(No Model.)

C. KELLNER.

ELECTROLYTIC PROCESS AND APPARATUS THEREFOR.

No. 588,276. Patented Aug. 17, 1897.

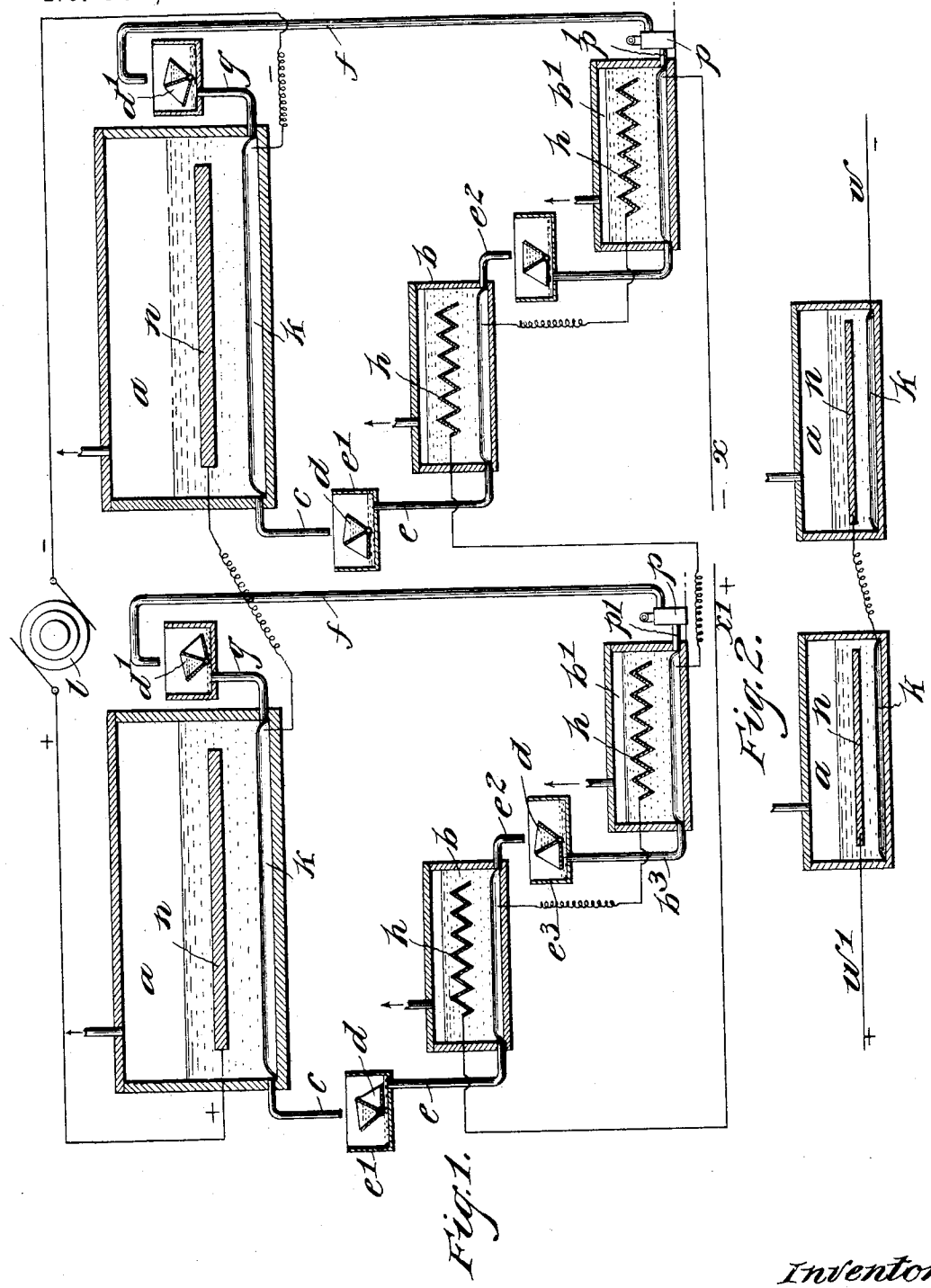

Fig. 1.

Fig. 2.

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ELECTROLYTIC PROCESS AND APPARATUS THEREFOR.

SPECIFICATION forming part of Letters Patent No. 588,276, dated August 17, 1897.

Application filed February 24, 1896. Serial No. 580,570. (No model.) Patented in Belgium April 11, 1895, No. 115,029; in France April 11, 1895, No. 246,574; in England April 11, 1895, No. 7,458; in Norway July 16, 1895, No. 4,451, and in Italy September 30, 1895, XXX, 39,385, and LXXVII, 190.

To all whom it may concern:

Be it known that I, CARL KELLNER, a subject of the Emperor of Austria-Hungary, residing at Vienna, in the Province of Lower Austria, in the Empire of Austria-Hungary, have invented certain Improvements in Electrolytic Processes and Apparatus Therefor, (for which patents have been obtained in the following countries, to wit: Belgium, No. 115,029, dated April 11, 1895; France, No. 246,574, dated April 11, 1895; England, No. 7,458, dated April 11, 1895; Norway, No. 4,451, dated July 16, 1895, and Italy, XXX, 39,385, and LXXVII, 190, dated September 30, 1895;) 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 appertains to make and use the same, reference being had to the accompanying drawings, and to letters of reference marked thereon, which form a part of this specification.

My invention has relation to the electrolytic decomposition of compounds whose electropositive constituent will combine or form an amalgam with mercury.

In the electrolytical treatment of the compounds referred to—as, for instance, the salts of metals which will amalgamate with mercury, such as the salts of the metals of the alkalies—as heretofore conducted great difficulties have been experienced in separating many of the electropositive constituents of these compounds from the mercury as fast as they combine or amalgamate therewith under the action of the electric current. On the other hand, in all the apparatuses used in these electrolytic processes so far as known to me it is very difficult to convert the energy generated by the decomposition of the amalgam into electric energy of a higher potential than that necessary to the electrolytic decomposition of the compound, because it is impracticable to connect in series the separating-cells—that is to say, the cells in which the electropositive constituent of the salt deposited in or amalgamated with the mercury is removed or separated—owing to the difference of potential relatively to that of the main current.

In order to facilitate the decomposition of the amalgam, various means have heretofore been proposed—namely, by increasing the surface in contact with the decomposing agent or reaction liquid, by heating said liquid, or by separating the amalgam from the mercury through the medium of the difference in their specific gravity. In most cases the ends in view are attained by these means, which, however, have a disadvantage in that comparatively large quantities of mercury are required. It has further been proposed to utilize the amalgam as a galvanic element and also to utilize the mercury as a bipolar electrode. In the former of the two propositions last referred to it is difficult to maintain the cells independently at a given potential, and in the last-named proposition it is hardly possible to avoid the oxidation of the mercury after a long period of operation. To avoid the latter disadvantage, the use of a second weaker source of electricity, as a dynamo-machine, for the purpose of continuously enriching the mercury with a certain proportion of metal has been proposed. This method has, however, given very uncertain results, because of the occlusion of hydrogen, in the absence of which the mercury does not give up the metal amalgamated therewith, notwithstanding the fact that the amalgam is in contact with water, and because when the apparatuses are connected in series two mutually-complementary currents pass through the same, giving rise to considerable difficulties when working on a large scale, owing to the difference in potential of the currents.

This invention has for its object to overcome the difficulties enumerated, so that the electrolytic decomposition of the compounds referred to can be effected economically and on a large scale.

The invention may be said to consist, essentially, in withdrawing the amalgam formed by an action of an electric current from the influence of such current, then moving the amalgam into contact with a suitable electrolyte and passing through the latter an electric current of a potential different from that of the main current for the purpose of decomposing the amalgam. In this manner I

am enabled to readily effect the separation from mercury of electropositive ions, which have heretofore been separated therefrom with difficulty. On the other hand, when working with salts of metals which are readily oxidized and dissolved by a suitable agent—as water, for instance—the auxiliary electric generator can be dispensed with and the energy developed by the reaction converted into electrical energy and utilized in the electrolytic process or otherwise, while a current of a higher potential than that of the decomposing current can thus be obtained.

That my invention may be fully understood, I will describe the same in detail, reference being had to the accompanying drawings, in which—

Figure 1 is a diagrammatic sectional view of an apparatus designed for carrying out my invention. Fig. 2 is a like detail.

As shown in Fig. 1, the apparatus consists, essentially, of a number of decomposing-cells *a*—that is to say, cells in which a salt of a metal capable of amalgamating with mercury is decomposed by the action of an electric current—and of a corresponding number of groups of separating-cells—that is to say, cells wherein the metal deposited in the mercury in the decomposing-cells is separated—*i. e.*, wherein the amalgam is decomposed.

In the drawings I have shown a group of two separating-cells *b b'* for each decomposing-cell, but the number of these separating-cells in each group may be varied, and, as shown, said cells are not only bodily isolated or separated from their respective decomposing-cells *a*, but they are also electrically isolated from said cells *a*.

Inasmuch as the liquid electrode (mercury) has to be moved from the decomposing-cells through their respective groups of separating-cells and thence back to said decomposing-cells, it is necessary that the flow of mercury be such as to prevent electrical connection therethrough between the two denominations of cells, which would be the case if such mercury were flowing in an uninterrupted stream from the cells *a* to the first cells *b* of the respective groups of separating-cells. This I avoid by providing any suitable means for interrupting or breaking up the flow of mercury, as cocks or valves. I prefer, however, to use rocking feed-hoppers *d d'*, angular in cross-section and partitioned off into feed-chambers, said hoppers constructed of a non-conductive material and adapted to empty first one and then the other feed-chamber during their rocking movements. As shown, the mercury and metal deposited thereon or amalgamated therewith by the action of an electric current in the cells *a* flows through a pipe *c* into one or the other hopper-chamber, said hopper *d* adapted to rock in a vessel *e'*, connected by pipe *e* with the first separating-cell *b* of a group of such, the mercury flowing from such cell through a pipe e^2, its flow being interrupted by a hopper in a vessel e^3, connected by pipe b^3 with the second separating-cell *b'*, and so on, if there are more, the last separating-cell of a group being connected by a pipe *p'* with the suction-port of a pump *p*, that moves the mercury freed from the metal amalgamated therewith through a pipe *f* back to the decomposing-cell *a*, the flow being likewise interrupted by a hopper *d'* in a vessel connected by pipe *g* with said cell.

The decomposing-cells *a* contain each a suitable anode, the mercury constituting the cathode, and said electrodes may be connected in parallel or in series with the terminals of a suitable source of electricity, as a dynamo *i* of high potential.

The separating-cells contain each a fixed electrode *h*, the amalgam constituting the second electrode, the cells of a group and the several groups of cells being connected together in series—that is to say, the mercury amalgam of the first cell *b* of the first group is connected with the electrode *h* of the second cell *b'* of said group, while the mercury amalgam of the latter cell is connected with the electrode *h* of the first cell of the second group, and so on throughout the series, the electrode *h* of the first cell *b* of the first group and the mercury or amalgam of the second cell *b'* of the last group being respectively connected with the positive and negative poles of a source of electricity, as the dynamo *l*, Fig. 2, of low potential, so that a current can be sent through the separating-cells, whereby the decomposition of the amalgam is facilitated and expedited, which is of great importance, as I am thereby enabled to readily decompose amalgams which under other conditions or in the processes as usually carried on can only be effected with great difficulty and under great disadvantages. On the other hand, when working with amalgams that are readily decomposed in the presence of a suitable electrolyte the generator *l* is dispensed with and the energy developed by the mutual reaction of the electrolyte and amalgam can be converted into electric energy, which may be utilized in any desired manner, or in the electrolytic process itself by introducing a number of decomposing-cells *a* into the circuit of the separating-cells, Fig. 3, the positive and negative conductors *w* and *w'* forming then a continuation of the like conductors *x* and *x'* of said circuit.

In the arrangement of the apparatus shown and described the potential of any one or more or of all the cells can be readily regulated by means of a suitable resistance or resistances, so that the variations which occur in all electrolytic processes in which mercury is used as a cathode can readily be adjusted.

From what has been said it will be seen that the described electrolytic process may also be carried out in most of the apparatuses as heretofore constructed for use with a mercury cathode.

Having thus described my invention, what

I claim as new therein, and desire to secure by Letters Patent, is—

1. In a continuous process for the electrolytical decomposition of compounds the electropositive constituents of which amalgamate with mercury, passing an electric current through a solution of such compound to a body of mercury included in the electric circuit and moving continuously out of and back into the field of action of the electric currents to successive points where the amalgam formed by such electric action acts as an anode, decomposing the amalgam successively at such points by means of a suitable decomposing agent in presence of a suitable cathode, connecting the successive electrodes in series, whereby an independent current of electricity is generated whose potential is higher than that of the electrolyzing-current, and utilizing such current, for the purpose set forth.

2. In electrolytic apparatus, a number of decomposing-cells having mercury cathodes and suitable anodes, said cells connected in series, in combination with a plurality of oxidizing-cells connected in series, and means for transferring the amalgam formed in the decomposing-cells to the oxidizing-cells in the presence of a suitable cathode and solution, means for utilizing the current set up in the oxidizing-cells, and means for returning the mercury from the oxidizing-cells to the primary or decomposing cells.

3. In an electrolytic apparatus, a series of decomposing-cells each containing a fixed anode and a liquid cathode, as mercury, said cells connected in series, in combination with a group of oxidizing-cells for each decomposing-cell, a fixed cathode in each of the oxidizing-cells, means for moving the liquid cathode from a decomposing-cell successively through the oxidizing-cells of a group and back to such decomposing-cell, an electrical supply for the cells, and means for preventing electrical connection through the liquid cathode between a decomposing-cell and the first and last oxidizing-cells of a group of such, for the purpose set forth.

4. In electrolytic apparatus, a plurality of decomposing-cells having mercury cathodes, said cells connected in series, in combination with a plurality of oxidizing-cells connected in series and means for dropping the amalgam formed in the decomposing-cell into the oxidizing-cells in succession, means for breaking the electrical connection between the cells, means for returning the mercury to the decomposing-cells and means for utilizing the current set up in the oxidizing-cells, substantially as and for the purpose set forth.

5. In an electrolytic apparatus, a series of decomposing-cells each containing a fixed anode and a liquid cathode, as mercury, said cells connected in series, in combination with a group of oxidizing-cells for each decomposing-cell, a fixed cathode in each of the oxidizing-cells, means for moving the liquid cathode from a decomposing-cell successively through the oxidizing-cells of a group and back to such decomposing-cell, suitable electrical connections connecting all of the oxidizing-cells in series, and means for preventing electrical connection between a decomposing-cell and the first and last oxidizing-cells of a group of such through the liquid cathode, for the purpose set forth.

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

CARL KELLNER.

Witnesses:
DEAN B. MASON,
HARRY BELMONT.