

No. 673,754.

Patented May 7, 1901.

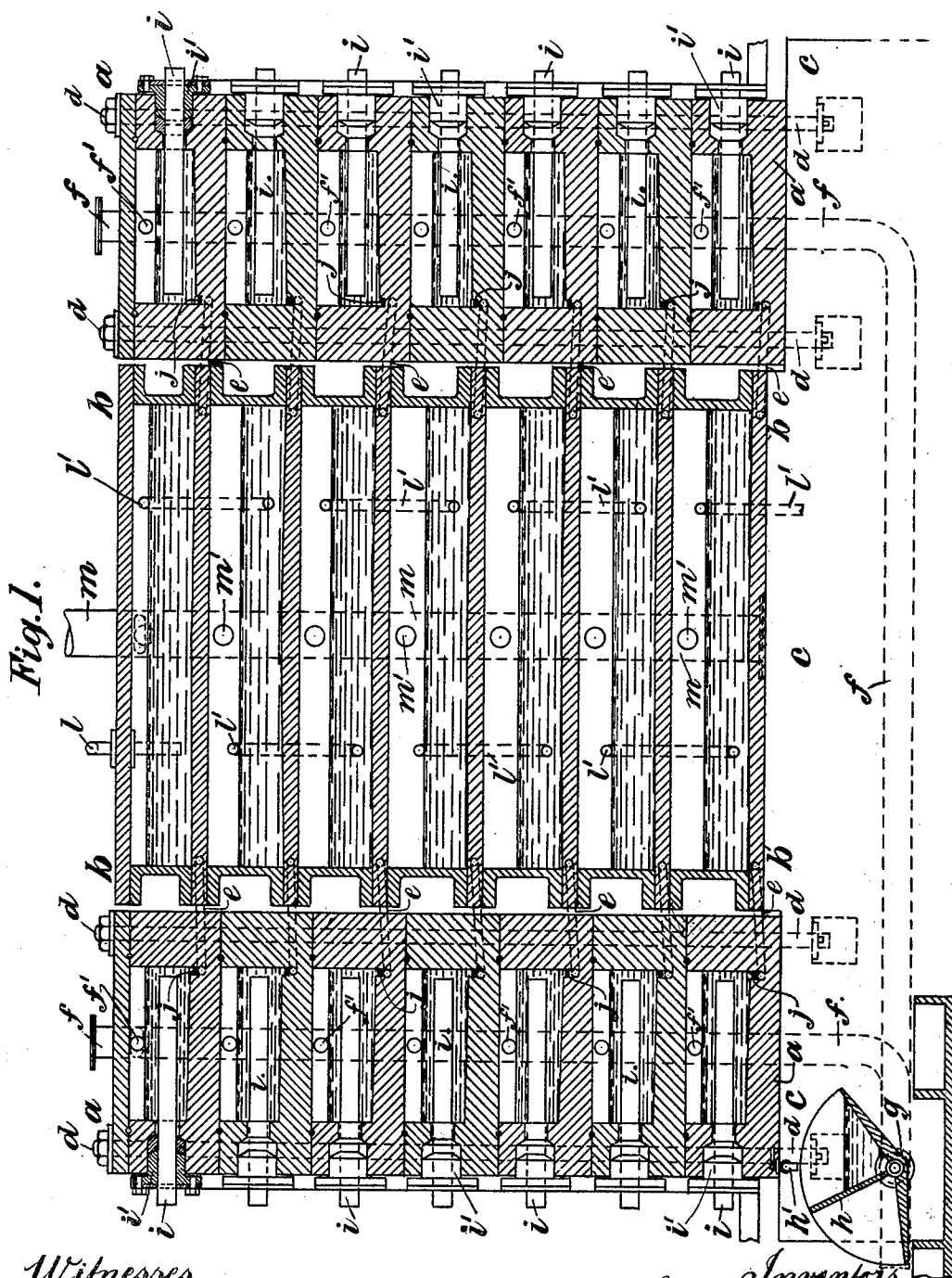
G. & G. W. BELL.

PROCESS OF ELECTROLYTIC DECOMPOSITION.

(Application filed June 7, 1898.)

(No Model.)

4 Sheets—Sheet 1.



Witnesses.

C. B. Kolton
Oldman

Inventors.

Inventors.
George Kelle
George William Kelle

By Richard R.

their Attorneys

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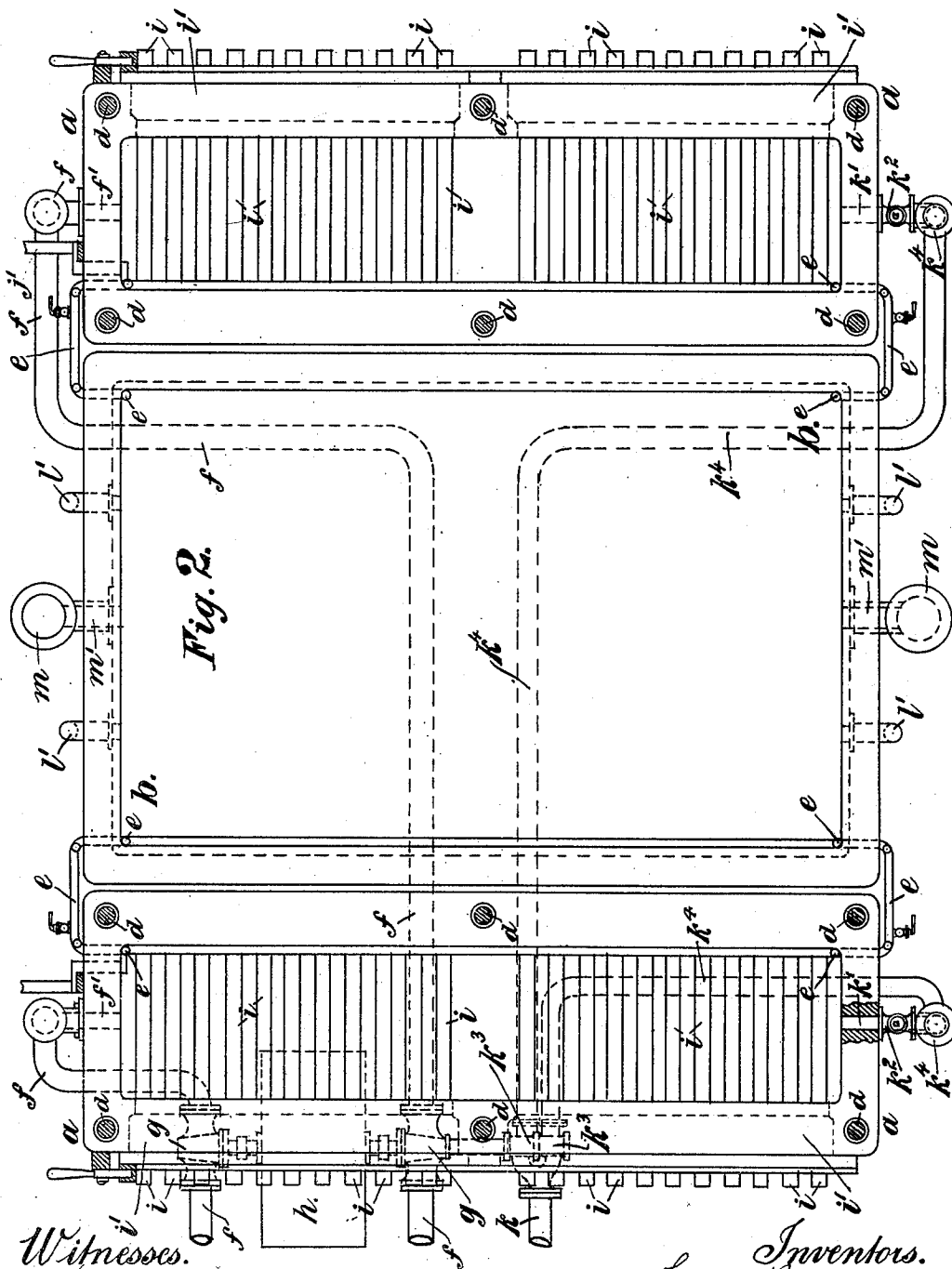


Fig. 2.

Witnesses.

C. B. Bolton

Attorney

Inventors.

George Bell

George William Bell

By Richardson

MADE IN AMERICA

No. 673,754.

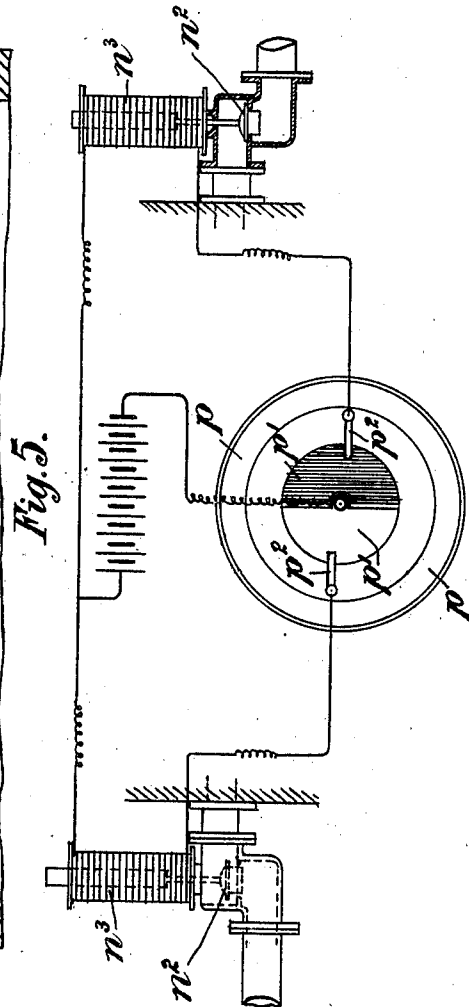
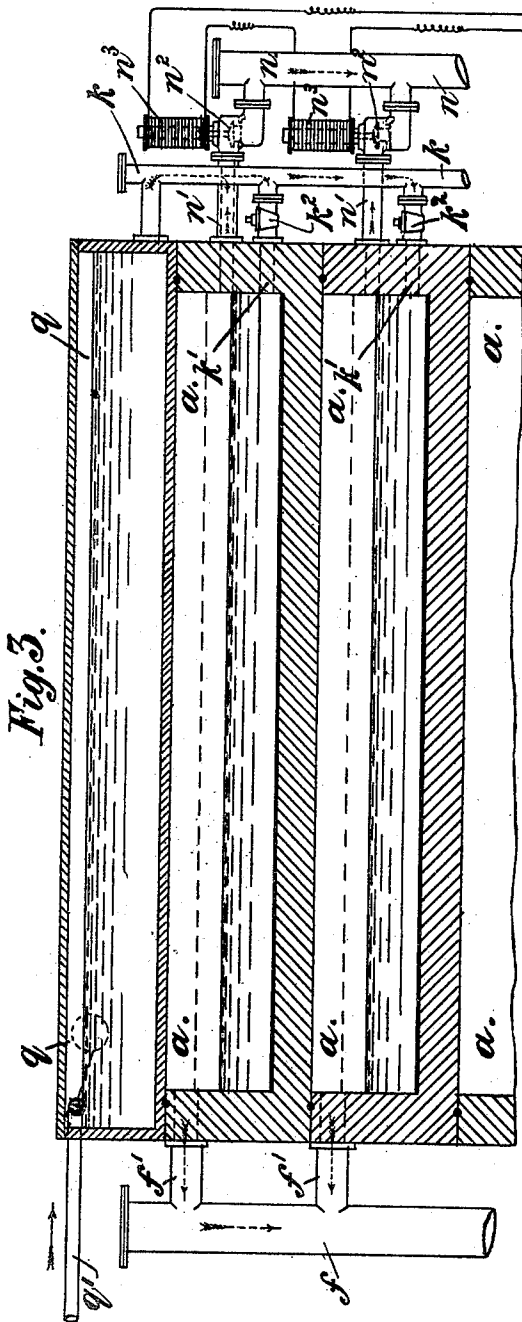
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4 Sheets—Sheet 3.



Witnesses.

E. B. Bolton

Adams

Inventors.

George Bell

George William Bell

By *Richard A.*

their Attorneys

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G. & G. W. BELL.

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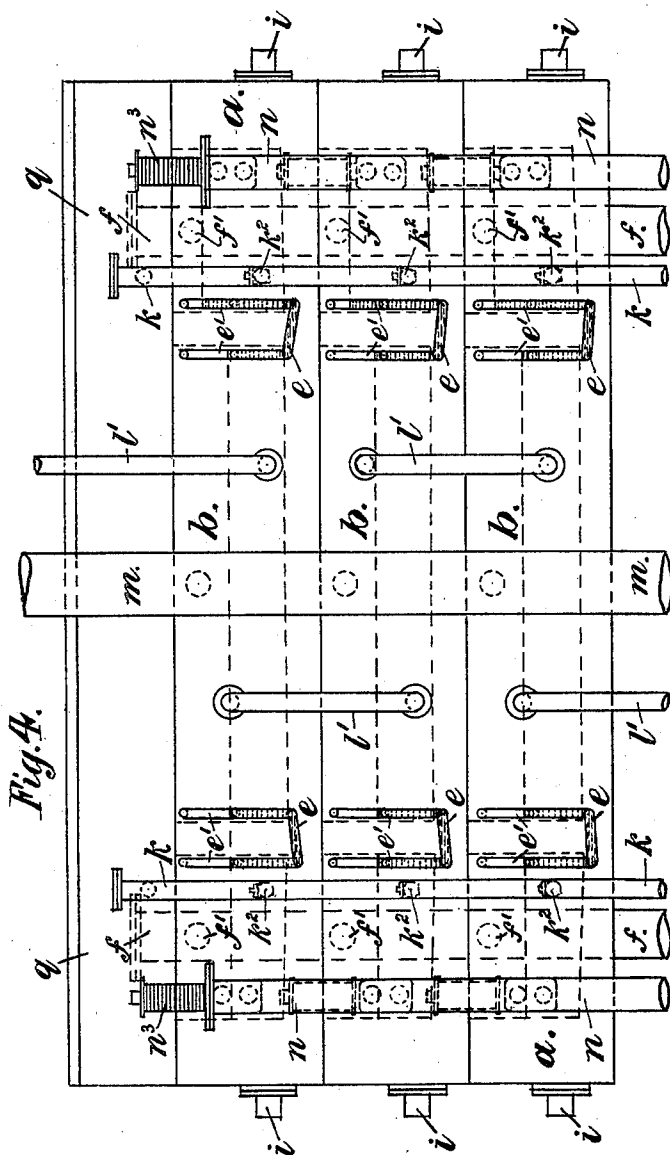
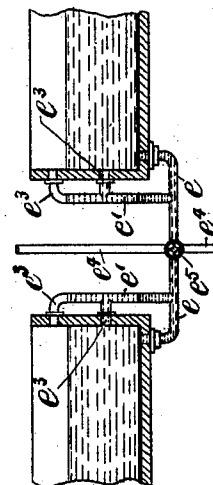


Fig. 6.



Witnesses.

E. B. Bolton

Attorney

Inventors.

George Bell

George William Bell

By Richard A.

their Attorneys

UNITED STATES PATENT OFFICE.

GEORGE BELL AND GEORGE WILLIAM BELL, OF LIVERPOOL, ENGLAND.

PROCESS OF ELECTROLYTIC DECOMPOSITION.

SPECIFICATION forming part of Letters Patent No. 673,754, dated May 7, 1901.

Application filed June 7, 1898. Serial No. 682,804. (No specimens.)

To all whom it may concern:

Be it known that we, GEORGE BELL and GEORGE WILLIAM BELL, subjects of the Queen of Great Britain, and residents of Liverpool, county of Lancaster, England, have invented certain new and useful Improvements in Processes of Electrical Decomposition of Alkali Salts, of which the following is a specification.

10 This invention has reference to a process for electrically decomposing alkaline salts in solution for the production of pure alkaline hydrates and chlorine from alkaline chlorides and for the decomposition of other salts of
15 alkali metals and similar substances for the the production of other products therefrom.

The chief object of the present invention, among other things, is to provide a practical and simple method of effecting the alternating action of the mercury—that is, the alternate movement of the mercury from the decomposing-chamber to the oxidizing-chamber and its return—without the employment of any moving cell or parts or appliances
25 within the cell itself and to thereby obviate the inherent defects of the use of moving parts in such apparatus, where there is produced the most corrosive of chemicals or substances, rendered more so by the presence of
30 the electric current, and in their nascent condition and where the most perfect insulation has to be maintained against the leakage of current.

According to this invention the method of
35 moving mercury from the decomposing-chamber to the oxidizing-chamber and from the oxidizing-chamber back to the decomposing-chamber is by alternately creating a difference of pressure upon the surface of mercury in the two chambers respectively. For instance, assuming the mercury to be lying in the bottom of the decomposing-chamber, then by artificially raising the pressure upon the surface of the mercury in this chamber,
40 as hereinafter described, rendering it greater than that in the oxidizing-chamber, (the two chambers being of course in communication by suitable conduits at their lower parts,) the mercury will be forced from the bottom
45 of the decomposing-chamber through these conduits into the bottom of the oxidizing-chamber, and then by removing this differ-

ence of pressure the mercury will flow back from this chamber by the head or pressure then existing on it. By repeating these actions the alternations of flow of mercury between the two—or there may be more—chambers is continuously accomplished.

A further description of this invention will be made with reference to the drawings, of which—

Figure 1 is a longitudinal section of a complete cell or apparatus for carrying out this invention, and Fig. 2 is a plan with the covers removed. Fig. 3 is a transverse section of a cell or apparatus adapted to act according to a modified method of that which obtains in the apparatus in Figs. 1 and 2, and Fig. 4 is an outside side elevation of the apparatus. Fig. 5 is a diagrammatic view illustrative of the mode of actuating the valves in this apparatus. Fig. 6 shows a detail.

Referring in the first instance to Figs. 1 and 2, the apparatus therein shown is one in which each cell comprises three chambers, of which two are decomposing-chambers and one an oxidizing-chamber. These chambers are respectively designated *a* and *b*. The two outside chambers *a* are arranged in multiple in a pile, one over the other, and are separate structures from the chambers *b*, (which may be disposed anywhere conveniently,) but connected with them, these chambers *b* being similarly arranged in a pile and all supported on a suitable rigid base *c*, to which they will be bolted down by common holding-down bolts *d*.

With regard to the details of the apparatus, *i* represents the anodes, which, say, are carbon rods, they being passed through gland stuffing-boxes *i'* common to several rods, fitted into the ends of the material of which the chambers *a* are formed, current being conveyed to them in any known suitable way. The bottoms or floors of these chambers are inclined toward the outlet part—the inner edge of the chambers—where the communicating pipes *e* connect them with the chambers *b*, and along this edge there is a metal—say iron—bar *j*, the surface of which is amalgamated with mercury and which is let into a groove in the bottom of the chamber, and this bar in each cell is coupled up with the return electrical conductor *j'* in each cell.

The current thus flows from the carbon anodes i through the mercury in each chamber a to the amalgamated bars j and away by the conductors j' . The effect of this construction and arrangement is that all the mercury practically will be caused to pass from each chamber a to b in each action and that when it is nearly all gone the resistance of the chamber will be very considerably raised, with the result that the electrolytic action and generation of chlorine will be practically stopped directly the mercury has practically all been driven out of the chamber a , and therefore the breaking of the lute of mercury in the conducting-pipes e by forcing it out of them is automatically obviated and the access of the liquor from a decomposing-chamber to an oxidizing-chamber, or vice versa, is prevented.

The method of producing the alternations of flow of the mercury from and back to the chambers a consists in the alternate closing up of the chambers a , thereby creating a rise of pressure by the accumulation of the gas given off, (chlorine, in the case of the electrolyte being a chloride,) which pressure, acting upon the surface of the liquid, will force the mercury at the bottom of the chambers a through the connecting-pipes e into the chambers b , and then by the release of this gas under pressure by opening the chambers a the mercury will flow back into a from b by the excess of head in b thus exerted.

The opening and closing of the chambers a and the consequent creation of pressure and its subsequent release by the gas given off in the decomposition of the electrolyte by the electric current is conveniently effected by a valve or valves, and under this invention this is accomplished by the employment of a single valve or valvular apparatus for a whole pile of chambers. This end is advantageously produced by the employment of a common chlorine or gas discharge pipe f for each pile of chambers a and a single valve for opening and closing it, communication between the chambers and the pipe being by branches f' , which carry off the gases from the chamber above the electrolyte. g is the tap or valve on each of these mains, and the two are operated—that is, opened and closed—by a double hydraulic tumbling-basin h , charged with water from a supply-tap h' , the taps or valves being so arranged that one is opened when the other is closed when the tumbling-basin is on the one or other side of its oscillation. The effect of this is that when one set of chambers a is closed and gas and pressure are accumulating in them the other set will be open and the mercury connected with one of the two sets will be receiving the alkaline base liberated by electrolysis and that connected with the other will be giving the base up to the liquor in the oxidizing-chambers b by the oxidation of the amalgam formed in a .

The flow of brine of full strength to the

chambers a to be decomposed is supplied to them by a common main k , passing through valves k^3 on the main branches k^4 , leading to the respective piles of decomposing-chambers, and which valves are also opened and closed at the same time as the gas-valves g by the tumblers h , the main k^4 having branches k' leading to each of the chambers a , each branch having regulating-taps k^2 thereon, which will be permanently set to give the required rate of feed. The level of the liquor is maintained in a by the outlet branches f' , connected with the main f , and the overflow of electrolyte takes place by way of these branches, so that the mains f serve both to carry off the gas given off in a as well as the overflow of electrolyte. The electrolyte will of course be separated and drawn off from the pipe f by any known suitable means.

The liquor used in the chambers b is passed in series through them, being introduced at the uppermost chamber by a pipe l , and then the overflow from this to the next chamber below is carried by connecting pipes or loops l' , and so on throughout the pile. These pipes will maintain the level of liquor in the chambers b , and the liquor in its descent will become stronger as it passes through the pile. The hydrogen given off in these chambers b is carried off by a main m , which communicates with the chambers by branches m' .

In lieu of the alternate opening and closing of the chamber a being effected by the hydraulic timing device shown and described it may be accomplished by any other equivalent timing means—as, for instance, an electricity motor-meter may be adapted to open and close the valve for every unit of quantity decided upon which passes through the meter, or it may be effected by a solenoid acting upon the valve, the current of which would be controlled by a timekeeping motor or mechanism or by other equivalent means.

The oxidizing-chambers b may be of iron or any other suitable material, and the chambers a may be of glass, earthenware, or other suitable material or combinations of material.

The apparatus shown in Figs. 3 to 5 is one adapted to carry out a modification of the method above described of alternating the flow of mercury from one chamber to the other. This modification consists in alternately raising and lowering the pressure on the mercury in one of the chambers by raising and lowering the hydrostatic head in one of the chambers of each cell. In the case shown this raising and lowering of the head of liquor is applied to the decomposing-chambers a . In this case the brine is supplied to the chambers a through the pipe k and branches k' , each of which has a regulating-tap k^2 on it, and the normal overflow and outlet takes place through the branches n' , connected with the common main n , a valve n^2 , controlled by a solenoid n^3 , being provided on each branch n' to close these branches when it is desired

to raise the head and to open them when it is desired to lower it. The escape of gas and also the overflow of electrolyte that may take place when the head has been raised is carried off by the common main f and branches f' . The three chambers a and b in this cell, as shown in Fig. 4, are represented in one piece; but in other respects than these the cells are the same as those shown in Figs. 1 and 2. In action the two side sets of chambers a are adapted to work alternately—namely, the hydrostatic head is high at one side when that at the other is low, and vice versa—this being effected by a rotating switch p , having a revolving contact p' , half of which is metallic and half insulating (shown shaded in the drawings) and on which the brushes p^2 , connected with the solenoids n^3 , bear. As this contact revolves it alternately energizes and deenergizes the magnets of the solenoids n^3 of the two sets of chambers a alternately, and thus one set of valves n^2 will be opened when the other is closed, and vice versa. When one of these sets of valves n^2 belonging to one of the chambers a is closed, the flow of electrolyte by the pipe k and branches k' will cause the level in all the chambers to rise, and this rise of level or raising of the hydrostatic head will cause the mercury at the bottom of the cell to flow into the oxidizing-chambers, where the level of liquor is constant, and then when the valves n^2 are opened the level again falls to the level of the outlet n' and the mercury returns. The electrolyte is supplied from the supply-tank q on the top of the pile to the pile a , and it is returned to this tank q through the pipe q' after passing through the saturator.

The operation of the cells generally and of the mercury in particular is rendered visible by constituting the pipes e into indicators—that is, by making them of glass and carrying up vertical portions e' , connected with the chambers a and b , below and above the level of the liquor in them, by branches $e^3 e^3$, the movement of mercury and its levels, as well as the levels of the liquors, can readily be directed and observed—and if the pipes e be placed, as they are, below the level of the bottom of the chambers by providing a vertical pipe e^4 , connected with e through a tap e^5 , the mercury can be drawn off from all

the chambers of the pile at any minute and the vessels or chambers emptied of mercury.

As regards the means of obtaining the variations of the hydrostatic head in the cells, it is not restricted to that above specified, as various equivalents of it may be employed without departing from the invention.

With regard to the shape of the cells or chambers a and b , these are in no way restricted to those given in the drawings, as they may be circular, of annular arrangement, as well as rectangular or polygonal, and, moreover, they are not restricted at all to the dispositions in the drawings nor to their number.

What is claimed in respect of the herein-described invention is—

1. A process of effecting electrolytic decomposition of salts of alkaline metals which consists in passing an electric current through an electrolyte of an aqueous solution of same to a body of liquid metal beneath it in the decomposing-chamber, next expelling the body of the liquid metal from the decomposing-chamber into an oxidizing-chamber and returning the body of liquid metal freed from alkali metal back to the decomposing-chamber by an artificial fluid-pressure acting on the surface of the liquid metal, substantially as described.

2. A process of effecting the electrolytic decomposition of salts of alkali metals which consists in passing an electric current through an electrolyte consisting of an aqueous solution of the same to a body of liquid metal, accumulating a portion of the gas generated under pressure in contact with the electrolyte, causing such compressed gas to expel the body of liquid metal from the decomposing-chamber into an oxidizing-chamber, oxidizing the metal therein, and finally removing the gaseous pressure from the electrolyte and permitting the liquid metal to flow back into the decomposing-chamber, substantially as described.

In witness whereof we have hereunto set our hands in presence of two witnesses.

GEORGE BELL.

GEORGE WILLIAM BELL.

Witnesses:

JOHN H. WALKER,

WILLIAM I. HUMPHRIES.