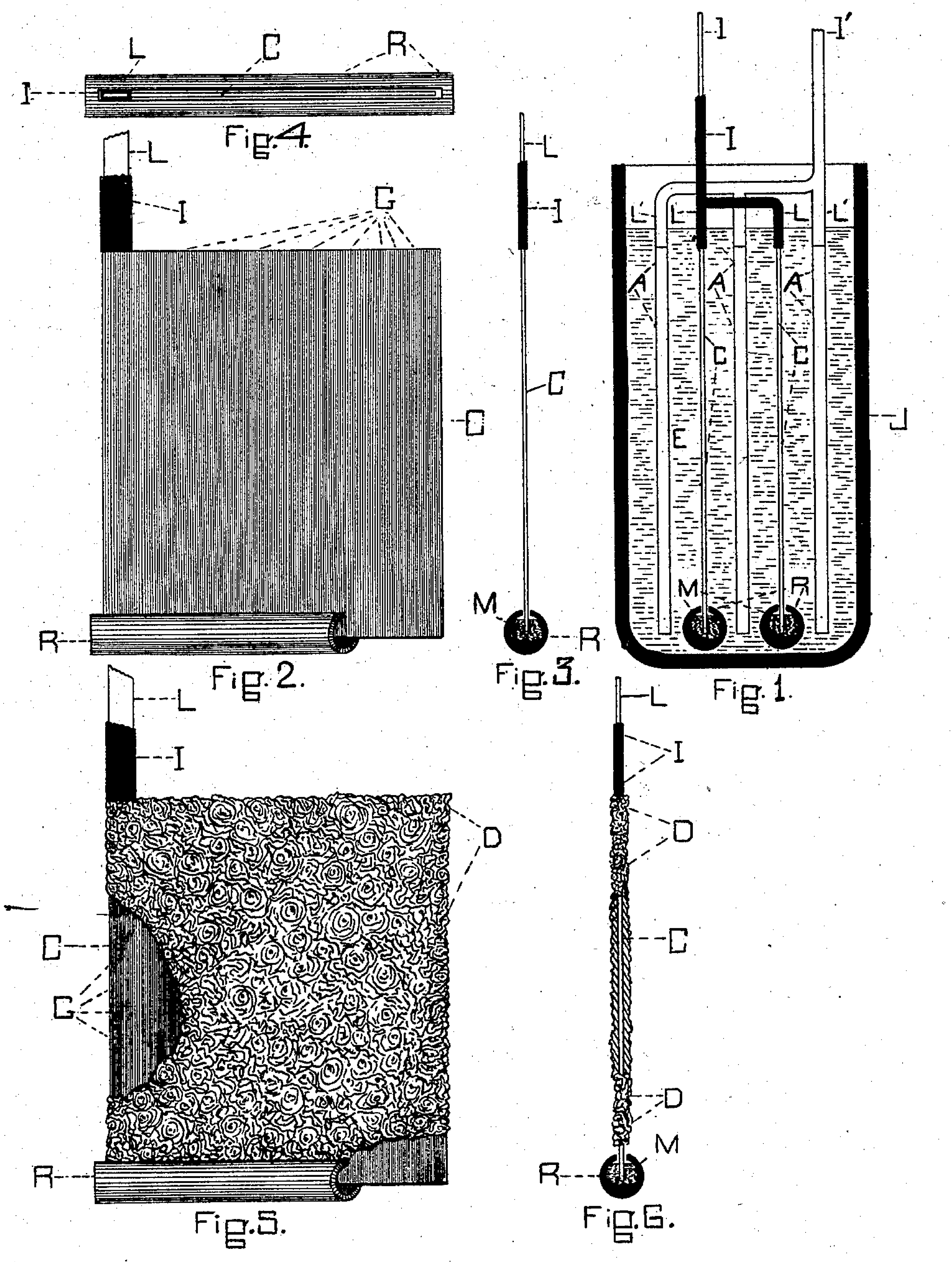
No. 719,872. PATENTED FEB. 3, 1903

C. J. REED.

ELECTROLYTIC APPARATUS.

APPLICATION FILED MAY 5, 1899.

NO MODEL. 2 SHEETS—SHEET 1



Witnesses

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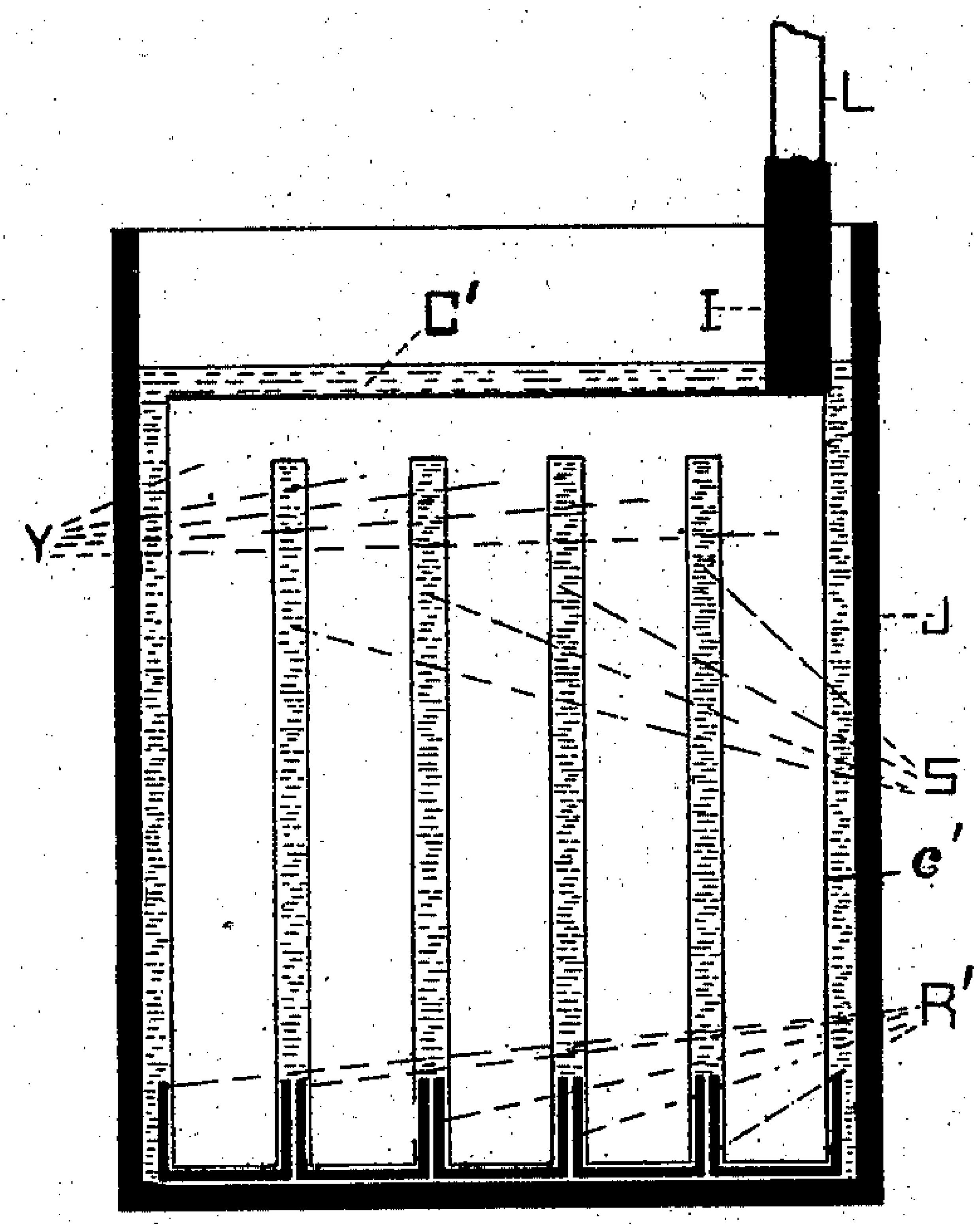

Fig. 8.

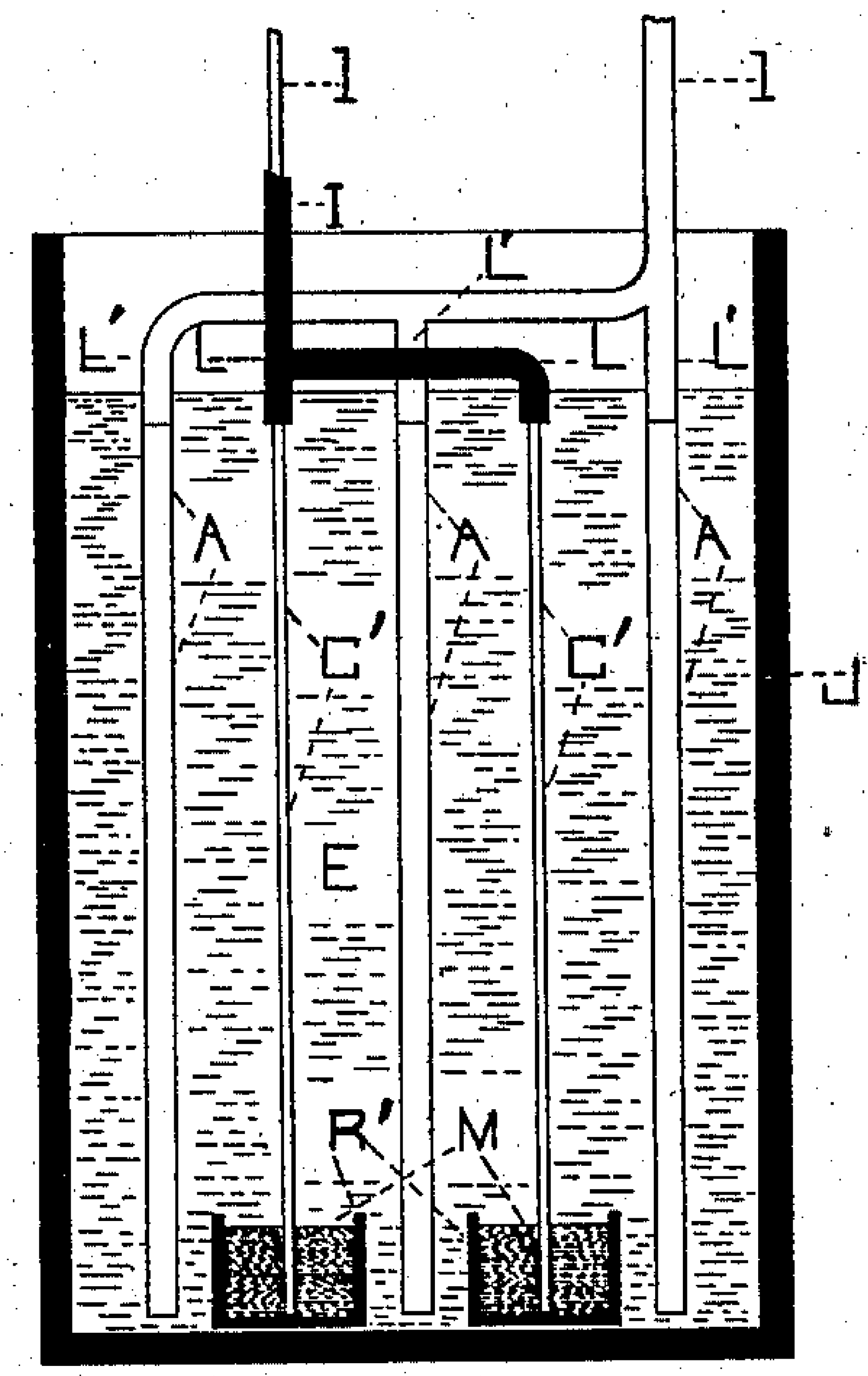

Fig. 7.

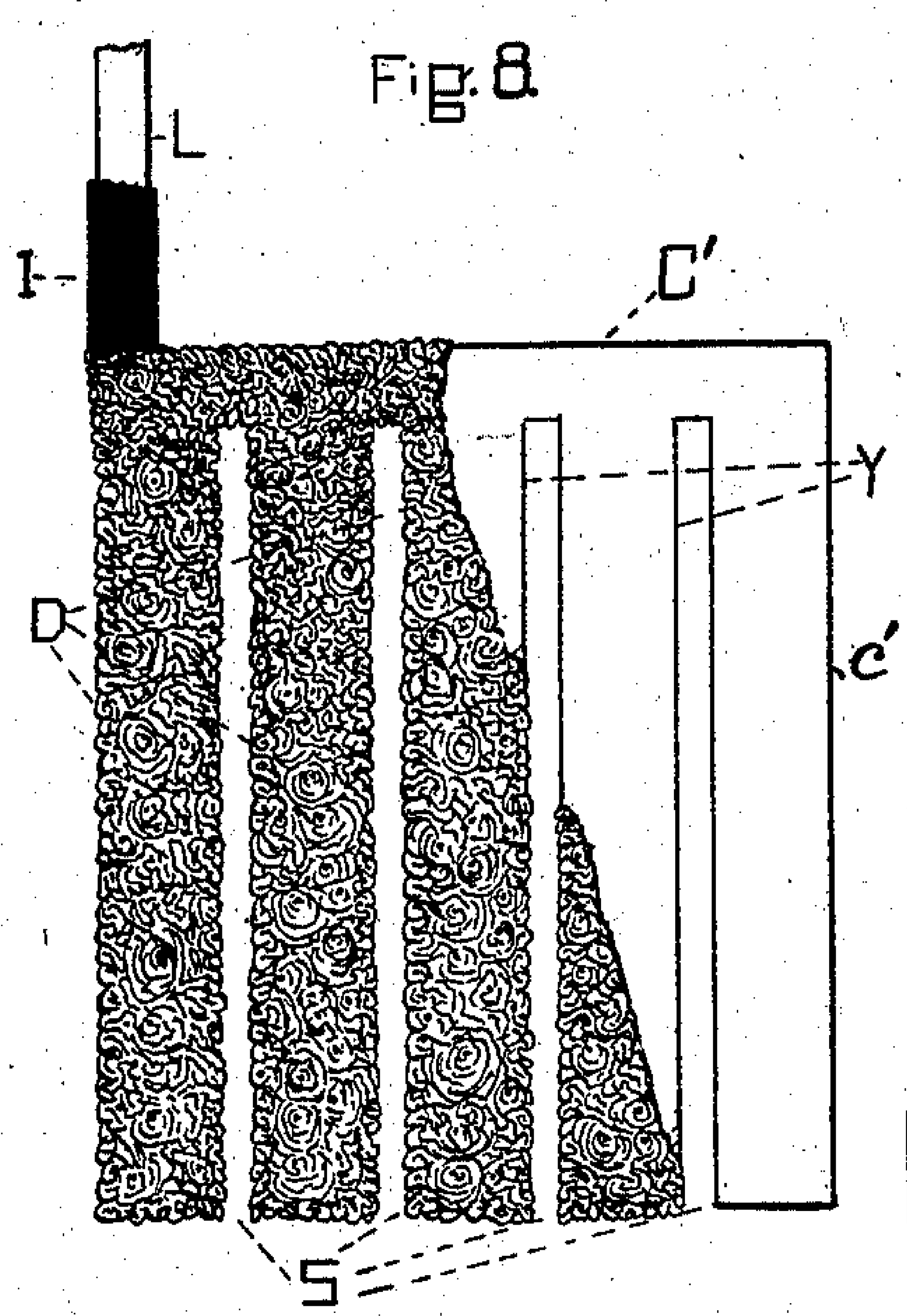

Fig. 15.

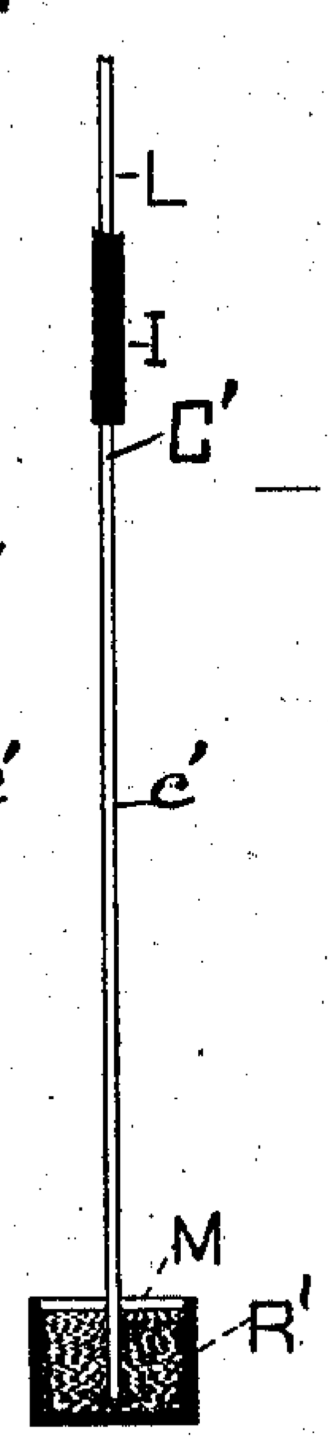

Fig. 9.

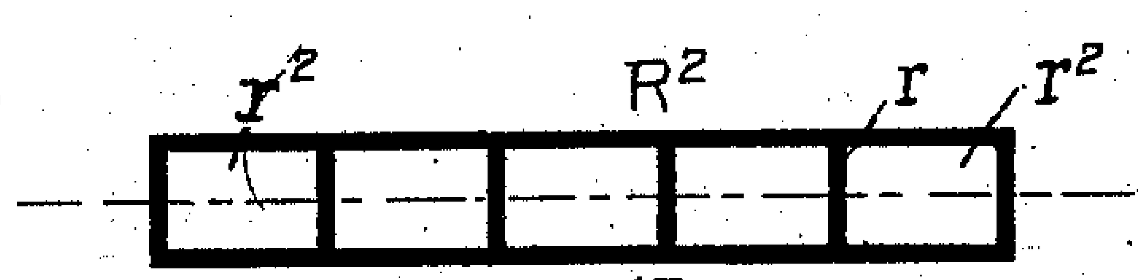

Fig. 10.

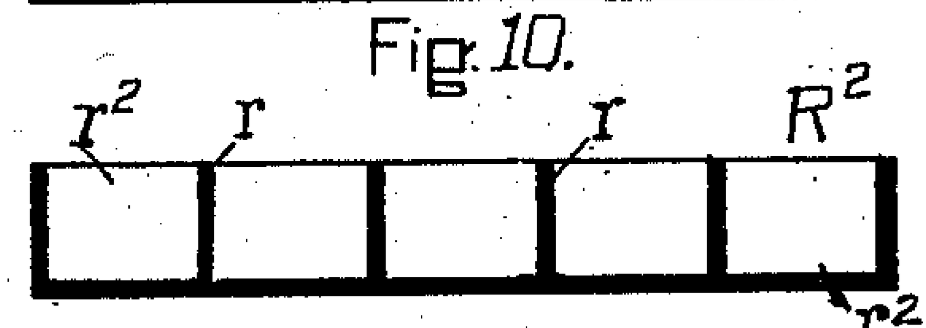

Fig. 11.

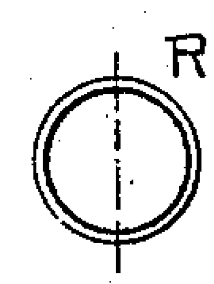

Fig. 12.

Fig. 13.

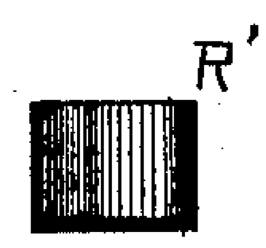

Fig. 14.

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UNITED STATES PATENT OFFICE.

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ELECTROLYTIC APPARATUS.

SPECIFICATION forming part of Letters Patent No. 719,872, dated February 3, 1903.

Application filed May 5, 1899. Serial No. 715,685. (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. 827,) of which the following is a specification.

My invention relates to electrolytic apparatus in which it is desired to deposit in a metallic state from an electrolyte a highly-electropositive metal, such as sodium, potassium, cadmium, or zinc; and it has for its object to provide a simple and efficient means for insuring a satisfactory amalgamation of such deposit.

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

Figure 1 is a sectional view of an electrolytic cell embodying one form of my invention. Fig. 2 is a side view of one of the cathode-plates and a portion of the mercury-containing receptacles shown in Fig. 1. Fig. 3 is an edge view of one of the cathode-plates and its mercury-containing receptacle. Fig. 4 is a plan view of the same. Figs. 5 and 6 are views corresponding, respectively, to Figs. 2 and 3, but showing a deposit of amalgamated metal on the cathode-plate, parts of such deposit being broken away. Figs. 7 and 8 are sectional views taken at right angles to each other of an electrolytic cell embodying cathode-plates and mercury-containing receptacles of modified construction. Fig. 9 is a view of a cathode-plate and mercury-containing receptacle, the former being shown in end elevation and the latter in section. Figs. 10 and 11 are respectively a plan view and a vertical section of a mercury-containing receptacle divided into compartments; and Figs. 12, 13, and 14 are detail views of a single-compartment receptacle. Fig. 15 is a side view of a cathode-plate of the form shown in Fig. 8, a portion of which is shown as provided with an amalgamated deposit.

In the electrolytic deposition of highly-electropositive metals from aqueous solutions it is customary in order to prevent a rapid redissolving of the metal to employ a cathode consisting either entirely or in part of mercury, the object of the mercury being to form an amalgam with the deposited metal which dissolves less readily than the metal in a free state. It is well known that if a vertical amalgamated plate be used as a cathode for electrolytic deposition of metal any mercury that may be at the bottom of the plate in contact with it will be absorbed and drawn up by the deposited metal. If the latter be, like zinc or lead, a metal easily amalgamated, the quantity of mercury that may be drawn up by this process is practically limited only by the quantity of metal deposited, which acts as a sponge or absorbent of mercury. Heretofore it has been usual in operations of this kind where vertical cathodes have been employed and where it was desired to redissolve and redeposit the metal to place in the bottom of the vat or electrolytic cell a small quantity of metallic mercury and depend upon its accidental contact with the cathodes or to employ a large quantity of mercury, covering the bottom to a considerable depth, and to limit the length of the anodes, so as to prevent short circuits. When only a small quantity of mercury is used and the bottom of the cell is not maintained exactly horizontal, the mercury may all run to one corner or one side of the cell, and thus make contact with only one or two of the cathode-plates. If a large quantity of mercury be used, the expense and the weight of the apparatus are greatly increased.

In accordance with my present invention I propose to confine a limited and proper quantity of mercury in contact with the bottoms of the cathode-plates in such manner that it will readily ascend by capillary attraction whenever metal is electrolytically deposited upon the surface of the plate. I propose also to provide a separate quantity of mercury for each cathode-plate or each division of a plate in such manner as to permit the anodes to extend to the bottom of the cell without danger of establishing short circuits.

The provision of a separate quantity of mercury for each cathode-plate is a satisfactory solution of the difficulties above referred to in certain cases; but where the cell is intended for portable use and its bottom does not, therefore, always remain in a horizontal position it is obvious that the angle may be such as to render it difficult to retain the mercury in the receptacles, particularly if each receptacle is of only sufficient capacity to hold the amount of mercury required for one plate. In such cases I provide a number of short receptacles for each plate either by placing partitions in a long receptacle or by providing separate cups, thus permitting of a tilting of the cell to a much greater angle than would be otherwise possible before any spilling of the mercury occurs.

In order to make sure that each of the small receptacles which are located at the bottom of the plate shall receive its own proper proportion of the mercury that descends to the bottom of the plate when the deposit is dissolved, I find it to be sometimes advantageous to divide the plate by vertical slots into as many separate areas as there are receptacles. By this arrangement the mercury on any one of the areas cannot get upon any other area, even when the plate is tilted to a considerable angle, but must work down into its own receptacle; otherwise it might be possible if the plate remained for a considerable time in an inclined position while the deposited metal was being dissolved for the greater part of the mercury to gravitate toward the lowest side or corner, whereby the lower receptacles would receive more mercury than they could hold, while the higher receptacles would not receive their proper amounts. The capacity of each receptacle should in practice be somewhat greater than that required to hold the mercury intended for it.

Referring now to Figs. 1 to 6 of the drawings, the electrolytic cell comprises a jar J, of glass, hard rubber, or other suitable material, an electrolyte E, containing a solution of a salt of the metal to be deposited—such, for example, as a solution of zinc sulfate—substantially vertical anodes or positive plates A, which may contain the metal to be deposited or which may be of platinum, carbon, lead, lead peroxid, or other suitable material not easily destroyed by the electrolytic or chemical action and are united to a suitable terminal l' by lugs L', substantially vertical cathode-plates C, electrically connected by lugs L to a terminal piece l, and receptacles R, preferably of inert material, such as hard rubber, one for each cathode-plate and each provided with a quantity of mercury M. Each of the receptacles R is shown as cylindrical in form and provided with a slot at its top, through which the lower edge of the plate projects into the mercury M. This particular form of mercury-containing receptacle is obviously not essential. It might be a trough or gutter in the bottom of and constituting an integral part of the jar J, if desired, or it might be a separate receptacle of different form in cross-section from that shown.

Each cathode-plate C is preferably constructed of copper or other suitable metal capable of being amalgamated without being destroyed or rendered either soft or brittle by the action of mercury, and its sides may be either comparatively smooth or one or both sides may be provided with vertical capillary grooves G, cut into the plate at any convenient distance apart, as indicated in Figs. 2 and 5. When capillary grooves are employed, I prefer to have them as near together and as numerous as possible, though I am not limited to any particular arrangement or distribution of these grooves on the surface of the plate. A different distribution may be used for a special purpose—as, for instance, an arrangement in groups. Furthermore, the grooves need not be exactly vertical, provided they extend from the lower part of the plate to or nearly to the upper part and are adapted to draw the mercury upward from the bottom. They may obviously be oblique, zigzag, or of other innumerable irregular forms without materially modifying or in any way departing from the invention.

As illustrated in Figs. 8 to 15, the cell J and its several elements may be the same in composition and arrangement as in the preceding figures, with the exception that each cathode-plate C' is partially divided into a number of substantially vertical divisions or areas c' by means of slots S, which extend nearly to the top of the plate, and a separate mercury-containing receptacle R is provided for each division or area. The number, form, and material of these receptacles may be varied to suit the desires or convenience of the manufacturer.

In Figs. 10 and 11 I have shown a long receptacle R^2, subdivided by partitions r into a number of short receptacles r^2, one for each division or area of the plate. In Figs. 12, 13, and 14 I have shown a single receptacle R' of cylindrical form for one of the areas or divisions of the plate, as many of these receptacles being employed as there are divisions. This receptacle might be oblong in cross-section and either angular or oval instead of cylindrical, as shown. It will be understoood also that the several divisions or areas of this plate may be provided with the capillary grooves described in connection with Figs. 1 to 6, or they may have comparatively smooth surfaces. The grooves will be generally found desirable in practice, however.

A deposit D of amalgamated metal such as is made in the operation of a cell of the kind here illustrated and described is shown on the plate in each of Figs. 5 and 15.

Where the general form of plate illustrated in Figs. 7, 8, 9, and 15 is employed it will be understood that the different areas may be formed by slots of curved or other form differing from that shown in the drawings and that the areas may be of unequal size. If the latter be the case, the mercury-containing receptacles should be approximately proportional in capacity to the areas of the corresponding portions of the cathode-plate.

The operation of my invention is as follows: An electric current is passed through the electrolyte in the proper direction to deposit the zinc or other electropositive metal from the electrolyte upon the cathode. This deposit absorbs mercury from the receptacles by capillary attraction, and as the deposit increases the amount of mercury absorbed increases until it is all taken out of the receptacles. Upon allowing the current to pass in the opposite direction the deposited metal redissolves, or it may be dissolved by standing in an acid solution, particularly if the lug l be connected through any suitable electric conductor and a translating device for absorbing electrical energy to the lug l' of anodes A, made of a strongly-oxidizing material, such as lead peroxid. As the deposited metal redissolves into the electrolyte the mercury is set free from the amalgam and flows down into the receptacles, each receptacle receiving the same mercury which was drawn from it. This will take place whether the bottom edge of the plate be in a horizontal position or be tilted to a considerable angle. This cycle of operations may be repeated indefinitely.

The term "electrolytic apparatus" herein employed is intended to include all forms of apparatus in which an electric current is or may be employed either continuously or interruptedly to produce chemical change either in the electrolyte or in either or both of the electrodes through which it passes. An accumulator or storage battery is a well-known and practical form of such apparatus; but I mention this as an example merely and not as a limitation of the invention to this specific variety of apparatus.

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

1. In an electrolytic apparatus, a substantially vertical cathode-plate having substantially vertical capillary grooves on its surface, one or more receptacles of inert material at the bottom and mercury in the receptacle or receptacles in contact with the plate, substantially as herein set forth.

2. In an electrolytic apparatus, a number of substantially vertical cathode-plates in a single cell each provided with capillary grooves upon its surface adapted to facilitate the upward movement of mercury and one or more separate receptacles at the bottom of each plate containing mercury in contact with the plate, substantially as herein set forth.

3. In an electrolytic apparatus, one or more amalgamated, substantially vertical, cathode-plates connected to a common conductor, the plates being provided with capillary grooves adapted to facilitate the upward flow of mercury, each plate having one or more separate receptacles at the bottom containing mercury in contact with the plate, substantially as herein set forth.

4. In an electrolytic apparatus, a number of substantially vertical amalgamated cathode-plates connected to a common conductor, each provided with capillary grooves adapted to facilitate the upward movement of mercury, substantially as herein set forth.

5. In an electrolytic apparatus, a number of substantially vertical amalgamated cathode-plates, or plates adapted to become amalgamated, connected to a common conductor, each having one or more separate receptacles at the bottom containing mercury in contact with the plate, the plates having capillary grooves adapted to facilitate the upward movement of the mercury, in combination with anodes and an electrolyte, substantially as herein set forth.

6. In an electrolytic apparatus, a substantially vertical cathode-plate having approximately vertical slots extending from the bottom upward nearly to the top and dividing the plate into distinct areas, and means for confining mercury to each of the separate areas, substantially as herein set forth.

7. In an electrolytic apparatus, a substantially vertical cathode-plate, having approximately vertical slots which divide the plate into a number of areas, each area being provided at the bottom with a separate receptacle containing mercury in contact with the area, substantially as herein set forth.

8. In an electrolytic apparatus, a number of substantially vertical cathode-plates in a single cell, connected to a common conductor, each plate being divided by approximately vertical slots into separate areas, and means for confining mercury to each of the separate areas, substantially as herein set forth.

9. In an electrolytic apparatus, a number of substantially vertical cathode-plates in a single cell connected to a common conductor, each plate being divided by approximately vertical slots into separate areas, and the separate areas being provided at the bottom with separate receptacles containing mercury in contact with the respective areas, substantially as herein set forth.

10. In an electrolytic apparatus an amalgamated cathode-plate, or plate adapted to become amalgamated, divided by approximately vertical slots into separate areas, each area having a separate receptacle at the bottom containing mercury in contact with the plate, in combination with anodes and an electrolyte, substantially as herein set forth.

11. In an electrolytic apparatus, an amalgamated cathode-plate, or plate adapted to become amalgamated, divided by approximately vertical slots into separate areas, each area having a separate receptacle at the bottom containing mercury in contact with the plate, in combination with anodes and an electrolyte containing a zinc salt, substantially as herein set forth.

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.