No. 719,873. PATENTED FEB. 3, 1903.

C. J. REED.

ELECTROLYTIC APPARATUS.

APPLICATION FILED MAY 5, 1899.

NO MODEL. 8 SHEETS—SHEET 1.

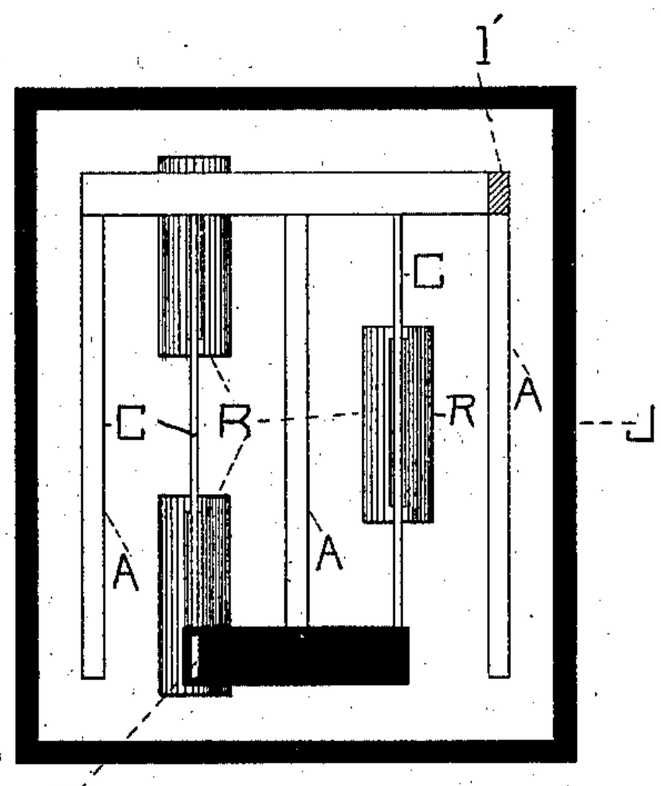


Fig. 3.

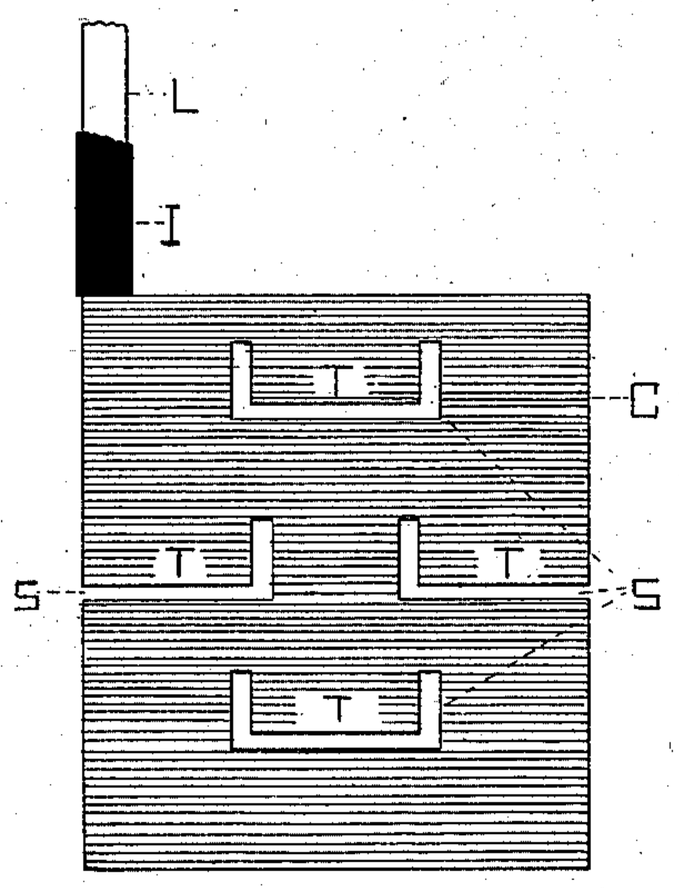


Fig. 4.

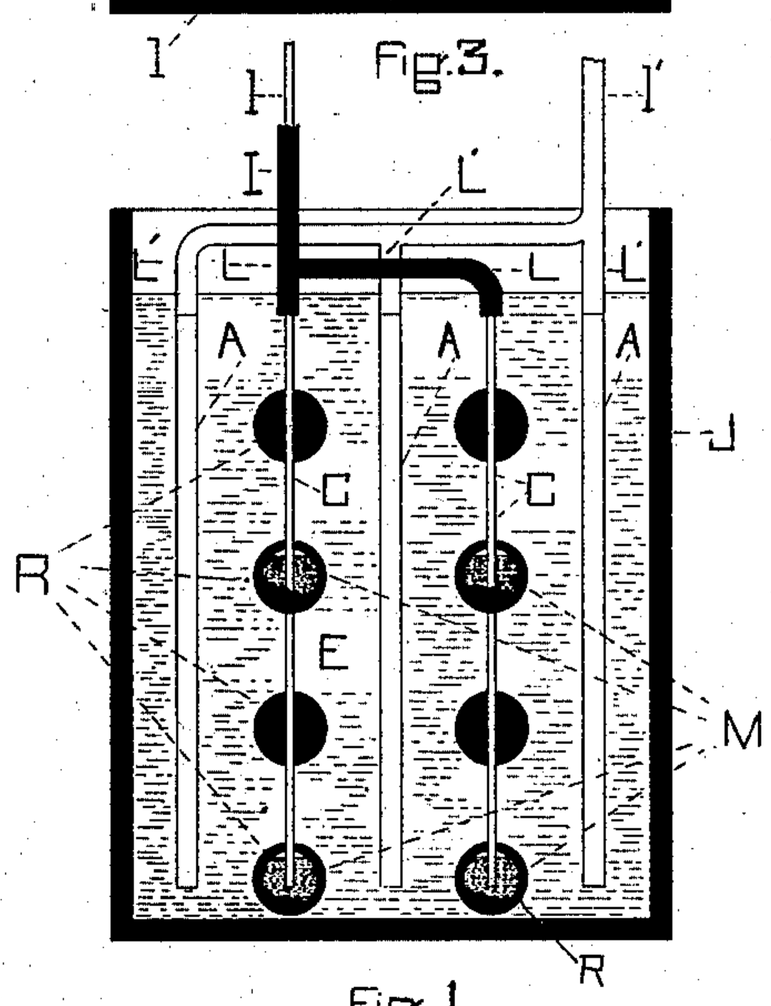


Fig. 1.

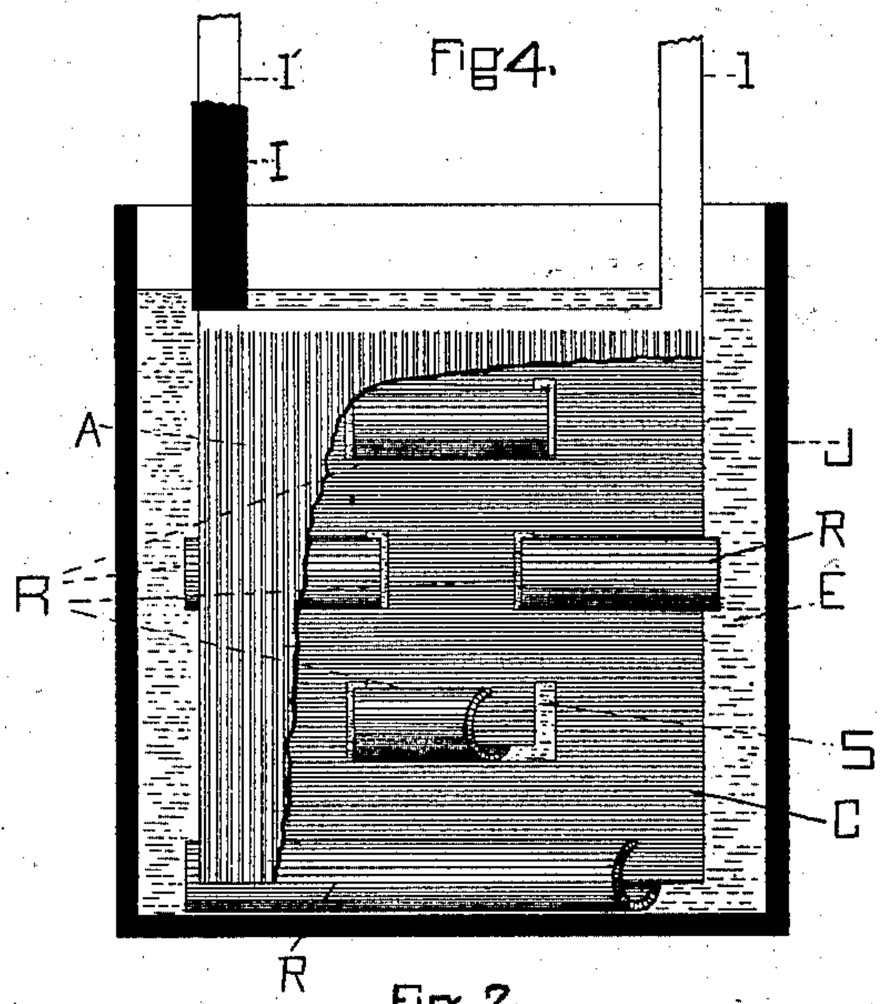


Fig. 2.

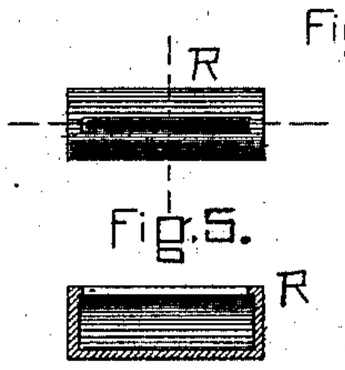


Fig. 5.

Fig. 6. Fig. 7.

Witnesses

J. Guernsey Wilt.

Frank D. Connor.

Inventor

Charles J. Reed

No. 719,873. PATENTED FEB. 3, 1903.

C. J. REED.

ELECTROLYTIC APPARATUS.

APPLICATION FILED MAY 5, 1899.

NO MODEL. 8 SHEETS—SHEET 2.

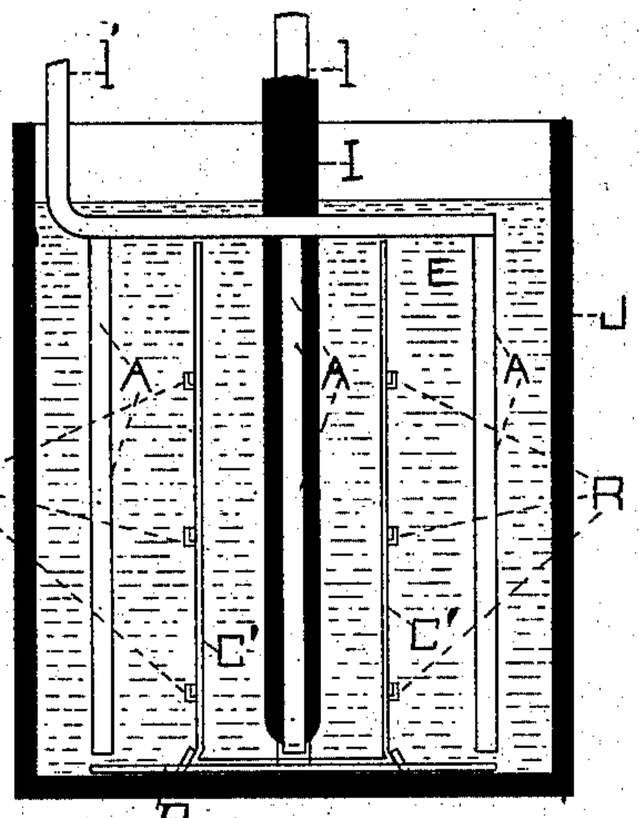


Fig. 8.

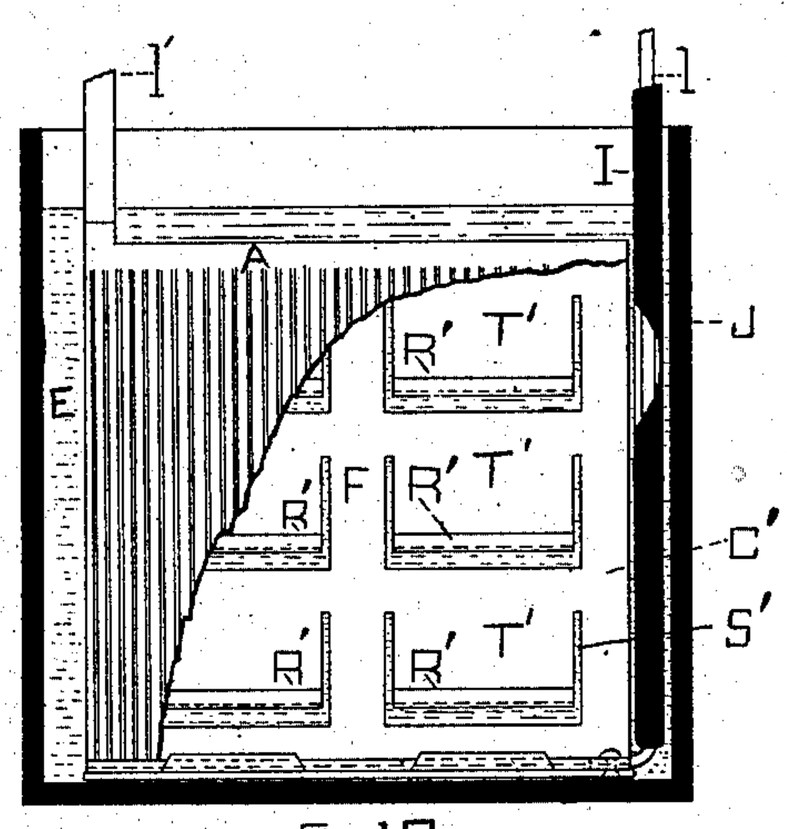


Fig. 10.

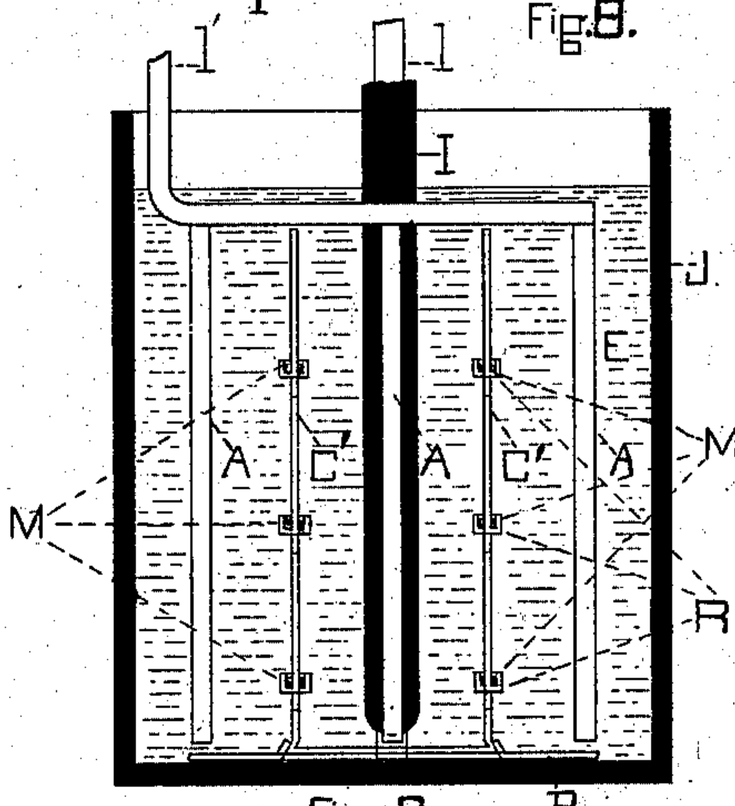


Fig. 9.

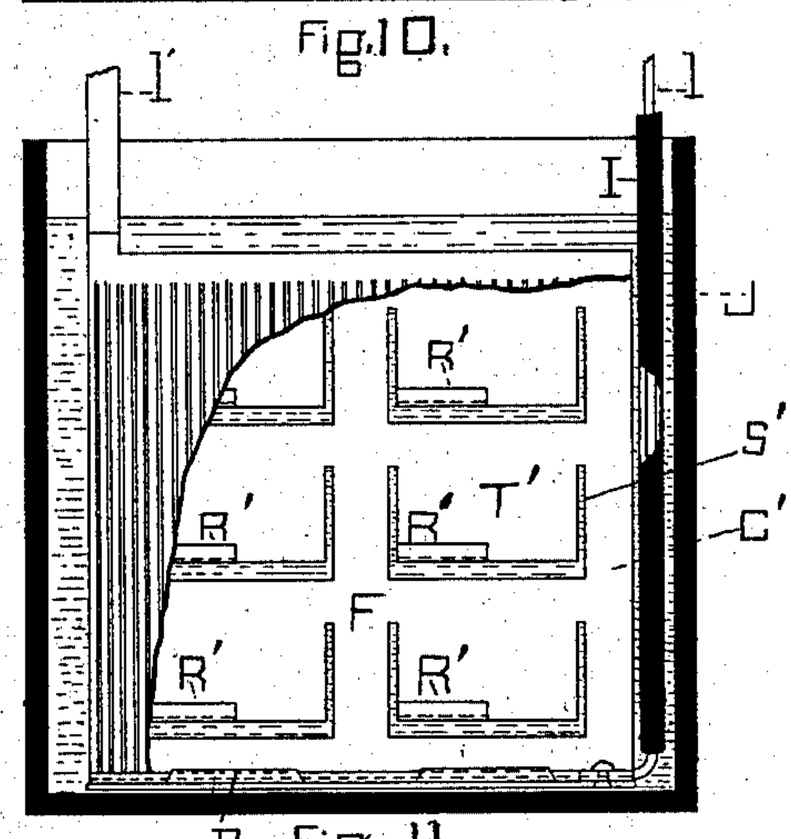


Fig. 11

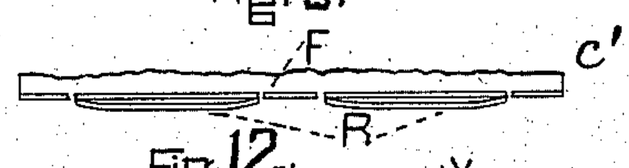


Fig. 12.

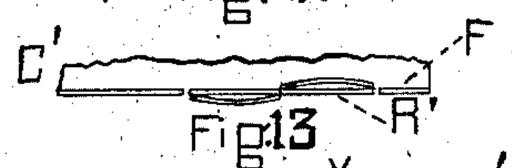


Fig. 13

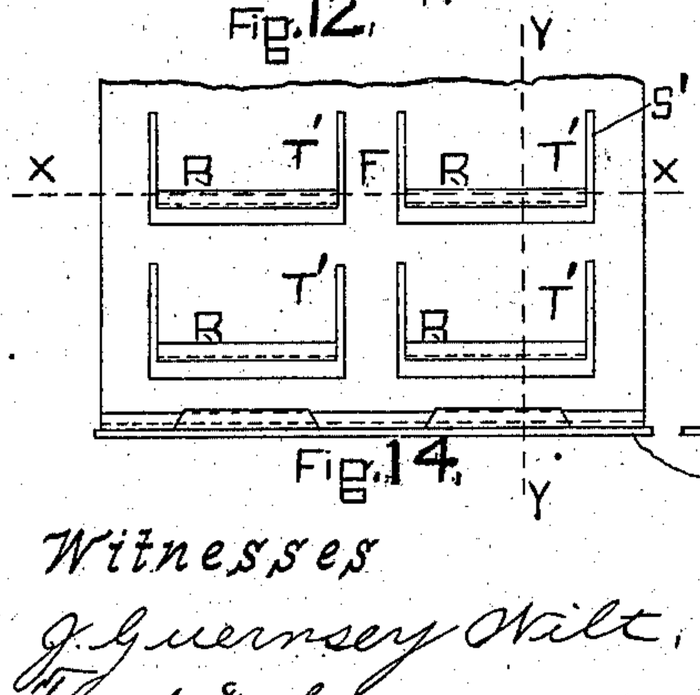


Fig. 14.

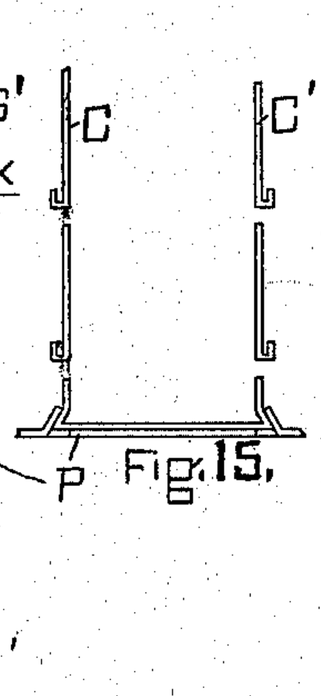


Fig. 15.

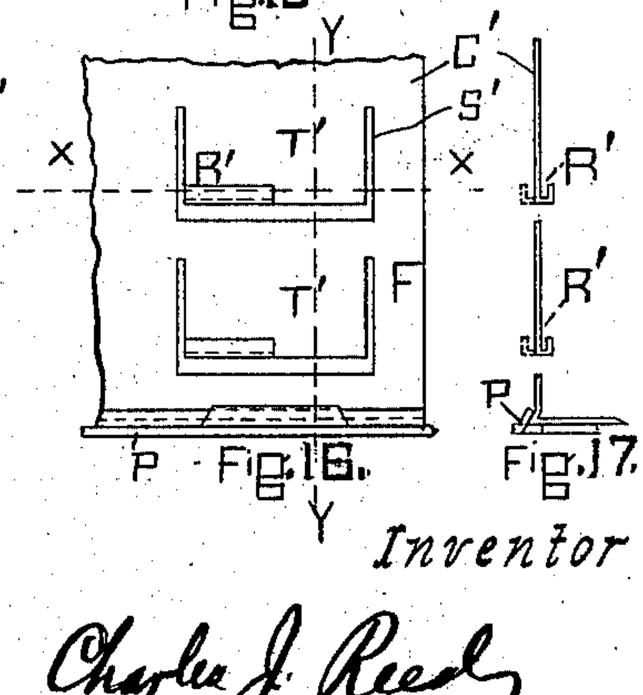


Fig. 16.

Fig. 17.

Witnesses
J. Guernsey Hall,
Frank D. Connor.

Inventor
Charles J. Reed

No. 719,873. PATENTED FEB. 3, 1903.

C. J. REED.

ELECTROLYTIC APPARATUS.

APPLICATION FILED MAY 5, 1899.

NO MODEL. 8 SHEETS—SHEET 3.

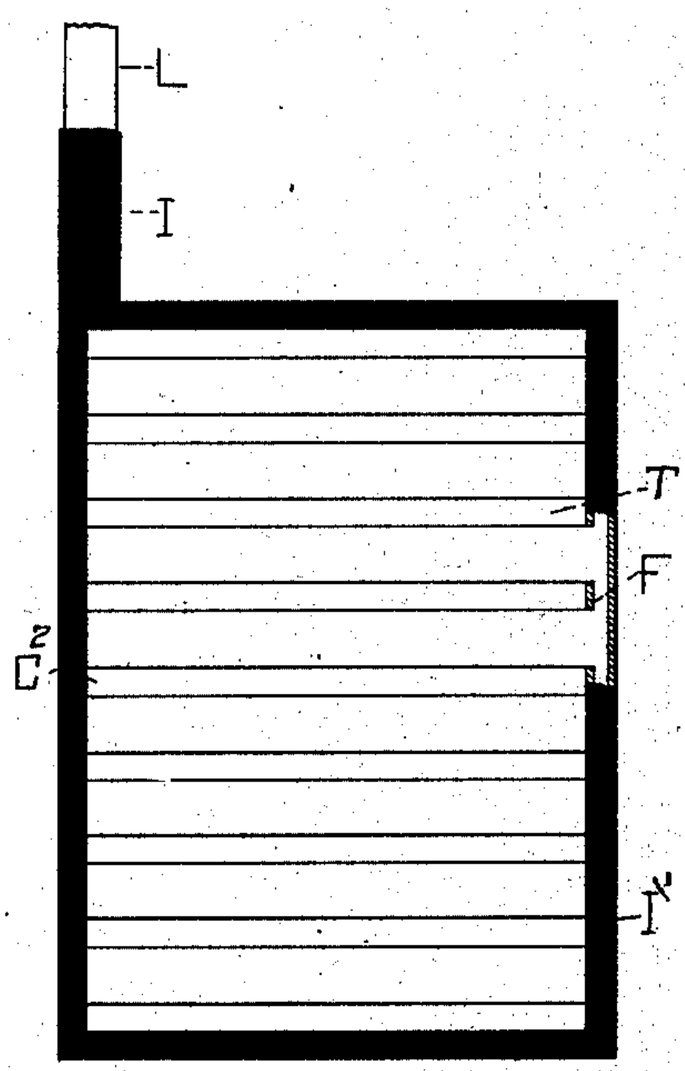


Fig. 18.

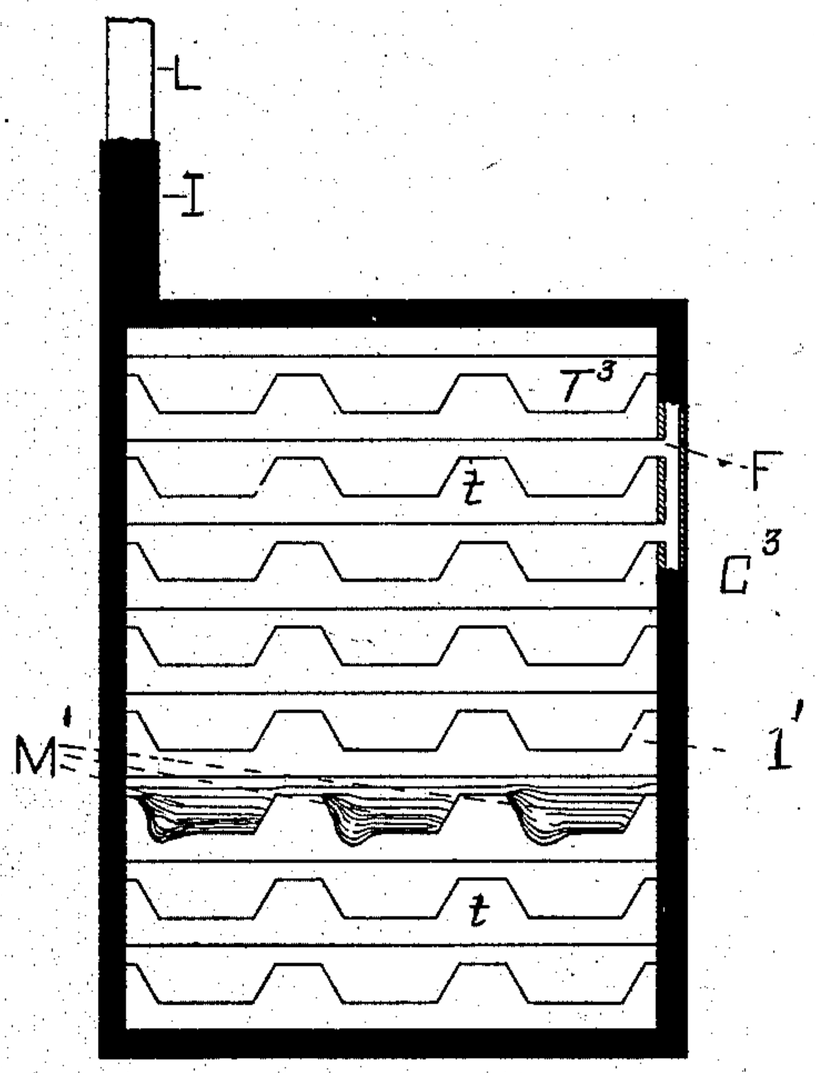


Fig. 19.

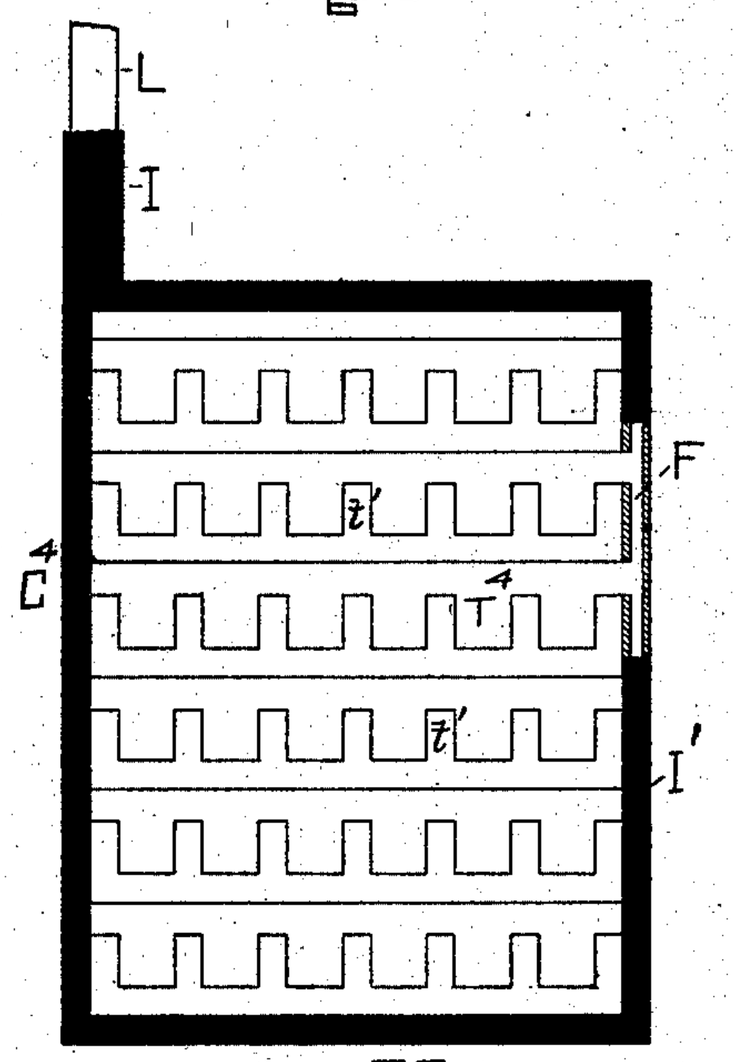


Fig. 20.

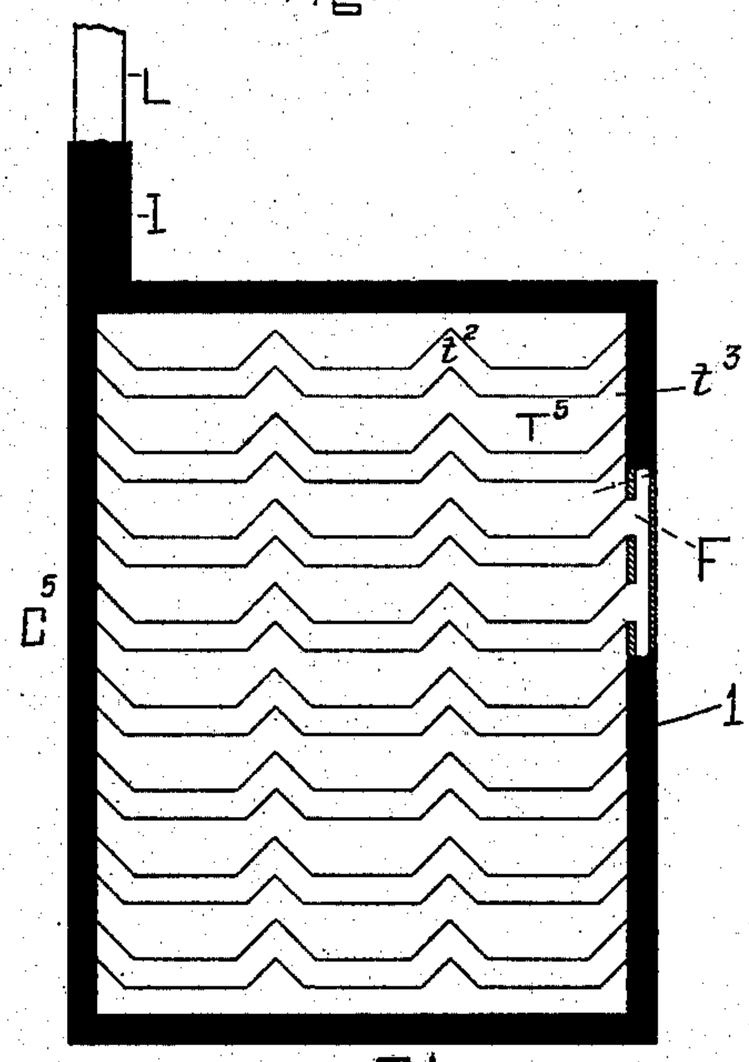


Fig. 21.

Witnesses
A. H. Brownbridge
Frank D. Connar.

Inventor
Charles J. Reed

No. 719,873. PATENTED FEB. 3, 1903.

C. J. REED.

ELECTROLYTIC APPARATUS.

APPLICATION FILED MAY 5, 1899.

NO MODEL. 8 SHEETS—SHEET 4.

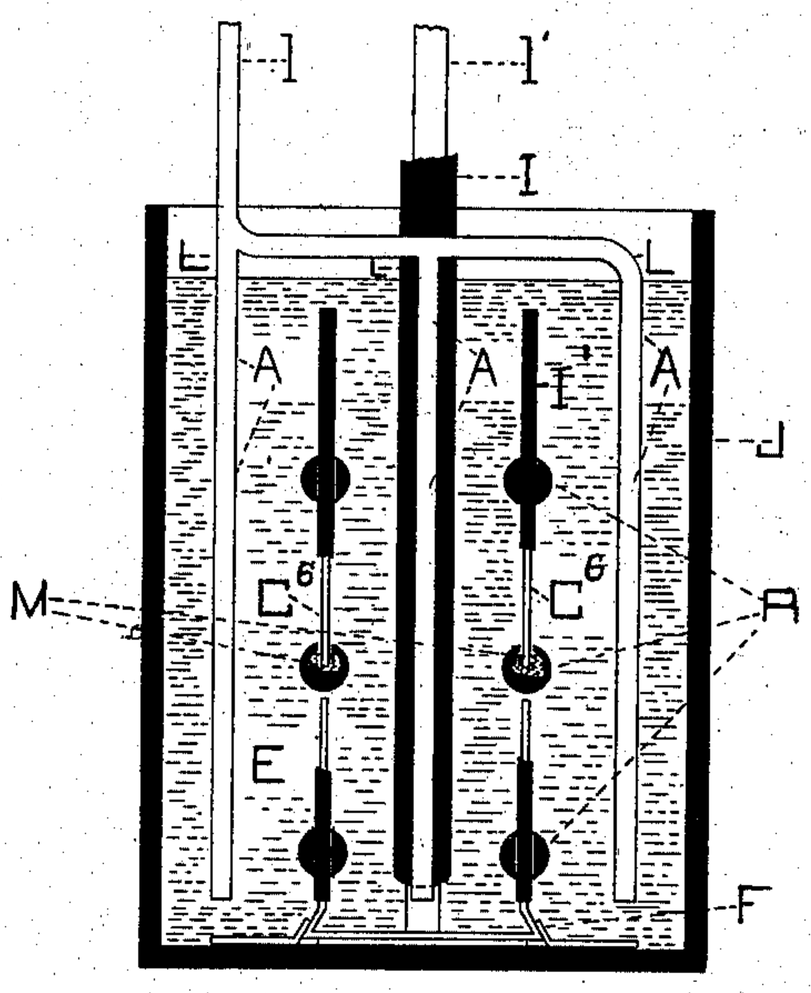


Fig. 23.

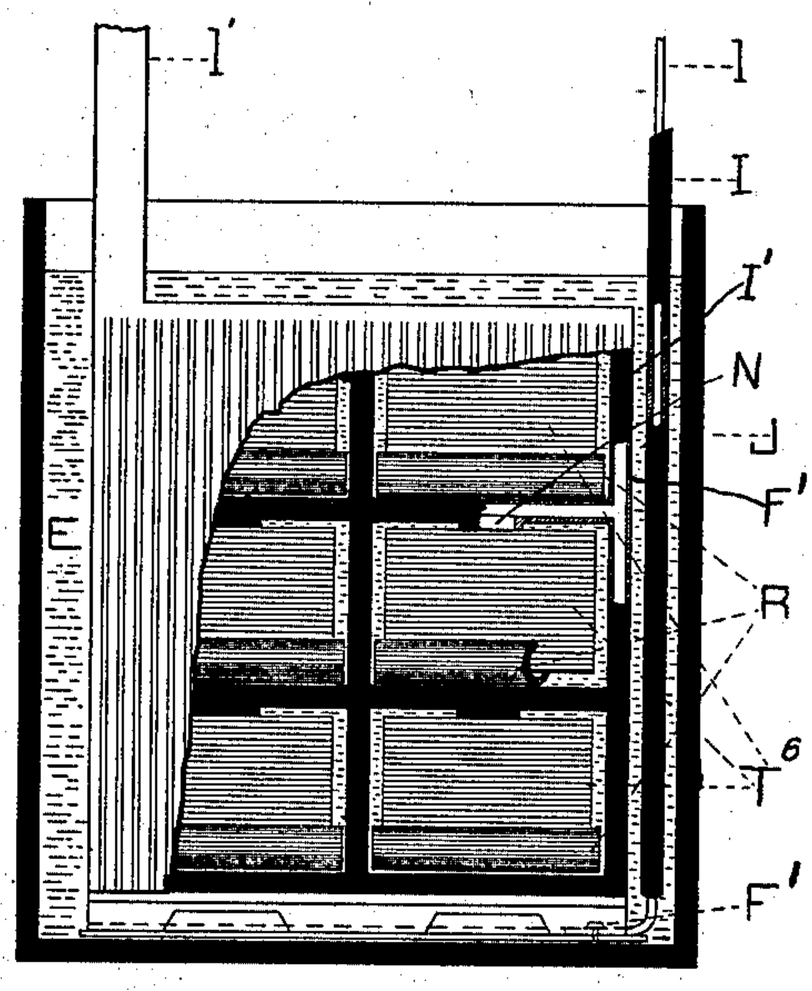


Fig. 22.

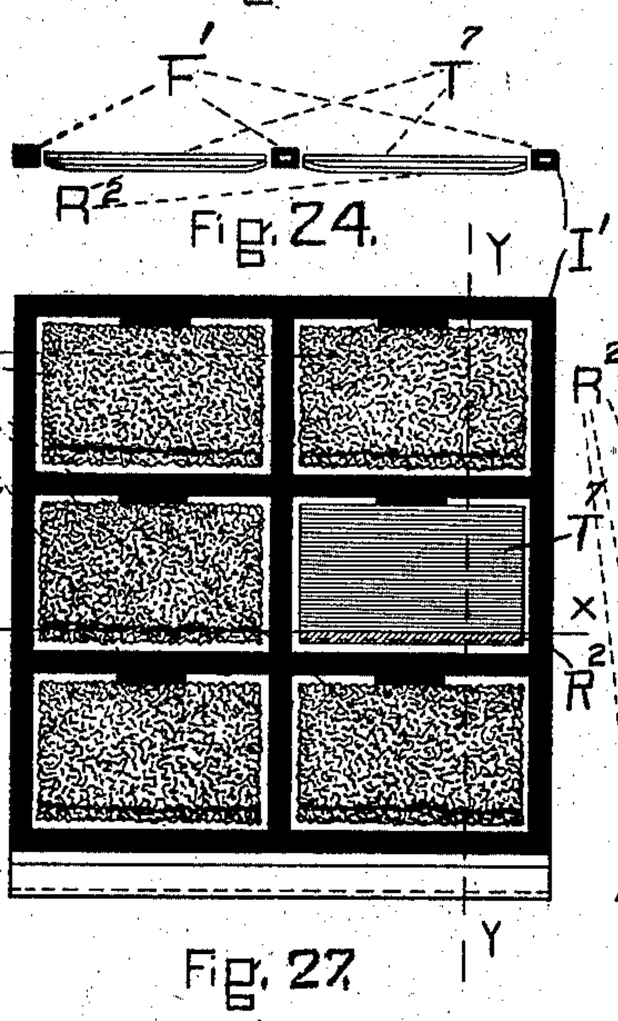


Fig. 24.

Fig. 27.

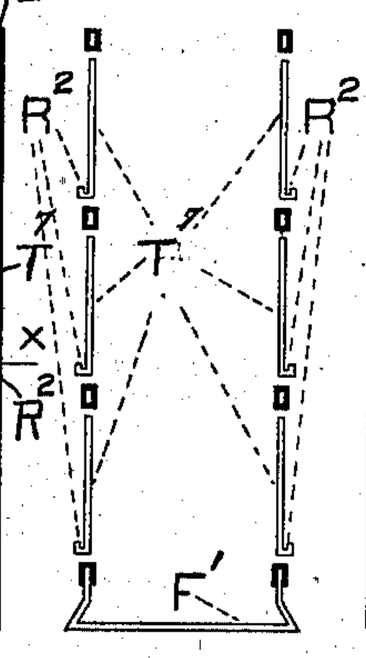


Fig. 26.

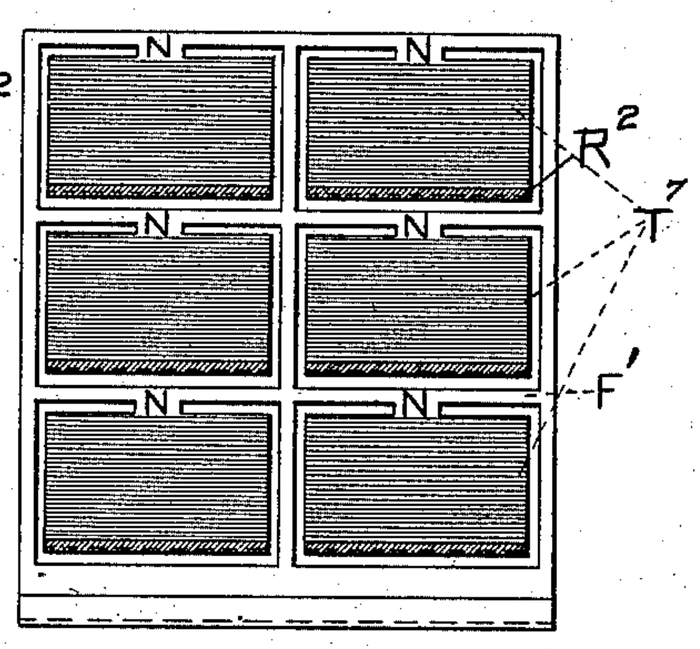


Fig. 25.

Witnesses

J. Guernsey Wilt.
Frank D. Cannon.

Inventor

Charles J. Reed

No. 719,873. PATENTED FEB. 3, 1903.

C. J. REED.

ELECTROLYTIC APPARATUS.

APPLICATION FILED MAY 5, 1899.

NO MODEL. 8 SHEETS—SHEET 5.

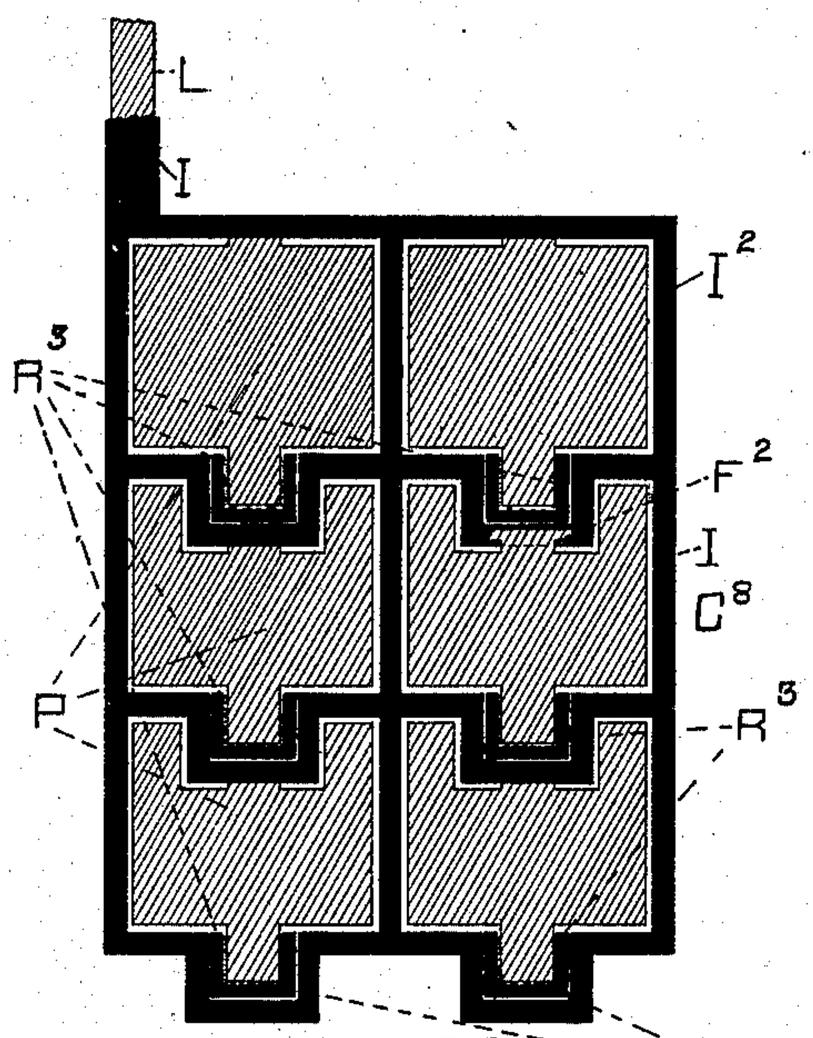


Fig. 28.

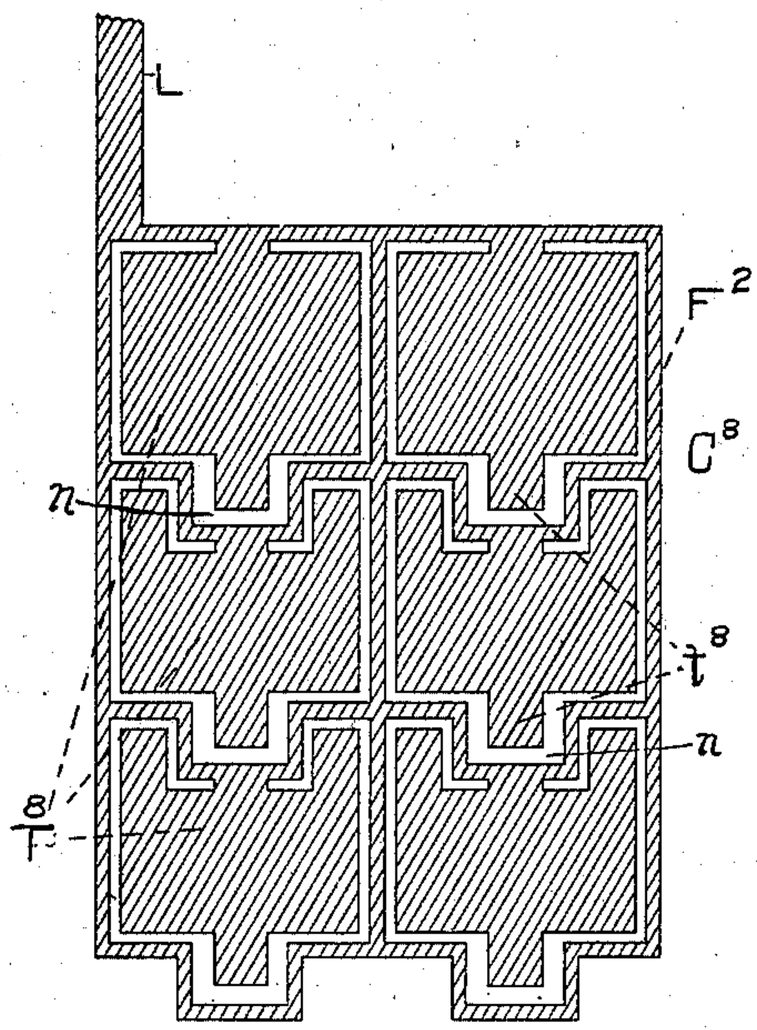


Fig. 29.

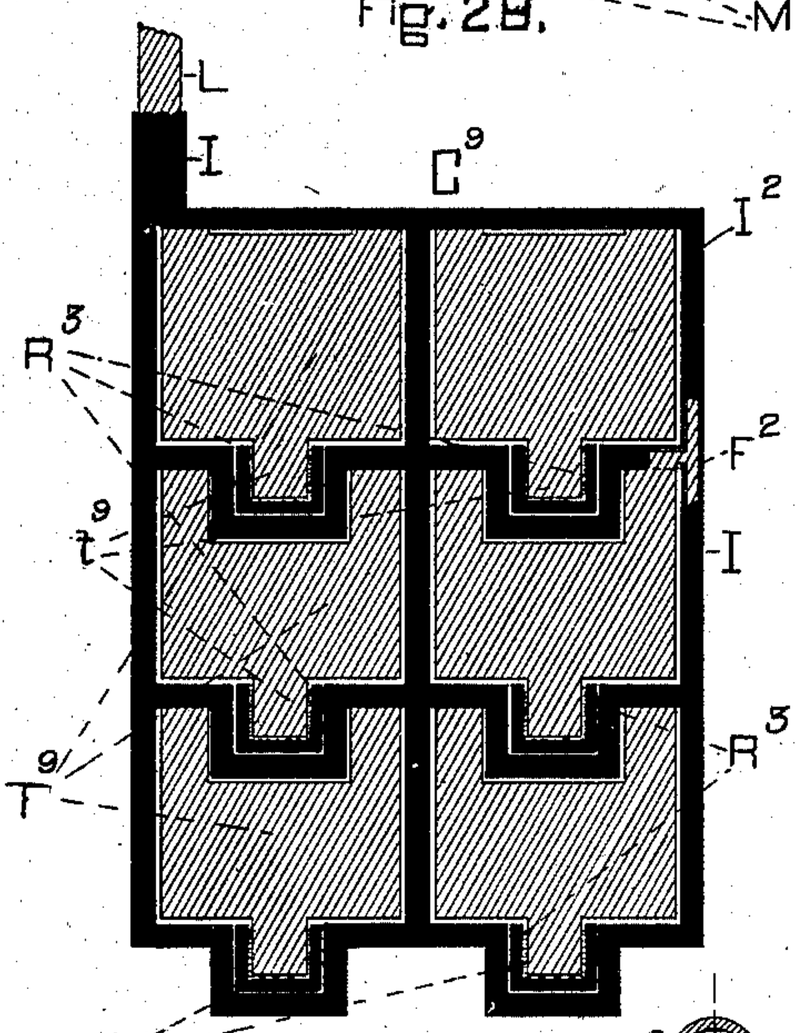


Fig. 30.

Fig. 32.

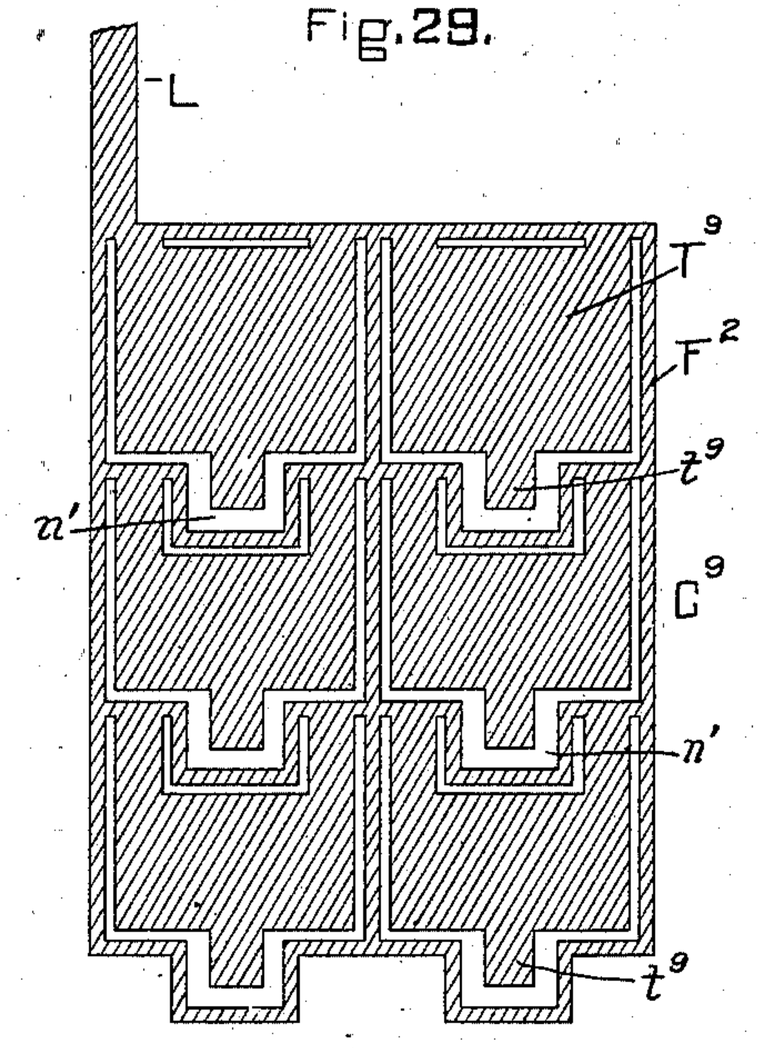


Fig. 31.

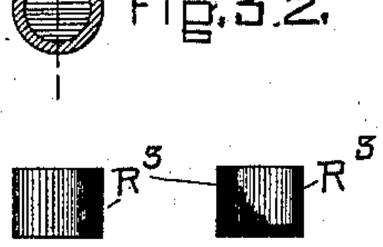


Fig. 33. Fig. 34.

Witnesses
W. H. Brownsbrough
Frank D. Connor.

Inventor
Charles J. Reed

No. 719,873. PATENTED FEB. 3, 1903.

C. J. REED.

ELECTROLYTIC APPARATUS.

APPLICATION FILED MAY 5, 1899.

NO MODEL. 8 SHEETS—SHEET 6.

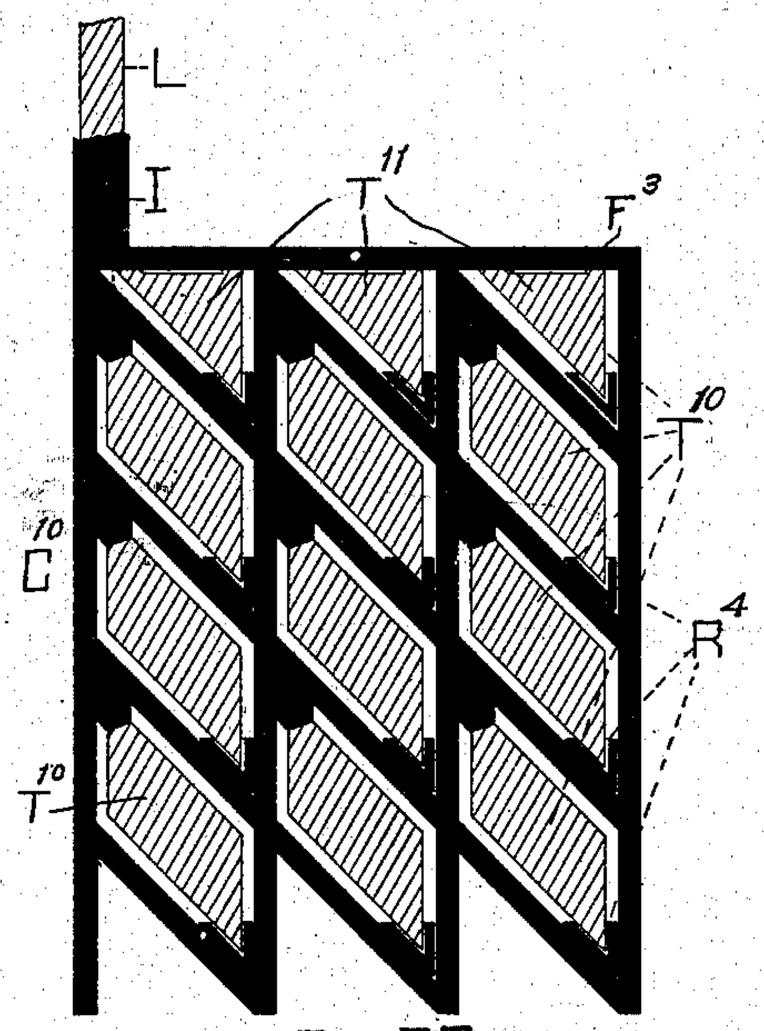


Fig. 35.

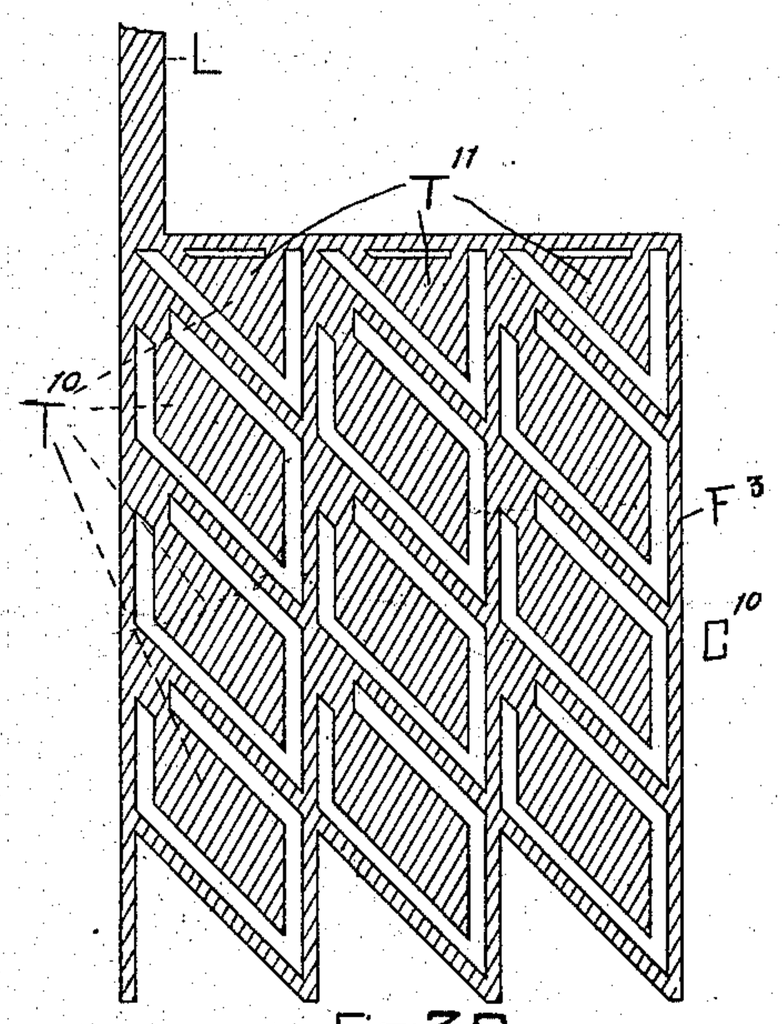


Fig. 36.

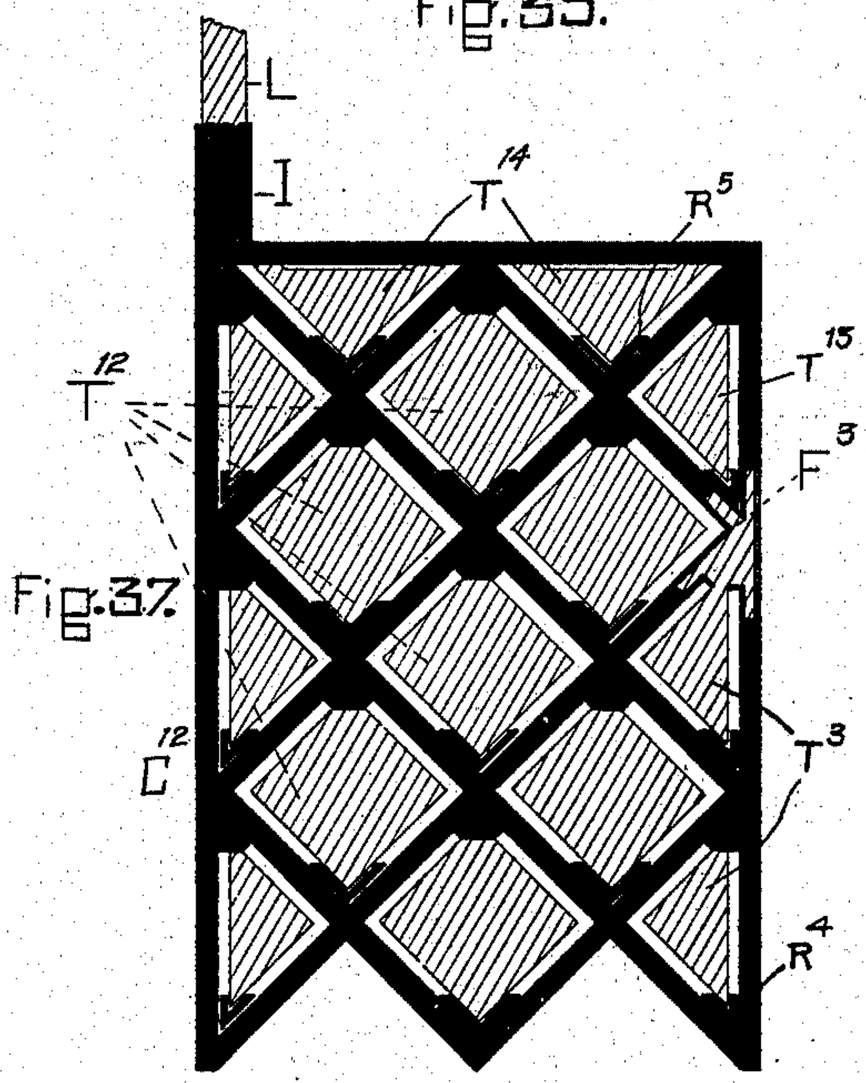


Fig. 37.

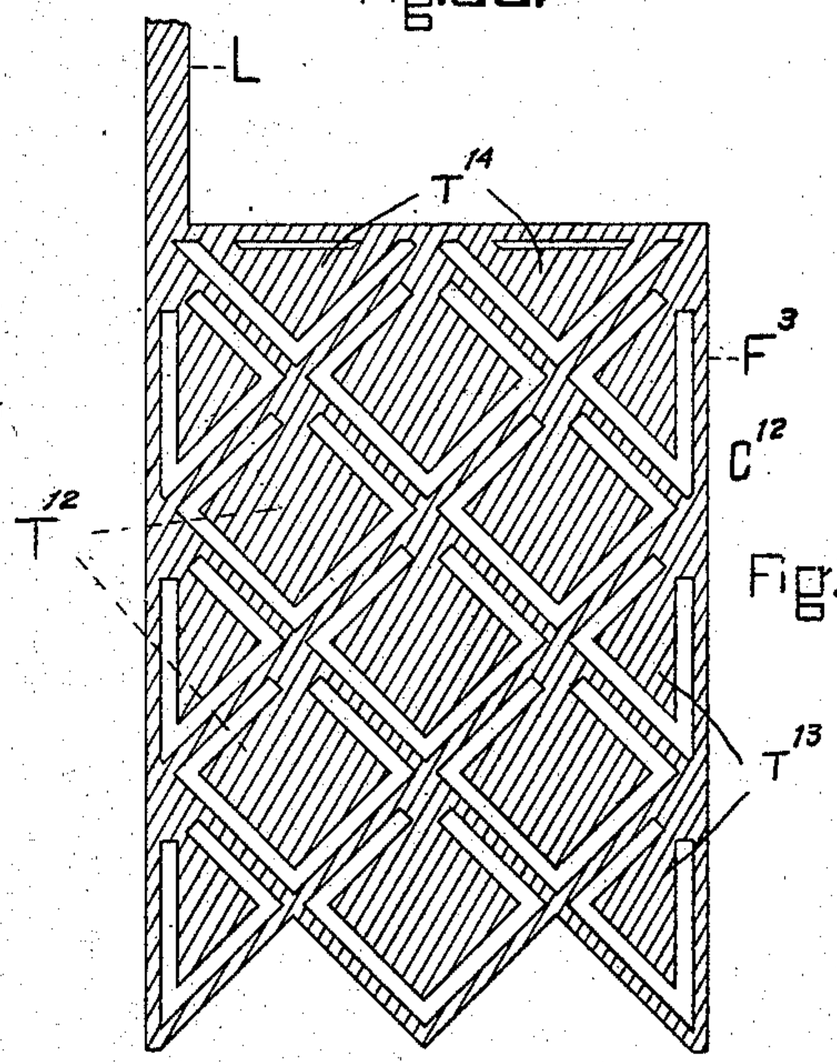


Fig. 38.

Fig. 39.

Fig. 40.

Witnesses
J. Guernsey Wilt,
Frank D. Connor.

Inventor
Charles J Reed

No. 719,873. PATENTED FEB. 3, 1903.

C. J. REED.

ELECTROLYTIC APPARATUS.

APPLICATION FILED MAY 5, 1899.

NO MODEL. 8 SHEETS—SHEET 7.

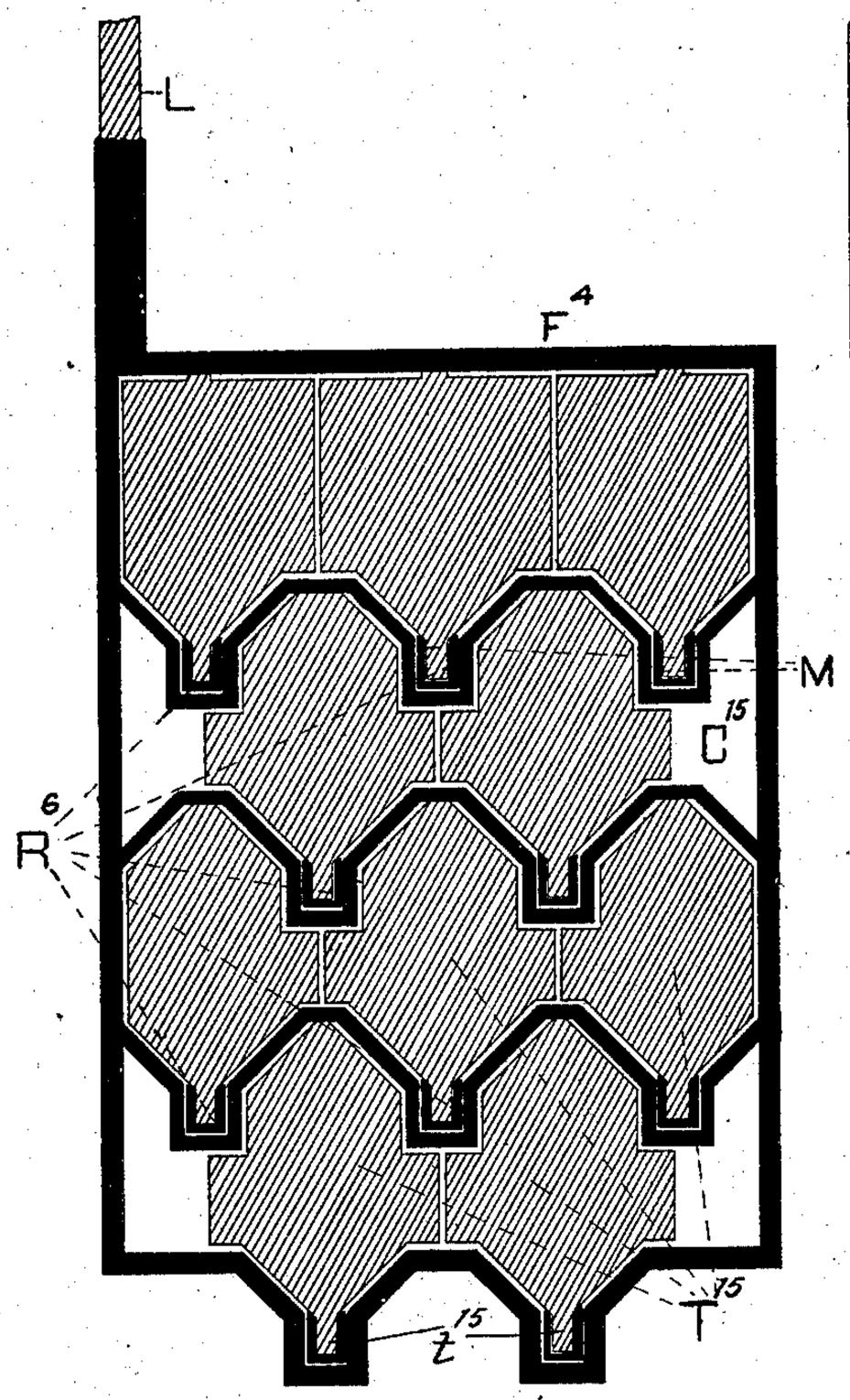


Fig. 41.

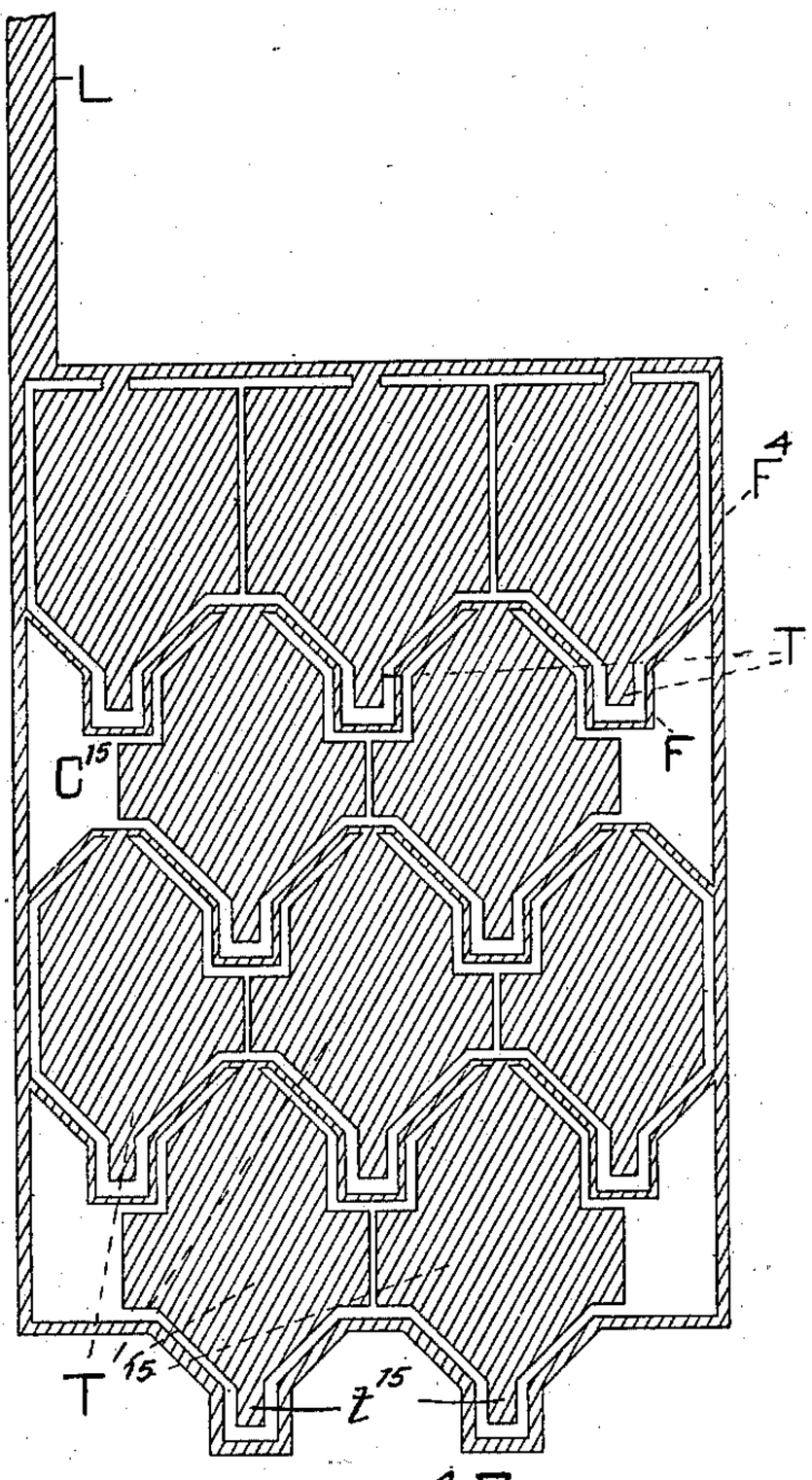


Fig. 42.

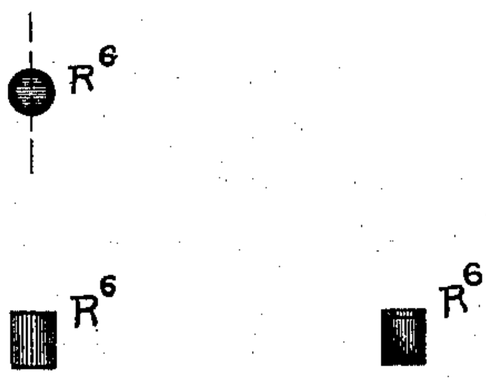


Fig. 43.

Witnesses
J. Guernsey Wilt,
Frank D. Connor.

Inventor
Charles J. Reed

No. 719,873. PATENTED FEB. 3, 1903.

C. J. REED.

ELECTROLYTIC APPARATUS.

APPLICATION FILED MAY 5, 1899.

NO MODEL. 8 SHEETS—SHEET 8.

Fig. 44.

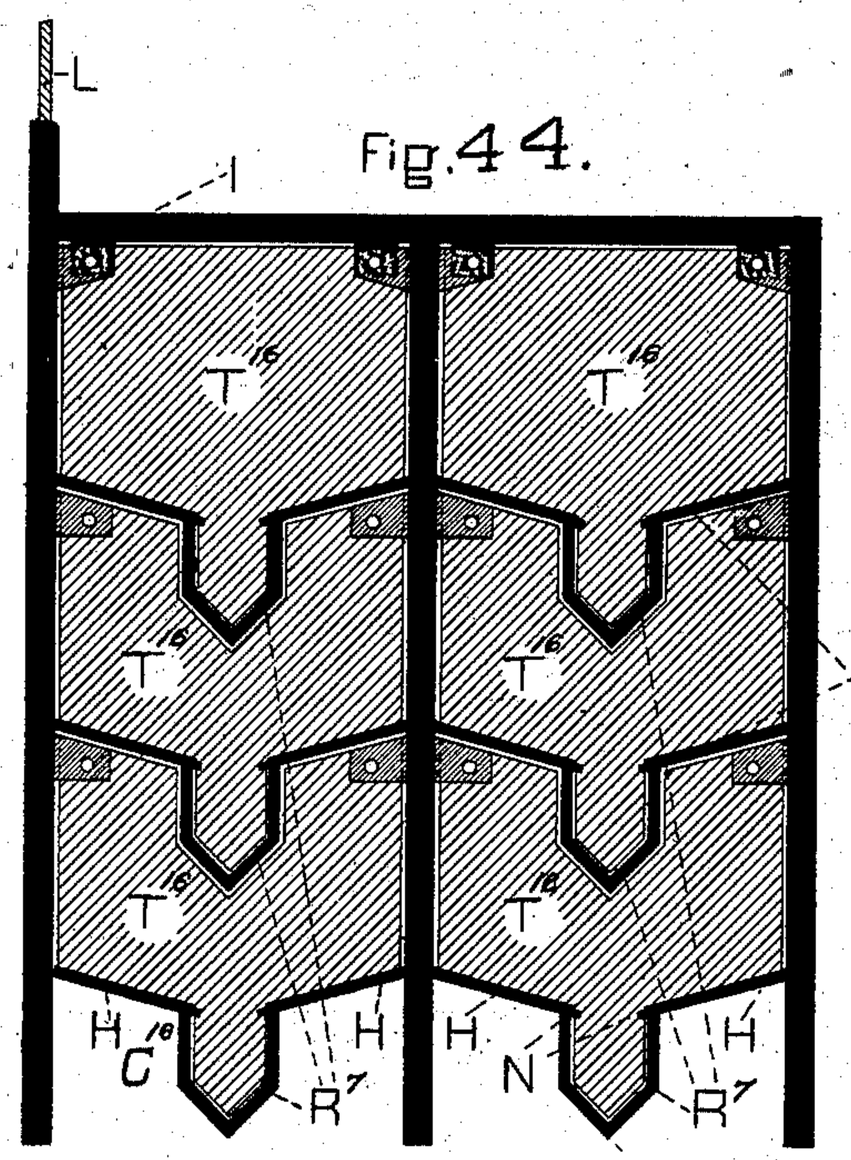
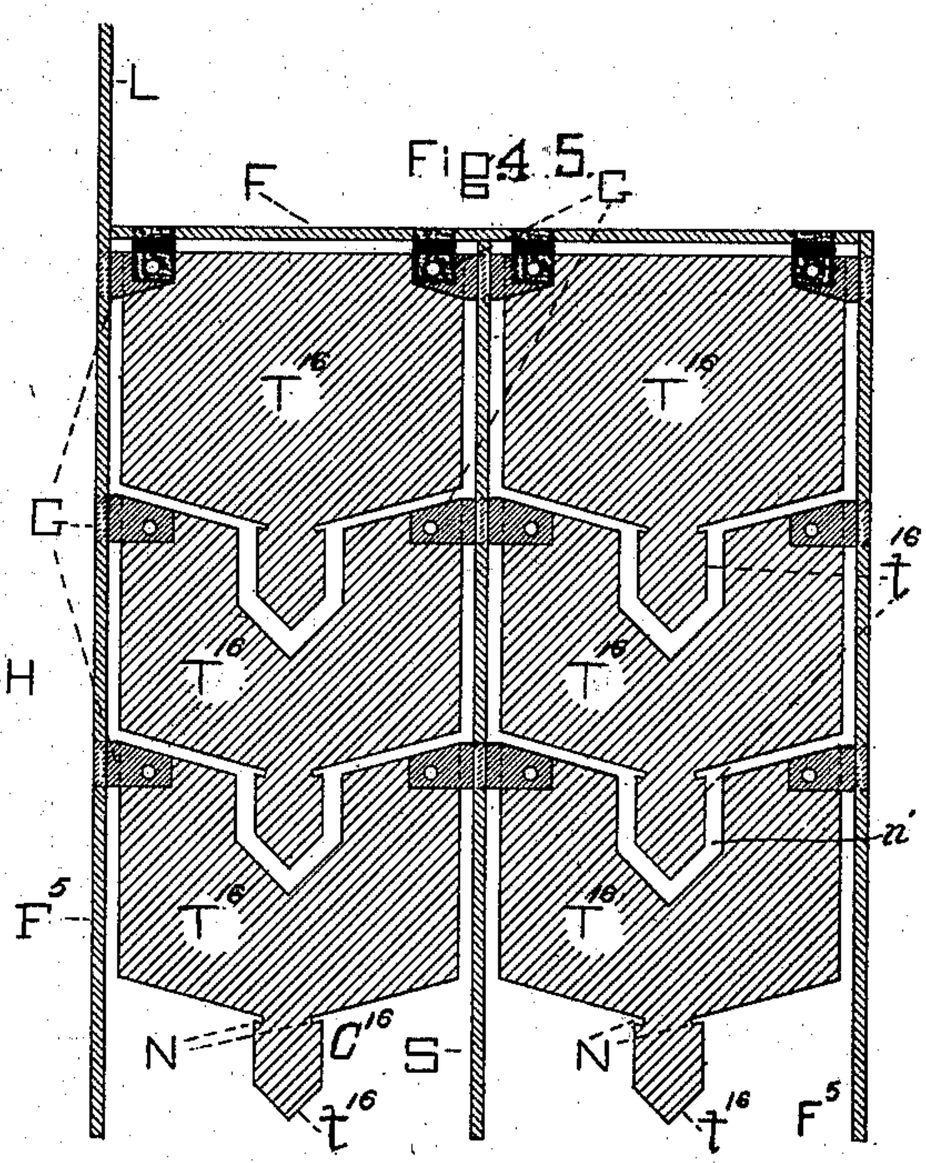


Fig. 45.



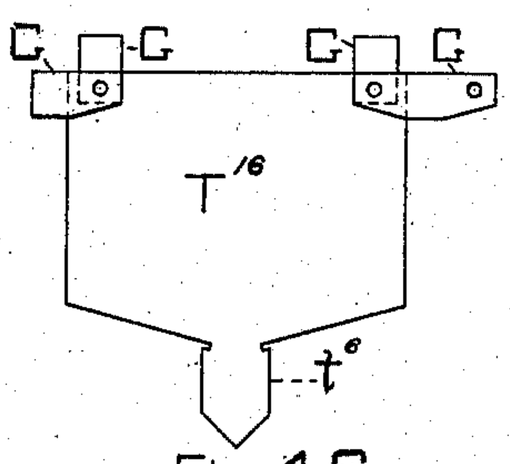


Fig. 46.

Fig. 50.

Fig. 51.

Fig. 52.

Fig. 53.

Fig. 55.

Fig. 47.

Fig. 56.

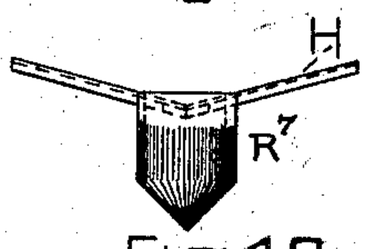


Fig. 48.

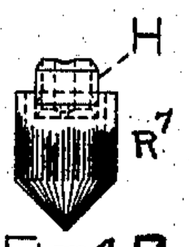


Fig. 49.

Fig. 54.

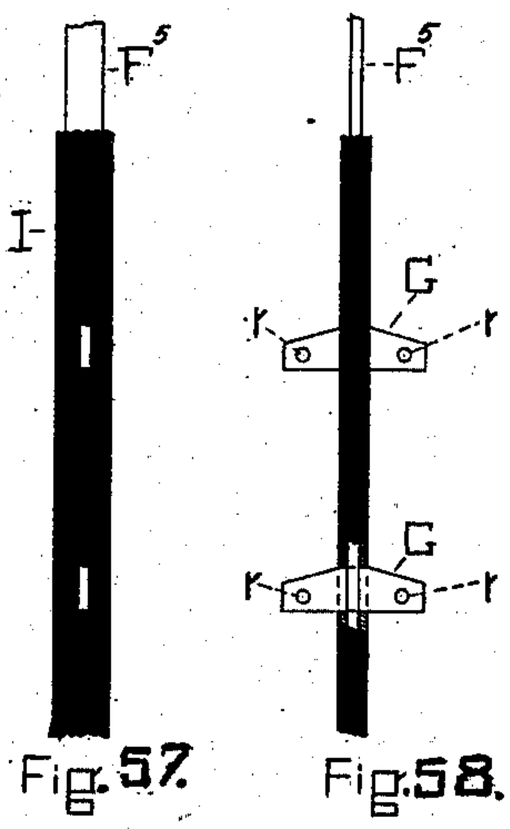


Fig. 57.

Fig. 58.

Witnesses

J. Guernsey Wilt,

Frank D. Connor.

Inventor

Charles J. Reed

UNITED STATES PATENT OFFICE.

CHARLES J. REED, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR TO THE SECURITY INVESTMENT COMPANY, A CORPORATION OF PENNSYLVANIA.

ELECTROLYTIC APPARATUS.

SPECIFICATION forming part of Letters Patent No. 719,873, dated February 3, 1903.

Application filed May 5, 1899. Serial No. 715,686. (No model.)

To all whom it may concern:

Be it known that I, CHARLES J. REED, a citizen of the United States, residing at Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented a new and useful Improvement in Electrolytic Apparatus, (Case No. 828,) of which the following is a specification.

My invention relates to electrolytic apparatus in which a highly-electropositive metal—such, for example, as sodium, potassium, cadmium, or zinc—is deposited from a solution of a salt of such metal in a metallic state upon an electrode immersed in such solution or electrolyte.

One of the objects of my invention is to subdivide the electrode-plate, which receives a deposit, or each of the plates, if there be more than one of the same kind, into a plurality of divisions or panels, so that the deposit thereon may be uniformly distributed and amalgamated.

A further object of the invention is to provide each of the panels or subdivisions of the plate with a receptacle for mercury at its lower edge, so as to insure uniform amalgamation of the deposit and obviate waste of the mercury.

A still further object of the invention is to provide a means for protecting the supporting-frame for the panels from electrolytic action and amalgamation, and thus preventing waste of the mercury.

My invention is illustrated in the accompanying drawings, in which—

Figure 1 is a vertical section of an electrolytic cell, showing one form of my invention. Fig. 2 is a sectional view of the cell, taken at right angles to the section of Fig. 1, portions of the apparatus being broken away. Fig. 3 is a plan view of the cell shown in Figs. 1 and 2. Fig. 4 is a side elevation of one of the plates shown in the preceding figures, and Figs. 5, 6, and 7 are detail views of one of the mercury-containing receptacles shown in Figs. 1, 2, and 3. Figs. 8 to 11 are sectional views of an electrolytic cell embodying plates of modified construction, and Figs. 12 to 17 are detail views of some of the parts shown in Figs. 8 to 11. Figs. 18 to 21 are side elevations of different forms of plates embodying my invention. Figs. 22 and 23 are sectional views taken at right angles to each other of an electrolytic cell similar to those shown in Figs. 8 to 11, but having plates and mercury-containing receptacles of modified construction. Figs. 24 to 27 are detail views of plates similar to those shown in Figs. 22 and 23, but having a different form of mercury-containing receptacle. Figs. 28 to 31 are views of plates having panels of different form from those shown in the preceding figures and also mercury-receptacles of different form and arrangement. Figs. 32 to 34 are detail views of a mercury-cup like those shown in Figs. 28 to 31. Figs. 35 to 38 are views of plates having panels of modified form, and Figs. 39 and 40 are detail views of the mercury-cups shown in Figs. 35 and 37. Figs. 41 and 42 are views of a plate embodying a still further modification as regards the form of the panels, and Fig. 43 illustrates in detail the form of mercury-cups shown in Figs. 41 and 42. Figs. 44 and 45 are views of a plate embodying modified panels as regards form and supporting means, and Figs. 46 to 58 illustrate details of construction embodied in the plate shown in Figs. 44 and 45.

In the electrolytic deposition of highly electropositive metals from aqueous solutions it is customary in order to prevent the rapid redissolving of the metal to employ an electrode consisting either entirely or in part of mercury, the object of the mercury being to form an amalgam with the deposited metal, which is more difficult to dissolve than is the metal deposited in a free state. The employment of pure mercury as an electrode is objectionable on account of its liquid state and also by reason of the impossibility of using it in any other form than that of a horizontal sheet, the upper surface only of which is active. Copper and certain other metals have such an affinity for mercury that plates made of these metals and placed in a vertical position will retain a limited amount of mercury on their surfaces. Plates of this kind have been tried and found to work when freshly prepared. If, however, it is desired to redissolve and redeposit the metal a number of times on the same electrode, as is the case in the operation of preparing caustic soda from

sodium chlorid, for example, it is found that the mercury at each successive operation of depositing and redissolving gradually works downward through the action of gravity and finally leaves the vertical surfaces of the electrode nearly destitute of mercury. By reason of this action the employment of vertical electrodes for the deposition and redissolving of highly-electropositive metals has not heretofore been generally successful. I propose to obviate this difficulty by partially subdividing each plate into a number of panels and providing each panel with its own receptacle for mercury, such receptacle being located at the bottom of a panel, so that all or a portion of its lower edge extends into the mercury, thus insuring the amalgamation of the deposit made upon that panel by the capillary action of the deposit. In most cases I find it desirable to make the mercury-receptacle of some inert material—that is, a material that will not be amalgamated by the mercury—such as glass, hard rubber, or other insulating material, though in some cases the receptacles may be formed by bending the lower edge of the panel. I regard the separate receptacle of inert material as preferable, for the reason that a metallic receptacle containing mercury and amalgamated both inside and out will not confine the mercury therein for an indefinite period, the amalgamated surfaces acting as a capillary siphon to draw the mercury up over the edges of the receptacle, from which it descends by gravity to the bottom of the electrolytic cell.

My invention also contemplates the employment of strips or panels of any desired form connected to a supporting-framework by integral extensions of greater or less extent or fastened thereto by means of separate strips by rivets or otherwise. Where separate strips or panels are separated from each other by slots, I find that a certain amount of mercury is always retained on the lower edge of each, in the form of a drop, by the surface tension of the mercury. If the strip or panel is made narrow enough, this drop of mercury will be sufficient to thoroughly amalgamate a large electrolytic deposit of metal upon the entire strip or panel. With this form of plate it is therefore feasible to dispense with the mercury-containing cups or receptacles, if desired, though such receptacles will ordinarily be found sufficiently useful to warrant their employment, since the amount of mercury available for amalgamating the panel may be materially increased over what would be held upon the edge of the panel by surface tension.

In order to facilitate the collection of the mercury in the receptacles when freed from the amalgam by the dissolving of the positive metal from the electrode, I have sometimes found it desirable to provide each panel with a lower edge that is inclined to the horizontal and to attach the mercury-containing receptacle to the lowest point. In some cases I also provide troughs or gutters along the inclined edges of the panels to facilitate the collection of the mercury and at the same time serve as covers for the receptacles in order to prevent splashing or spilling of the mercury after it has been collected.

In cases where substantially vertical plates are divided up into a plurality of panels or strips each of such panels or strips is necessarily connected to a conducting support or framework at one or more points. If exposed to the action of the electrolyte, a deposit forms upon the framework and connecting portions, as well as upon the panels, and the mercury tends to amalgamate these portions of the deposit, as well as that upon the panels. If it is desired to redissolve the metal from and to redeposit it upon the same electrode a number of times, a small quantity of mercury will be taken from the panels by the deposit upon the framework each time that deposition takes place, and upon redissolving the metal this mercury is liberated and some or all of it escapes to the bottom of the cell. In order to prevent the escape of mercury in this manner, I provide the framework with an insulating cover—such, for example, as rubber. Glass, wax, or other insulating material would serve the purpose; but I prefer to use hard rubber on account of its lightness and durability. When the framework is entirely protected in this manner from electrolytic action, it obviously receives no deposit and need not be amalgamated. If it be not amalgamated, there is no possibility of the escape of mercury from the panels, and the framework is also protected against the dissolving action of the electrolyte when the deposit is allowed to redissolve and when a current is passed through the cell in the direction opposite to that which takes place when the deposit is made.

Referring now particularly to Figs. 1 to 7 of the drawings, J is a jar containing an electrolyte E, having a salt of an electropositive metal in solution. The electrodes A, which may be of a substance not readily destroyed or injured by electrolytic and chemical action—such, for example, as platinum, lead, or lead peroxid—are connected through lugs L′ to a common conducting-strip l'. The electrodes C are connected to a common conducting-strip l by means of lugs L and alternate in position with the plates A, as is usual in apparatus of this general character. In the form here shown each electrode C consists of a sheet of copper or other suitable metal not readily destroyed or injured by the action of mercury and is partially subdivided by slots S, so as to provide a plurality of panels T at different heights. The lower edge of each of the panels T is provided with a receptacle R, of hard rubber or other inert material, and in case the lower edge of the plate is not divided it will be provided with a similar receptacle extending throughout its length. I find it advantageous in practice to arrange the receptacles in alternate vertical

columns, so that the receptacles in one column overlap those in the adjacent columns, thus allowing any mercury that may escape from one receptacle to be caught in the receptacles below it in the adjacent columns. While this arrangement of receptacles I find to be advantageous in practice, I do not limit myself to any particular arrangement or to any specific form of receptacle. Each receptacle R is provided with a sufficient amount of mercury M to insure proper amalgamation of the section of the plate above and adjacent to it.

Referring now to Figs. 8 to 17, the jar J and electrolyte E are or may be the same as the corresponding parts shown in the preceding figures. The jar J, electrolyte E, and electrodes A are or may be the same as the corresponding parts shown in the preceding figures and already described. The electrodes C′, which may be of copper or other suitable metal which is easily amalgamated and which is not easily destroyed or rendered either soft or brittle by the action of mercury, as has already been indicated, are shown as of U shape and supported at the bottom by means of a dovetail connection with the supporting-plate P, the common conducting-strip *l* being attached to the bottom of the electrode, as indicated. Each electrode C′ consists, essentially, of a plurality of panels T′, which are separated from the plate by a slot S′, except at the upper side. As here shown, each plate is provided at its bottom with a receptacle R′, formed by bending upward all or a portion of the lower edge of the panel. As shown in Figs. 8 and 15, the receptacles are on one side only of each plate, and as shown in Figs. 9 and 17 they are on both sides of the plate or panel. The terminal connecting rod or strip *l* is here shown as provided with a sheath of insulating material I in order to protect it from electrolytic action and from the deposit of metal thereon from the solution.

In Figs. 18 to 21 I have shown four forms of electrode in which the panels are in the form of substantially horizontal strips connected at each end to the two side bars or pieces of the conducting-framework F. These horizontal strips or panels and the supporting-framework may be made out of a single piece of metal, or the strips may be fastened to the framework by rivets or otherwise. In Fig. 18 the strips T^2 of the electrode C^2 have straight plain edges and are separated from each other by slots of uniform width. In Fig. 19 the strips or panels T^3 of the plate C^3 are provided with notches *t* in their bottom edges in order to prevent the mercury from running from one end to the other of the panel when the plate is tilted at an angle to the horizontal, as is apt to be the case in a portable cell. In Fig. 20 the strips T^4 of the plate C^4 differ from the strips T^3 of Fig. 19 in having a greater number of notches *t′* and also as regards the shape of the notches, the function in the two cases being the same. In Fig. 21 the strips or panels T^5 of the plate C^5 are provided with V-shaped notches t^2 and are connected to the framework F by upwardly-inclined terminals t^3 in order to still further guard against the passage of mercury from the panels to the framework in case the latter is not protected by an insulated sheath or covering.

It is evident that many other forms of strips or panels may be employed, if desired, and I therefore do not intend to limit my invention in this regard.

In Fig. 19 I have indicated at M′ the position of the drops of mercury on one of the strips when the plate is tilted, as is apt to be the case with portable cells.

I have shown the framework in each of Figs. 18, 19, 20, and 21 as provided with an insulating sheath or covering I′; but it is to be understood that such a protective covering may be either used or not in these and in the other forms of electrode, as may be found desirable in practice in any particular case.

In Figs. 22 and 23 I have shown an electrolytic cell the electrodes of which are supported and connected as shown in Figs. 10 to 17. In this form, however, the plates C^6 are each divided up into a plurality of panels T^6, each of which is connected to the supporting-framework F′ by a small metal strip N at the top, the superficial area of the connecting portion being thus reduced in order to make each panel as nearly as possible an independent surface for receiving the deposit and at the same time connecting all of the panels of each plate electrically to a single terminal. In this form also each panel is provided at its lower edge with a receptacle R, of inert material, for the mercury, and the framework is covered by a protecting-coating I′ of inert material.

In Figs. 24 to 27 I have illustrated a plate C^7 of substantially the same form and connected to the supporting-framework F′ by the same means as the plates of Figs. 22 and 23; but instead of employing separate mercury-receptacles of inert material the lower edges of the panels T^7 are bent upward to form the cups or receptacles R^2 for the mercury. All but one of the panels of the plate illustrated in Fig. 27 are shown as provided with an amalgamated deposit D.

In Figs. 28 and 29 I have shown a plate C^8, consisting of a number of panels T^8, each of which is connected to the supporting-framework F^2 by a narrow strip of metal at its top and provided with a comparatively narrow projecting portion t^8 at its bottom. In the forms here shown and described the panels are severally provided with receptacles at their lower edges, which are of considerable length in proportion to their depth, being generally of the same length as the panels. I have found in practice that where the receptacles are so constructed the mercury is liable to run out at one end when the cell or plate is inclined sufficiently to raise one end of the receptacle or plate a considerable dis-

tance above the other. I find that by reducing the length and increasing the depth of the receptacle this difficulty is to a great extent overcome. In order to utilize receptacles of this form without leaving vacant spaces of great width between adjacent panels, I cut a notch n in the upper edge of each panel T^8, with the exception of the top row, these notches being of such width as to exactly accommodate the receptacles R^3 of the panels immediately above, and all of the panels are provided at their lower edges with projections t^8, which extend into the mercury M in the receptacles.

The plate C^9 shown in Figs. 30 and 31 differs from that shown in Figs. 28 and 29 only in having two narrow top connections with the framework F^2 in lieu of a single narrow connection. In each of these forms the framework F^2 may be provided with a protective-covering of inert material I^2. The cylindrical form of cup or receptacle R^3 shown in Figs. 32 to 34 is convenient for use in this connection; but receptacles of other forms may obviously be employed, if desired.

I have found in practice that the forms of panels thus far shown and described are not such as to facilitate the collection of mercury in the receptacles as rapidly as may sometimes be desired by reason of the fact that the lower edges of the panels are substantially horizontal. In order to facilitate the collection of the mercury in the receptacles at a more rapid rate, I have devised other forms of panels, some of which are illustrated in the succeeding figures of the drawings.

In Figs. 35 and 36 the panels T^{10} of the plate C^{10} are shown in the form of oblong parallelograms (except the upper row T^{11}, which are in the form of triangles connected at two points to the framework F^3) arranged in diagonal rows, so that the upper corner of each panel is joined to the supporting-framework F^3, and the lower corner or tip projects into a conical-shaped cup or receptacle R^4.

In Figs. 37 and 38 most of the panels of the plate C^{12} are in the form of rectangular plates T^{12}, the outer ones at the sides being, however, in the form of triangles T^{13}. Those in the top row are also in the form of triangles T^{14}, but are connected to the framework F^3 at two points instead of at one. Conical-shaped receptacles R^4 are provided for the mercury at the lower ends of the several panels T^{13}, and receptacles R^5 of slightly-different form are provided for the panels T^{12} and T^{14}.

The receptacle R^4, employed in connection with each of the panels shown in Figs. 35 and 36 and in connection with each of the side triangular panels T^{13} shown in Fig. 37, is illustrated in Fig. 39, and the receptacle R^5, employed in connection with each of the rectangular panels T^{12} and the upper triangular panels T^{14} in the plate shown in Fig. 37, is illustrated in Fig. 40. These receptacles may have a different form in cross-section than that shown, if desired.

In Figs. 41 and 42 I have shown a plate C^{15}, comprising a number of panels T^{15} of polygonal form, each of which is connected to the framework F^4 by a narrow strip of metal at its top and the lower edge of which has two downwardly and inwardly inclined portions terminating in a projecting tongue t^{15}, this tongue extending into a cylindrical cup or receptacle R^6, containing mercury M, the form of the cup being particularly shown in Fig. 43. This cup obviously might be oblong in cross-section and either angular or oval in contour, if desired.

It is sometimes found advantageous in practice to provide some means in addition to those already shown and described for facilitating the collection of mercury from the panels into the receptacles and at the same time for preventing the mercury from splashing or spilling out of the receptacles after it has been collected. I have illustrated such means in Figs. 44 to 58, and in Figs. 44, 45, and 46 have also shown a plate C^{16}, composed of panels T^{16} of such form as to facilitate the amalgamation of the deposit thereon and the collection of the mercury when the deposit is dissolved and also to economize space to the greatest possible degree. In this plate the panels T^{16} are severally supported at the two upper corners by means of lugs or ears G, fastened thereto by rivets r and suitably attached to the supporting-framework F^5, and each panel is provided with a lower edge that inclines downwardly and inwardly from both side edges to near the middle point, where the panel terminates in a tongue t^{16}, which projects into the receptacle R^7. The upper edge of each panel, except those of the top row, also has two inclined portions terminating near the middle in a notch r' of the form of the cup belonging to the plate above and which rests therein. In order to facilitate collecting the mercury from the panels and also to prevent splashing from the receptacles, I provide the lower edge of each panel with troughs or gutters H, the inner ends of which extend into or over the receptacle and may be supported thereby by means of a dovetail-groove connection, as indicated in the drawings, or otherwise. These troughs or gutters may be made of hard rubber or other preferably inert material, and they may also be attached to the framework or to the panel in any suitable manner, or they may be integral parts of the receptacle itself.

The details of construction of the plate illustrated in Figs. 44 and 45 as regards the means of attaching the panels to the framework F^5, the insulation of the latter, the receptacles and gutters, are shown in Figs. 46 to 58, in order that a full disclosure of the invention as worked out by me in practice may be made; but, as already indicated, these de-

tails may be varied to suit the convenience or desires of the manufacturer or designer without departing from the invention.

While I have shown electrodes and mercury-receptacles of considerable variety, I have not attempted to show all forms which would fall within the scope of my invention, and while all the varieties shown are not equally well adapted for every class of work, each of the forms has been found operative and useful in practice and each comprises the subdivision of the plate into panels, and nearly all include a separate mercury-receptacle for each panel either of different material or formed from the panel itself. Each of the forms may embody a protective covering of inert material for the supporting-framework, or such framework may be employed without the covering in order to save expense or for other reasons, although, as has already been stated, such covering will generally be found desirable.

The operation of my invention is as follows: An electric current from a dynamo or other suitable source is passed through the electrolyte containing in solution an electropositive metal, such as zinc, and through the electrodes in the proper direction to cause deposition of the metal on the panels of the cathode-plates. As the metal is deposited upon the amalgamated surfaces of the panels it unites with the mercury, forming an amalgam of zinc and mercury. This amalgam by capillarity or molecular attraction absorbs more mercury from the receptacles. When the deposit of metal is completed, the mercury may or may not all be used, that which is not required remaining in the receptacles. If the deposited metal be now allowed to redissolve, either by standing in contact with a corrosive electrolyte (which may be rapidly accomplished by connecting the electrode having the deposit through any suitable electric conductor or translating device for absorbing electrical energy to the other electrode consisting of a highly oxidizing substance, such as lead peroxid) or by passing an electric current through the cell in the opposite direction. As the deposited metal redissolves the liberated mercury descends through the action of gravity and is collected in the receptacle immediately below, where it remains until it is again drawn out in a succeeding operation.

The term "electrolytic apparatus" as employed herein is intended to include all forms of apparatus in which an electric current is or may be employed either continuously or interruptedly or produce chemical change either in the electrolyte or electrodes through which it passes. An accumulator or storage battery is an example of this class, which will probably be more generally employed than any other; but I do not desire or intend to limit the invention to any specific apparatus in this general class.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. In an electrolytic apparatus, an electrode consisting of a substantially vertical conducting amalgamated plate or plate adapted to become amalgamated, provided with receptacles of inert material at various heights above its bottom, and having projections extending into the several receptacles in contact with the mercury therein, substantially as herein set forth.

2. In an electrolytic apparatus, an electrode consisting of a substantially vertical conducting-plate of material not easily destroyed by mercury and consisting of a plurality of strips or panels located at various heights above the bottom and attached to a common support or framework, the separate strips or panels being provided with receptacles of inert material containing mercury, substantially as herein set forth.

3. In an electrolytic apparatus, an electrode consisting of a substantially vertical amalgamated conducting-plate made up of a plurality of strips or panels located at various heights and having means for retaining mercury upon the separate strips or panels, substantially as herein set forth.

4. In an electrolytic apparatus, an electrode consisting of a substantially vertical amalgamated conducting-plate divided by perforations or slots into separate areas located at various heights, each of which has means for retaining mercury at its lower edge, substantially as herein set forth.

5. In an electrolytic apparatus an electrode consisting of a substantially vertical conducting-plate, amalgamated or adapted to become amalgamated, divided by horizontal slots or perforations into a number of separate panels at various heights above the bottom, the lower edges of said panels being notched or toothed, substantially as herein set forth.

6. In an electrolytic apparatus, a cathode consisting of one or more substantially vertical, amalgamated, conducting-plates, each plate having separate areas or panels at various heights above the bottom, and each panel having means for retaining mercury, in combination with suitable anodes and an electrolyte containing a highly-electropositive metal, substantially as herein set forth.

7. In an electrolytic apparatus, an electrode consisting of a substantially vertical conducting-plate of material not easily destroyed by mercury, having panels or areas at different heights above the bottom of the plate, each panel being nearly surrounded by a perforation or slot through the plate and provided at its lower edge with a receptacle containing mercury, substantially as herein set forth.

8. In an electrolytic apparatus, an electrode consisting of a substantially vertical conducting-plate of material not easily destroyed by mercury, having panels or areas at different heights above the bottom of the plate, each

panel being nearly surrounded by a perforation or slot through the plate and provided at its lower edge with a receptacle of inert material containing mercury in contact with the bottom of the panel, substantially as herein set forth.

9. In an electrolytic apparatus, an electrode consisting of a substantially vertical conducting-plate of material not easily destroyed by mercury, having panels or areas at different heights above the bottom of the plate, each panel being surrounded on all sides except the top by a perforation or slot through the plate, and provided at its lower edge with a receptacle containing mercury, substantially as herein set forth.

10. In an electrolytic apparatus, an electrode consisting of a substantially vertical conducting-plate having panels or areas at different heights above the bottom of the plate, each panel surrounded on all sides except the top, by a perforation or slot through the plate, and provided at its lower edge with a receptacle of inert material containing mercury in contact with the bottom of the panel, substantially as herein set forth.

11. In an electrolytic apparatus, an electrode consisting of a substantially vertical plate made up of a conducting framework or support and a plurality of separate plate-panels located at various heights and electrically connected to it, and a covering of insulating material for the framework which prevents, to a great extent, direct contact between the latter and the electrolyte, substantially as herein set forth.

12. In an electrolytic apparatus, an electrode consisting of one or more substantially vertical plates each comprising a conducting-framework and a number of separate plate-panels disposed at different heights, and means for protecting the framework against electrolytic action, substantially as herein set forth.

13. In an electrolytic apparatus, an electrode consisting of one or more substantially vertical plates, each having a conducting-framework and a number of amalgamated panels at different heights, the framework being protected against electrolytic deposition and each panel having means for retaining mercury on its lower edge, substantially as herein set forth.

14. In an electrolytic apparatus, an electrode consisting of one or more substantially vertical plates, each having a conducting-framework and a number of amalgamated panels at different heights, the framework being protected against electrolytic deposition and each panel having a receptacle of inert material containing mercury in contact with the panel, substantially as herein set forth.

15. In an electrolytic apparatus, an electrode consisting of one or more substantially vertical plates, each having a conducting-framework and a number of amalgamated panels at different heights, the framework being protected against electrolytic deposition and each panel having means for retaining mercury on its lower edge, in combination with a suitable electrode of opposite polarity and an electrolyte, substantially as herein set forth.

16. In an electrolytic apparatus, an electrode consisting of one or more substantially vertical plates, each having a conducting-framework and a number of amalgamated panels at different heights, the framework being protected against electrolytic deposition and each panel having means for retaining mercury on its lower edge, in combination with an electrolyte containing a highly-electropositive metal and electrodes of opposite polarity containing an oxidizable substance, substantially as herein set forth.

17. In an electrolytic apparatus, an electrode consisting of one or more substantially vertical plates each made up of a conducting framework or support and a number of panels at different heights, electrically connected to it, each panel being provided at its lower edge with a receptacle having a depth not less than its greatest horizontal dimension, and containing mercury in contact with the panel, substantially as herein set forth.

18. In an electrolytic apparatus, an electrode consisting of a substantially vertical plate, made up of a conducting framework or support and a number of amalgamated panels at different heights, electrically connected to it, the framework being protected from chemical and electrolytic action, and each panel being provided with a receptacle of inert material at its lower edge containing mercury in contact with the panel, the receptacle having a depth substantially equal to or greater than its greater horizontal dimension, in combination with an electrolyte containing a highly-electropositive metal and electrodes of opposite polarity containing an oxidizable substance, substantially as herein set forth.

19. In an electrolytic apparatus, an electrode consisting of a substantially vertical plate made up of a conducting framework or support and a number of panels, at different heights, electrically connected to the framework, each panel having an inclined lower edge provided with a receptacle containing mercury in contact with the panel at its lowest point, substantially as herein set forth.

20. In an electrolytic apparatus, an electrode consisting of a substantially vertical plate made up of a conducting framework or support and a number of panels, at different heights, electrically connected to the framework, each panel having an inclined lower edge provided with a receptacle of inert material containing mercury in contact with the panel at its lowest point, substantially as herein set forth.

21. In an electrolytic apparatus, an electrode consisting of a substantially vertical

plate made up of a conducting framework or support and a number of amalgamated panels, at different heights, electrically connected to it, each panel being provided with a receptacle at its lower edge containing mercury in contact with the panel, said edge having one or more inclined portions terminating at the lowest point or points in the receptacle, substantially as herein set forth.

22. In an electrolytic apparatus, an electrode consisting of a substantially vertical plate made up of a conducting framework or support and a number of amalgamated panels, at different heights, electrically connected to it, the framework being protected from chemical and electrolytic action, and each panel being provided with a receptacle of inert material at its lower edge containing mercury in contact with the panel, the lower edge of each panel having one or more inclined portions terminating at the lowest point or points in the receptacle, in combination with a suitable electrode of opposite polarity and an electrolyte, substantially as herein set forth.

23. In an electrolytic apparatus, an electrode consisting of a substantially vertical plate made up of a conducting framework or support and a number of panels, at different heights, electrically connected to the framework, each panel being provided at its lower edge with a receptacle containing mercury in contact with the panel, and with troughs or gutters leading into the receptacle, substantially as herein set forth.

24. In an electrolytic apparatus, an electrode consisting of a substantially vertical plate made up of a conducting framework or support and a number of panels, at different heights, electrically connected to the framework, each panel being provided at its lower edge with a receptacle of inert material containing mercury in contact with the panel, and with troughs or gutters leading into the receptacle, substantially as herein set forth.

25. In an electrolytic apparatus, an electrode consisting of a substantially vertical plate made up of a conducting framework or support and a number of amalgamated panels, at different heights, electrically connected to it, each panel being provided with a receptacle at its lower edge containing mercury in contact with the panel, said edge having one or more inclined portions terminating at the lowest point or points at the receptacle and being provided with a trough or gutter for each inclined portion, substantially as herein set forth.

26. In an electrolytic apparatus, an electrode consisting of a substantially vertical plate made up of a conducting framework or support and a number of amalgamated panels, at different heights, electrically connected to it, each panel being provided with a receptacle of inert material at its lower edge containing mercury in contact with the panel, said edge having inclined portions terminating at the receptacle and being provided with troughs or gutters to the receptacle, substantially as herein set forth.

27. An electrode comprising a series of electrically-connected conducting-sections arranged one above the other and having their adjacent edges separated, and non-electric conducting mercury-containing channels receiving the lower edges of said sections.

28. An electrode consisting of a metal plate divided transversely into a series of sections electrically connected to each other and non-conducting mercury-containing tubes having slots and slipped over the lower edges of the sections.

29. In an electrode for electric batteries, a sheet-metal plate having its intermediate body formed with one or more divisions or slots and non-conducting slotted tubes inserted in the partial divisions or slots and containing mercury for the purpose described.

30. In an electrode for electric batteries, an upright conducting-plate having sections formed by a series of substantially parallel partial transverse divisions or slots in combination with non-conducting mercury-containing tubes arranged in the divisions or slots and having slots receiving the lower ends of the plate-sections for permitting the rise and fall of the mercury over the superimposed portions of the plate.

31. In an electrode for electric batteries, a series of upright conducting-sections, receptacles containing mercury in contact with said sections, an upright conductor connecting said sections, said conductor being coated with a non-electric conducting material for the purpose described.

32. In an electrode for electric batteries, an upright conducting-plate having a series of substantially parallel partial transverse divisions or slots for the purpose described, the upright edges of said plate being provided with a coating of insulating material, and a non-conducting mercury-containing support in each of the slots, the mercury being in contact with the adjacent upper wall of the slot.

33. A battery comprising a cell for the electrolyte, positive and negative electrodes, one of the electrodes being divided into sections, and a series of transverse mercury-supporting pieces arranged one above the other in the divisions between the sections, said sections being electrically connected to each other.

34. In an electrode, the combination of an upright metal strip having a non-electric conducting-coating, a plurality of metal pieces electrically connected to the strip, and a series of mercury-containing non-conducting pieces having channels receiving portions of said plates.

In testimony whereof I have hereunto subscribed my name this 1st day of May, 1899.

CHARLES J. REED.

Witnesses:
JAMES W. LAWS,
ROBT. B. FLETCHER.