No. 712,218. Patented Oct. 28, 1902.

A. E. TRUESDELL.

ELECTROLYTIC CELL.

(Application filed Apr. 13, 1901.)

(No Model.)

Fig. 1.

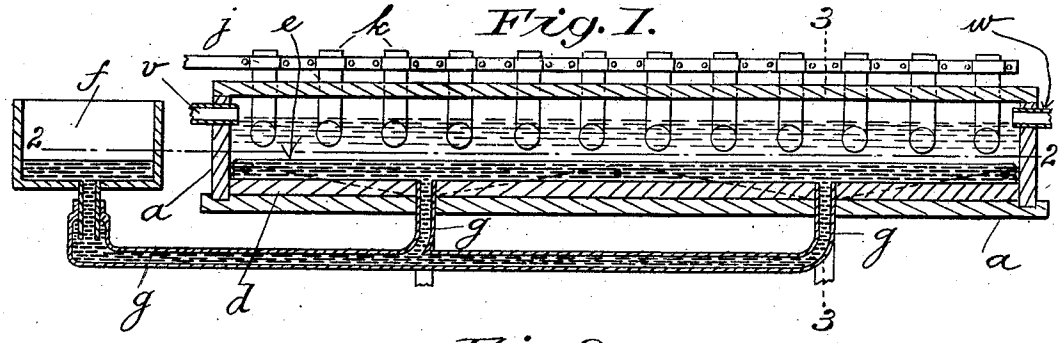


Fig. 2.

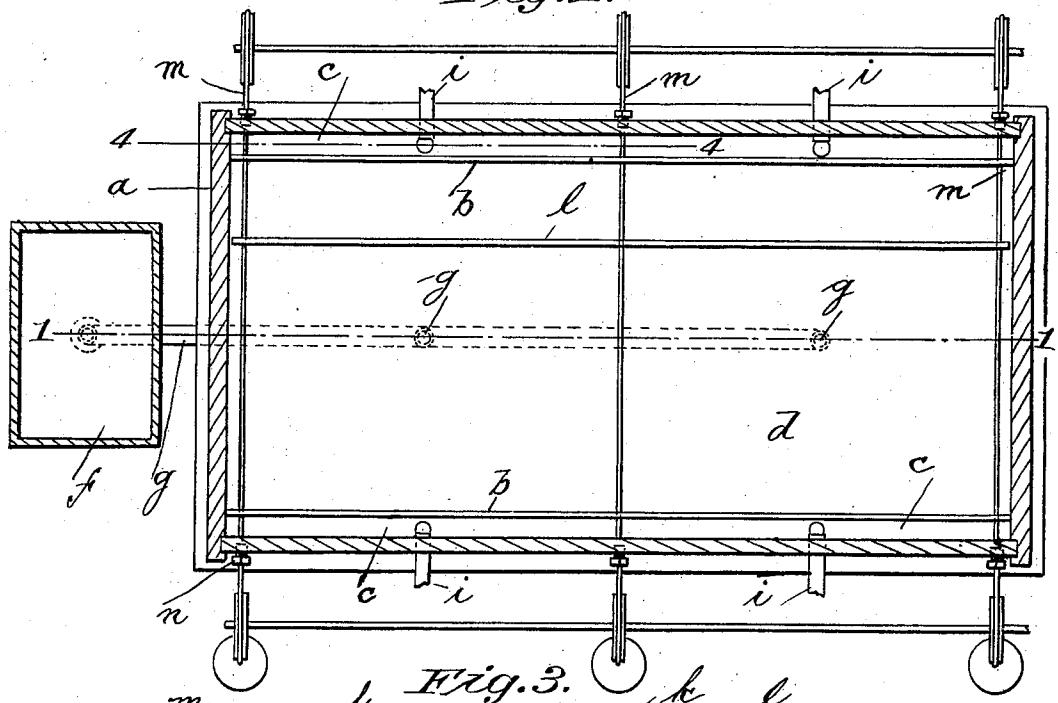


Fig. 3.

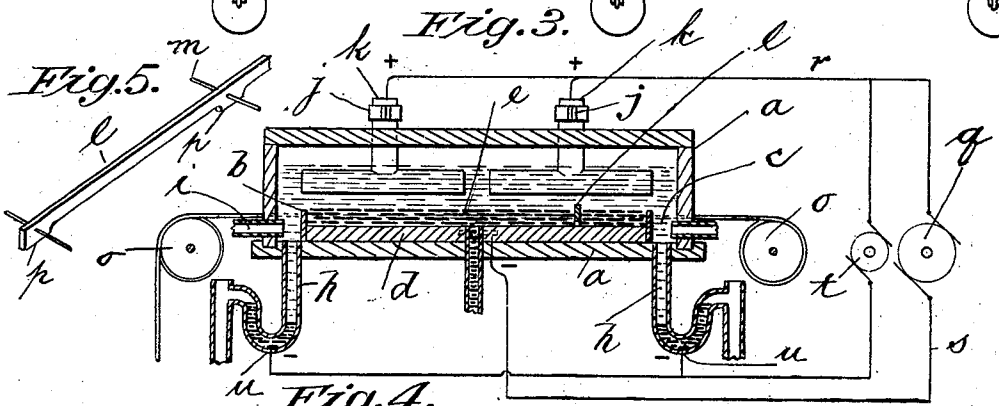
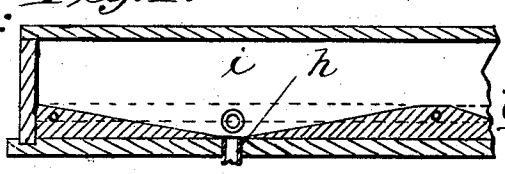


Fig. 5.

Fig. 4.



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ARTHUR E. TRUESDELL, OF PITTSFIELD, MASSACHUSETTS.

ELECTROLYTIC CELL.

SPECIFICATION forming part of Letters Patent No. 712,218, dated October 28, 1902.

Application filed April 13, 1901. Serial No. 55,700. (No model.)

To all whom it may concern:

Be it known that I, ARTHUR E. TRUESDELL, a citizen of the United States of America, residing at Pittsfield, in the county of Berkshire and State of Massachusetts, have invented new and useful Improvements in Electrolytic Cells, of which the following is a specification.

This invention relates to electrolytic processes, the object thereof being the improvement of an electrolytic cell particularly adapted to the treatment of solutions containing salts of the alkaline metals. It is well known that one of the principal difficulties in electrolyzing these solutions is due to the chemical affinity between the element separated at the cathode on the one hand and the solvent of the salt and substances which the solvent may contain on the other hand. This action of the element on the solvent and others due to the presence in the solvent of the elements separated at the anode are known as "secondary reactions" and are accompanied by the evolution of heat. These chemical actions in the cell after the separation of the ions has begun are a distinct loss, as they consume energy and greatly lower the efficiency of the apparatus considered as one adapted to the separation and recovery of the elements as such.

Of the many methods suggested and in use designed to overcome or prevent secondary reactions in electrolytic cells the method in which a cathode of mercury is employed has met with much favor, since the metallic element of the salt immediately on separation from the solution combines with the mercury to form an amalgam, which amalgam is liquid when containing a small per cent. of the element, and therefore lends itself readily to mechanical displacement. If means are not employed for immediately removing this element from a contact with the solution, chemical action will take place between them, forming a new salt of the element, which, if it be soluble, will enter again into the solution and again become subject to the electrolyzing action of the cell the same as in the first instance.

In the referred-to cells of the mercurial type, which are now largely in use, the chief drawbacks are, first, that the ion on separation does not readily combine with the mercury, owing to the fact that the latter is in motion, or, second, that the removal of the amalgam as formed from contact with the solution is neither positive nor complete.

The object of this invention is to prevent secondary reaction in the solution by first effecting the positive separation of the amalgam from the cathode-body; second, by reducing to the smallest possible area the point of contact of said amalgam with the solution; third, by applying to said separated amalgam a current of electricity auxiliary to the main current of the cell, and, fourth, by the introduction of a recharged solution at or near the point of contact of the separated amalgam with the solution.

In the drawings I show one form of construction embodying my invention whereby the improvements above recited may be practically carried out.

Figure 1 is a vertical longitudinal section through an electrolytic cell embodying my invention. Fig. 2 is a sectional plan view on line 2 2, Fig. 1. Fig. 3 is a sectional elevation on line 3 3, Fig. 1. Fig. 4 is a longitudinal section on line 4 4, Fig. 2. Fig. 5 is a perspective view of a portion of one of the sweeps designed to gather the amalgam.

Referring to the drawings, *a* represents a vat or cell of any suitable material, such as slate or earthenware, having therein two oppositely-located ribs *b*, of suitable material, parallel with and near to the opposite sides of said vat or cell *a* and extending from one end thereof to the other, leaving a channel *c* between the side wall of the cell and said ribs. Covering the bottom of the cell between the ribs is located a floor *d*, of cast-iron, carbon, or other suitable conductor, said floor and said ribs, together with the end walls of the cells, constituting a rectangular depression adapted to contain a body of mercury (indicated by *e*) whose depth is determined by the height of the ribs *b* above the floor. A reservoir *f* of mercury may be located at a convenient distance from the cell and connected through the floor *d* by pipes *g* with the interior of the cell, the connection between the reservoir *f* and the pipes *g* being extensible, thereby permitting the raising and lowering of the reservoir for the maintenance of the level of the mercury within the cell. This

vertical adjustment may be effected by screwing the reservoir in and out of the end of the pipe *g*, and, if desired, this adjustment may be made automatic by a suitable connection with any part of the machine, whereby a periodic raising of the reservoir will cause an overflow of the mercurial cathode-body, and thereby effect the depositing of the amalgam formed on the surface of said body in the channels *c*, from whence the amalgam is carried away through the pipes *h*. When the removal of the amalgam is thus effected by the raising of the level of the cathode-body, the sweep *l* may be dispensed with. The preferable construction, however, is that shown in the drawings, which comprises means for mechanically sweeping the amalgam from the surface of the cathode-body into the channels *c*, all as hereinafter described.

The bottom of the channel *c*, between the ribs *b* and the sides of the cell *a*, is, as shown in Fig. 4 and by dotted lines in Fig. 1, made to converge, preferably, at two points in the channel, and at the lowest point of said convergence is located a pipe *h*, which is trapped, as shown in Fig. 3, and which leads to any suitable point where the separation of the amalgam into its constitutent elements takes place, the mercury which is set free being returned eventually to the reservoir *f* and the element separated from the solution treated as may be desired.

It is very important that after the amalgam has been separated from the cathode-body its point of contact with the solution should be reduced to the smallest possible area and that said point of contact should be well removed from the anode, and to that end the pipes *h* are located as described, and the area of the exposure of the amalgam equals only the area of the pipe *h* in cross-section.

Pipes *i* serve for the introduction into the cell of the charged solution which fills the cell up to the overflow-pipe *v*, another pipe *w* being introduced into the cell to provide for the escape of any gas which may be formed.

k represents carbon anodes, preferably arranged, as shown in Fig. 3, in double rows extending down through the cover of the cell and being supported thereby, the T-heads of said anodes being submerged in the solution and extending transversely of the cell. The particular shape and manner of support of the anodes is immaterial, however. A bar *j*, preferably of copper, embraces the ends of the anodes, which project through the cover of the cell, and is in electrical communication with the source of electricity which operates the cell.

The before-referred-to means for mechanically removing the amalgam which forms on the surface of the cathode-body consists of a sweep or scraper bar *l*, shown in its relation to the cell in Figs. 2 and 3, and an enlarged perspective view of a portion thereof is shown in Fig. 5. This bar is preferably made of glass, porcelain, or other suitable substance, supported on the floor *d* of the container by the feet *p*, formed on the lower edge of the bars, which rest on said floor. This sweep extends lengthwise of the container and in any suitable manner may be given a movement transversely of the cell toward the channel *c* by any suitable means. The means shown in the drawings consist of wires *m*, extending through suitable stuffing-boxes *n* in the sides of the cell and connected with the sweep. These wires may be wound around or pass over pulleys *o*, located on opposite sides of the cell, supported on suitable shafts, to which motion may be imparted in any desirable way to effect said traverse motion of the sweep either at a continuous speed or periodically, as desired.

The main source of electricity is indicated by *q*, from the positive role of which a wire connection *r* extends to the bars *j* and from the negative pole of which a wire connection *s* is carried to the floor of the container.

Of course when the vat is in operative position it is filled with the solution up to the height of the overflow-pipe *v*, which solution covers the entire cathode-body. The pipes *h*, through which amalgam is discharged, have their traps sealed by said amalgam. Fresh amalgam as it is swept from time to time into the channel *c* will run into the discharge-pipe and displacing a part of the amalgam forming the seal of the trap takes its place in the latter, thus preventing the passage of solution therethrough, but taking care of the amalgam as it is received.

It will be observed that as the amalgam is removed from the cathode-body it does not come to a state of rest until it reaches the trap in the pipes *h*, and herein lies one of the novel features of the invention, for by the removal of the amalgam in the manner described its contact with the solution is reduced to the cross-sectional area of the pipe *h*, and that contact is at a point well removed from the anode, and therefore the opportunity for reaction is much limited. To prevent as far as possible the effect of even this limited contact with the solution, an auxiliary source of electricity *t* is provided whose positive pole is connected into the line *r*, running to the anodes, but whose negative pole is connected, as at *u*, with the amalgam which always fills the trap in the discharge-pipe *h*, and the current from this auxiliary source by well-known means may be so regulated as to density as to practically reduce to a minimum any reaction due to the contact of the solution with the amalgam in the discharge-pipes. Furthermore, it has been found in practice that by effecting the inflow of fresh solution through the pipes *i* at the bottom or substantially the bottom of the incline within the channel *c* and permitting it to flow upward therefrom into the cell tends to largely counteract the

tendency to reaction of the amalgam within the discharge-pipe or of the amalgam accumulating on the top of the pond of mercury.

The reason for introducing the fresh solution in the immediate neighborhood of the removed amalgam is because the fresh solution contains fewer elements calculated to react on the amalgam than does the solution in the cell which has been subjected to the decomposing action of the electric current. The introduction of this solution at the point described and the restriction of the area of the separated amalgam to as great a degree as is practicable greatly reduce the probability of reaction of the amalgam or, more properly, of the elements therein contained.

From the above description it is seen that means are employed for removing positively the amalgam from the surface of the mercury as rapidly as desired into the channel, from whence it is run into discharge-pipes, whereby it is removed almost entirely from contact with the solution, and during this movement continually subjected to influences for preventing its decomposition and reaction on the solution, first, by the contact of the inflowing recharged solution and, second, by the connections *u* with the auxiliary source *t* of electricity, and the result is a continuously-acting cell free from the objections referred to above as inherent in the type of cells now in use.

Having thus described my invention, what I claim, and desire to secure by Letters Patent of the United States, is—

1. The combination in an electrolytic apparatus, of a vat, a fluid-metal cathode, a container therefor, a suitable anode, a source of electricity, suitable connections from said source to said cathode and anode, whereby, under operative conditions, an amalgam may be formed on said cathode, a channel having an inclined bottom at the side of said container, means for removing said amalgam to said channel, an outlet from the lowest point in the latter and a trap in said outlet, substantially as described.

2. The combination in an electrolytic apparatus, of a vat, a body of mercury therein constituting a cathode, a container for said mercury, a channel having an inclined bottom at the side of said container, a sweep for brushing the surface of said mercury in the direction of said channel, an outlet at the lowest point in the latter, a trap in said outlet, and a pipe in said vat located in proximity to said outlet for the introduction of solution; suitable anodes in the vat, and electrical connections between said anodes and cathode, substantially as described.

3. The combination in an electrolytic apparatus, of a vat, a cathode of mercury, a container for said cathode, a suitable channel in the side of the container, and a discharge-pipe in said channel, and a trap in the discharge-pipe; an anode, a main source of electricity and an auxiliary source of electricity, suitable connections between said main source to the anode and the cathode, and connections from said auxiliary source to the anode and to said trap in the outlet-pipe, and means operating on the surface of the cathode whereby an amalgam formed thereon may be separated therefrom and carried into said channel, said outlet-pipe, and said trap, all substantially as described.

4. The combination in an electrolytic apparatus, of a vat, a cathode of mercury, a suitable anode, a source of electricity, electrical connections between said anode and cathode whereby, under operative conditions, an amalgam will be formed on said cathode, means for separating said amalgam from the cathode, an outlet from the vat for said amalgam, a trap in said outlet for retaining a part of the amalgam, a second source of electricity connected through its positive pole to said anode and through its negative pole with the interior of the trap, substantially as described.

5. The combination in an electrolytic apparatus of the class described, comprising a vat adapted to contain a solution to be acted upon, a suitable anode, a cathode of mercury, and suitable electrical connections with said anode and cathode whereby, under operative conditions, a mercurial amalgam may be formed on said cathode; of means for effecting the separation of said amalgam from said cathode, an auxiliary electrical circuit, and connections therefrom to said anode and to said separated amalgam, substantially as described.

6. In an electrolytic cell having a fluid-metal cathode and suitable anodes whereby under operative conditions an amalgam may be formed on said cathode, a main electrical circuit connected with said anode and cathode, means for separating the amalgam from the latter, and an auxiliary electrical circuit through said separated amalgam, said amalgam constituting the cathode of such auxiliary circuit, substantially as described.

7. In an electric cell of the class described wherein an amalgam is formed in the presence of the solution, an anode and a cathode in the cell, a main circuit therefor, means for separating the amalgam from the cathode, an auxiliary circuit through the separated amalgam, said amalgam constituting the cathode of said auxiliary circuit.

8. In an electrolytic cell, wherein an amalgam is formed in the presence of the solution, an anode and a cathode in the cell, a main circuit therefor, a channel, means for separating the amalgam from the cathode whereby it is deposited in said channel, a discharge-pipe leading from said channel, and means for restricting the area of said separated amalgam to substantially the area of the discharge-pipe, during the operation of the cell, and a column of the electrolyte maintained therein.

9. In an electrolytic cell wherein an amalgam is formed in the presence of the solution,

an anode and a cathode in the cell, a main circuit therefor, a channel, means for separating the amalgam from the cathode, whereby it is deposited in said channel, a discharge-pipe leading from the channel, and means whereby the area of separated amalgam exposed to the solution may be restricted substantially to the area of said discharge-pipe, and means for introducing fresh solution in the vicinity of that part of the separated amalgam so exposed.

10. In an electrolytic cell having a suitable cathode and a suitable anode whereby under operative conditions an amalgam may be formed on the cathode, a channel on the cell having an inclined bottom, means for separating the amalgam from the cathode and depositing it in said channel, and a trap located under the cell and entering said channel at its lowest point, substantially as described.

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