$

Side of the anode.	*Side of the cathode.*
$2Cl' + 2Ag + 2\oplus = 2AgCl.$ $SO_4'' + H_2O + \frac{1}{2}Pb + 2\oplus = \frac{1}{2}PbO_2 + H_2SO_4.$ $SO_4'' + 2Ag + 2\oplus = Ag_2SO_4.$ $SO_4'' + H_2O + \frac{1}{2}Pb + 2\oplus = \frac{1}{2}PbO_2 + H_2SO_4.$	$2AgCl + 2H' = 2HCl + 2Ag + 2\oplus.$ $\frac{1}{2}PbO_2 + Ca'' + H_2O = Ca(OH)_2 + \frac{1}{2}Pb + 2\oplus.$ $Ag_2SO_4 + 2H' = H_2SO_4 + 2Ag + 2\oplus.$ $\frac{1}{2}PbO_2 + 2Na' + H_2O = 2NaOH + \frac{1}{2}Pb + 2\oplus.$

The resulting phenomenon is:

$$2NaCl + CaSO_4 + 4H_2O = 2NaOH + 2HCl + Ca(OH)_2 + H_2SO_4.$$

What I claim now as my invention is:

1. A device for carrying out chemical

processes by electrolysis, comprising a receptacle subdivided into cells containing electrolytes, a positive electrode arranged in the cell provided at one end of the receptacle, a negative electrode arranged in the cell provided at the opposite end of the receptacle, means provided between adjacent cells adapted to act as carriers for the substances adhering thereto when current is supplied to said electrodes, and means for moving said first mentioned means so that the part of the latter situated in one cell is alternately brought into the adjacent cell owing to the movement imparted to said means.

2. A device for carrying out chemical processes by electrolysis, comprising a receptacle subdivided into cells containing electrolytes, a positive electrode arranged in the cell provided at one end of the receptacle, a negative electrode arranged in the cell provided at the opposite end of the receptacle, rolls provided between adjacent cells adapted to act as carriers for the substances adhering thereto when current is supplied to said electrodes, and means for moving said rolls so that the part of each roll situated in one cell is alternately brought into the adjacent cell owing to the movement imparted to said roll.

3. A device for carrying out chemical processes by electrolysis, comprising a receptacle subdivided into cells containing electrolytes, a positive electrode arranged in the cell provided at one end of the receptacle, a negative electrode arranged in the cell provided at the opposite end of the receptacle, metallic rolls provided between adjacent cells adapted to act as carriers for the substances adhering thereto when current is supplied to said electrodes, and means for moving said metallic rolls so that the part of each roll situated in one cell is alternately brought into the adjacent cell owing to the movement imparted to said roll.

4. A device for carrying out chemical processes by electrolysis, comprising a long trough subdivided into cells containing electrolytes, a positive electrode arranged in the cell provided at one end of the trough, a negative electrode arranged in the cell provided at the opposite end of the trough, metallic rolls provided between adjacent cells adapted to act as carriers for the substances adhering thereto when current is supplied to said electrodes, and means for rotating said metallic rolls so that the part of each roll situated in one cell is alternately brought into the adjacent cell.

In testimony that I claim the foregoing as my invention, I have signed my name.

DR. VIKTOR GERBER.