No. 699,415. Patented May 6, 1902.

C. J. REED.

ELECTROLYTIC APPARATUS.

(Application filed Aug. 1, 1901.)

(No Model.) 2 Sheets—Sheet I.

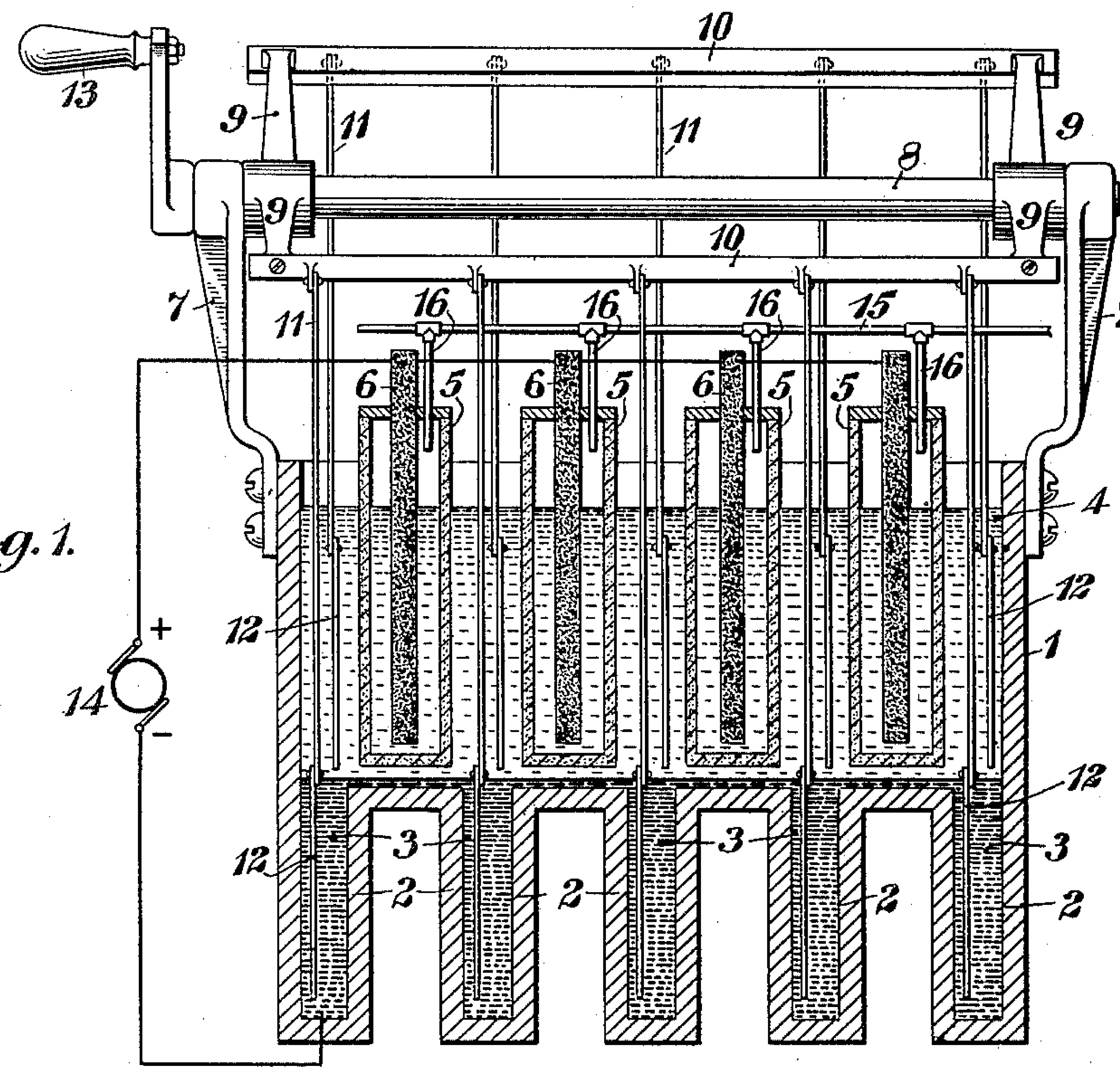

Fig. 1.

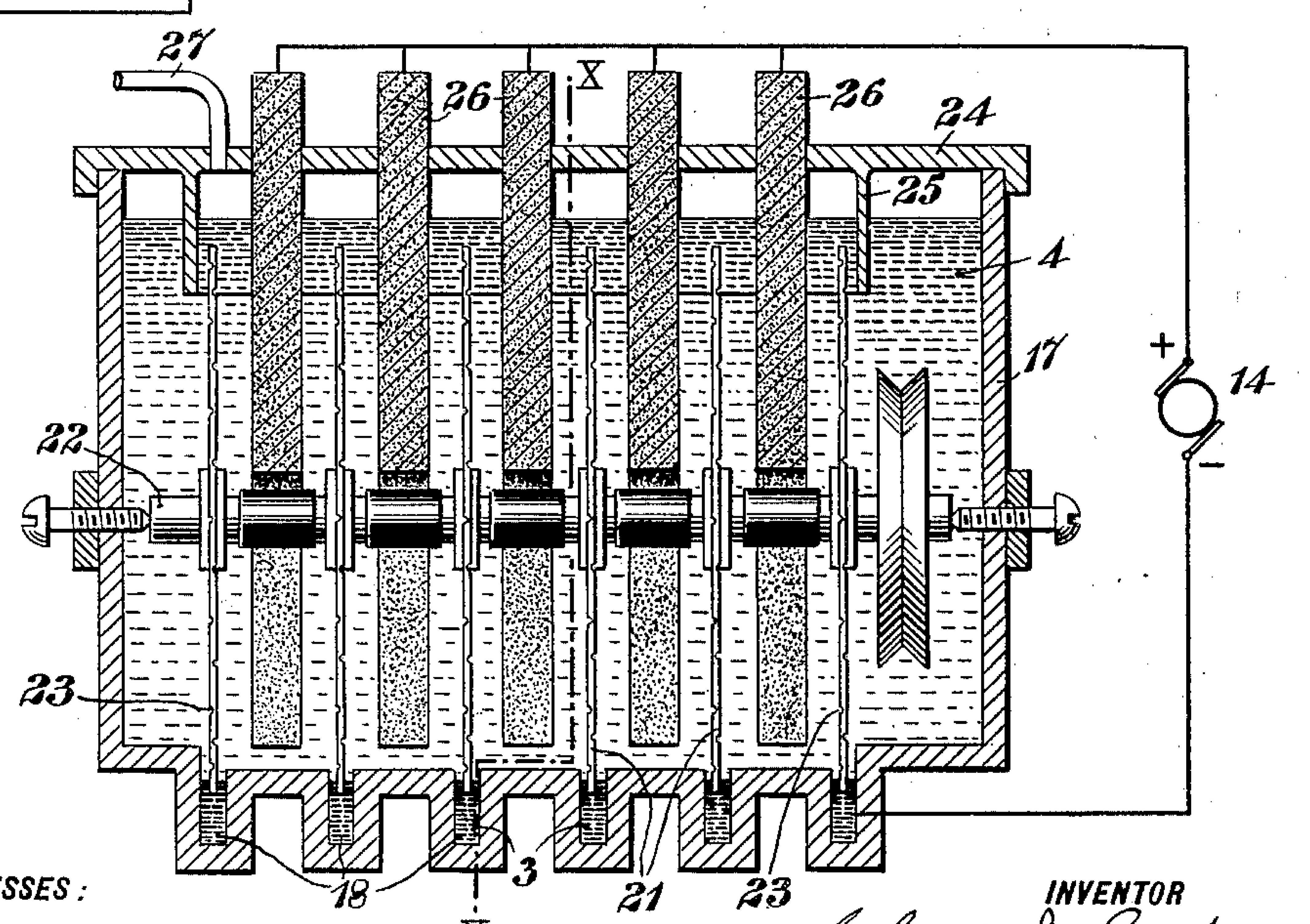

Fig. 2.

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Fig. 3.

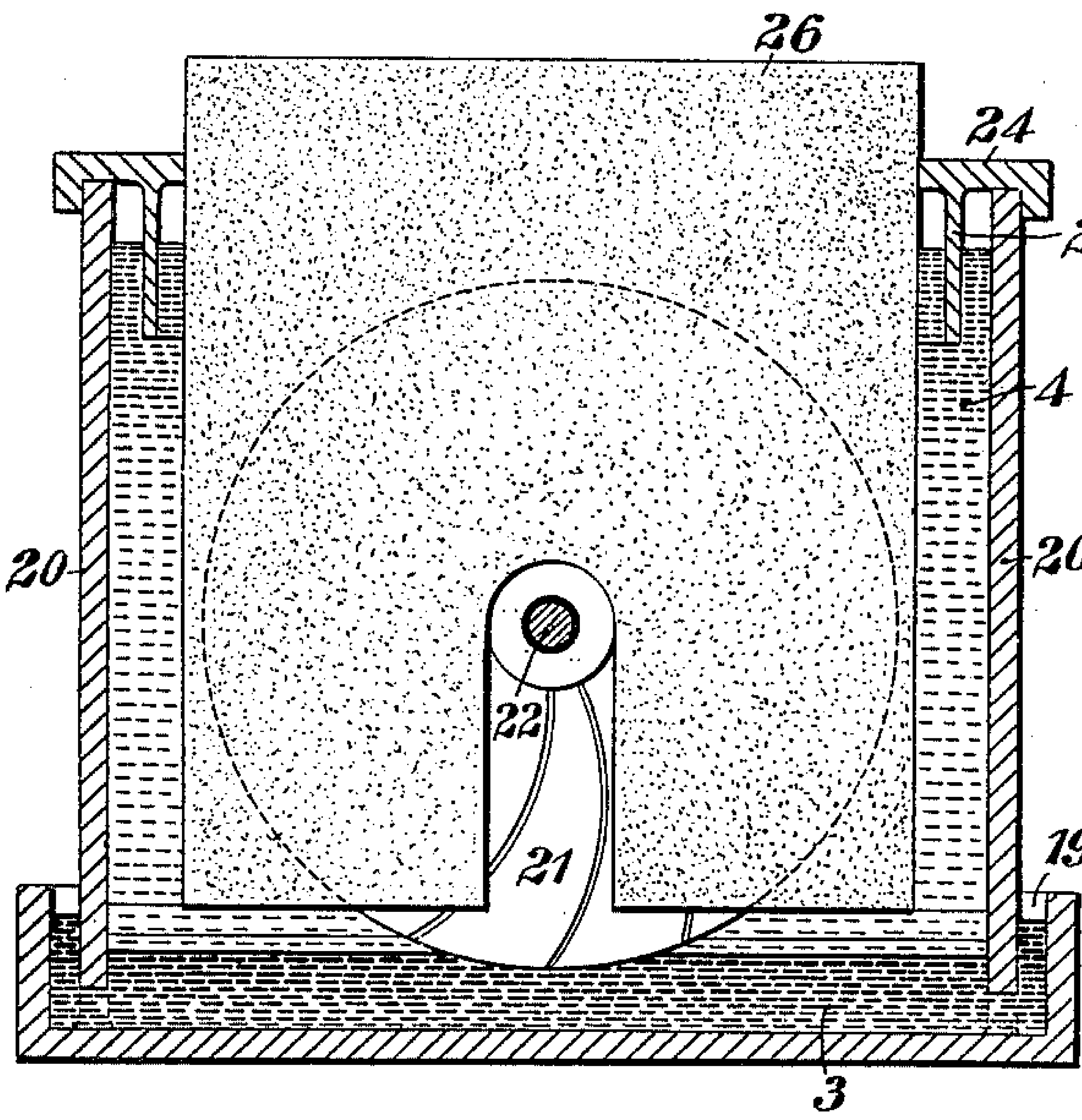


Fig. 4.

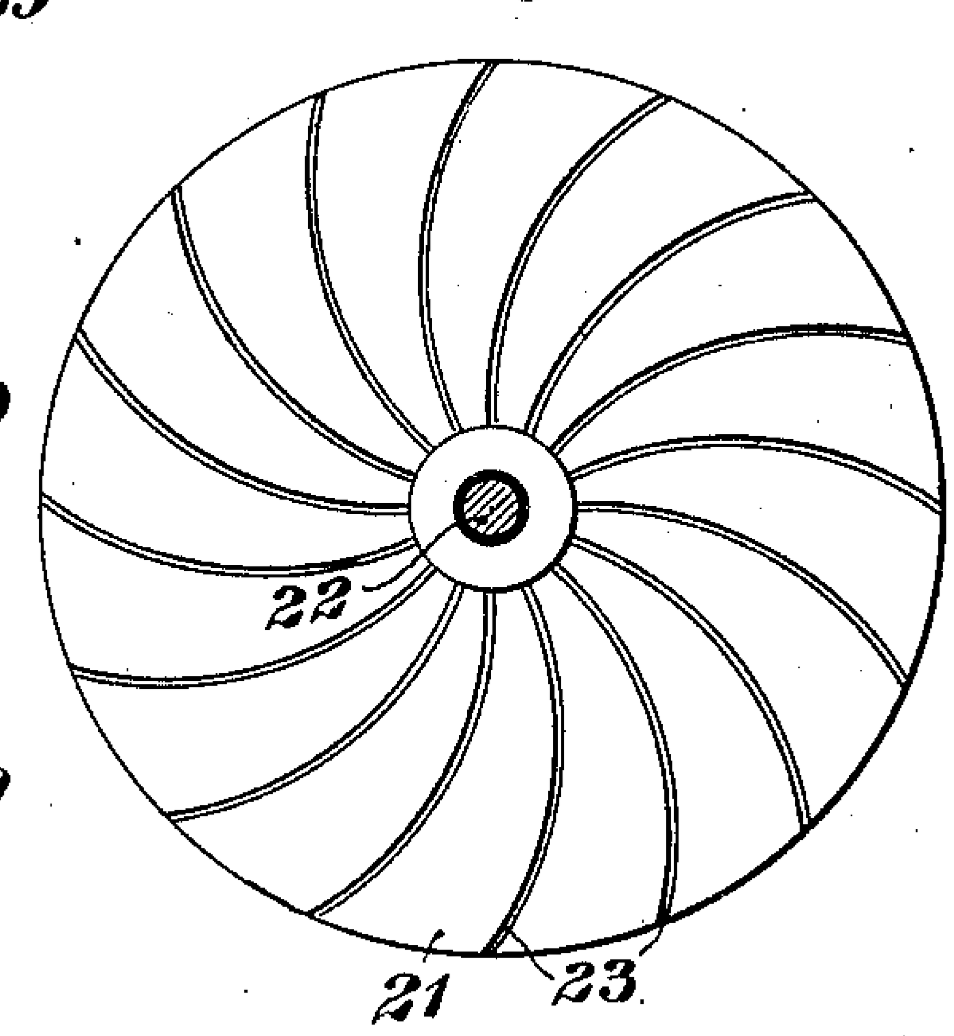


Fig. 5.

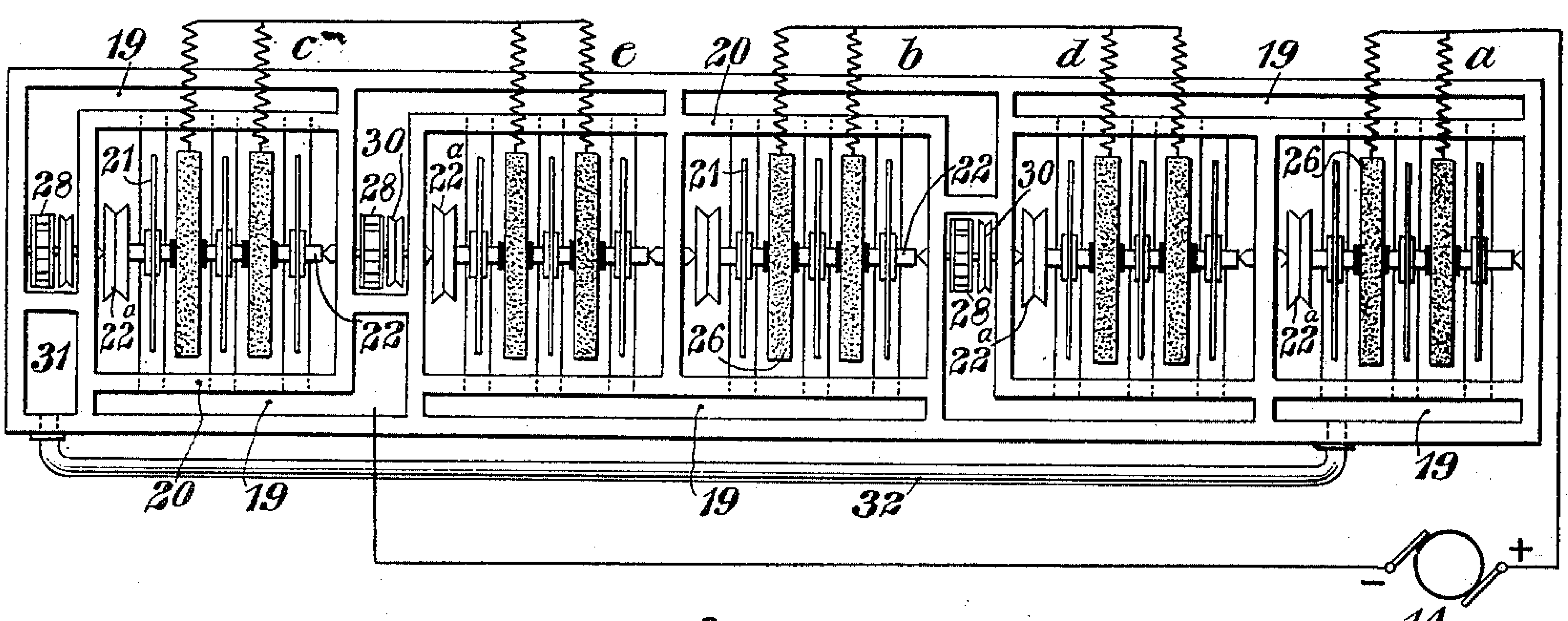
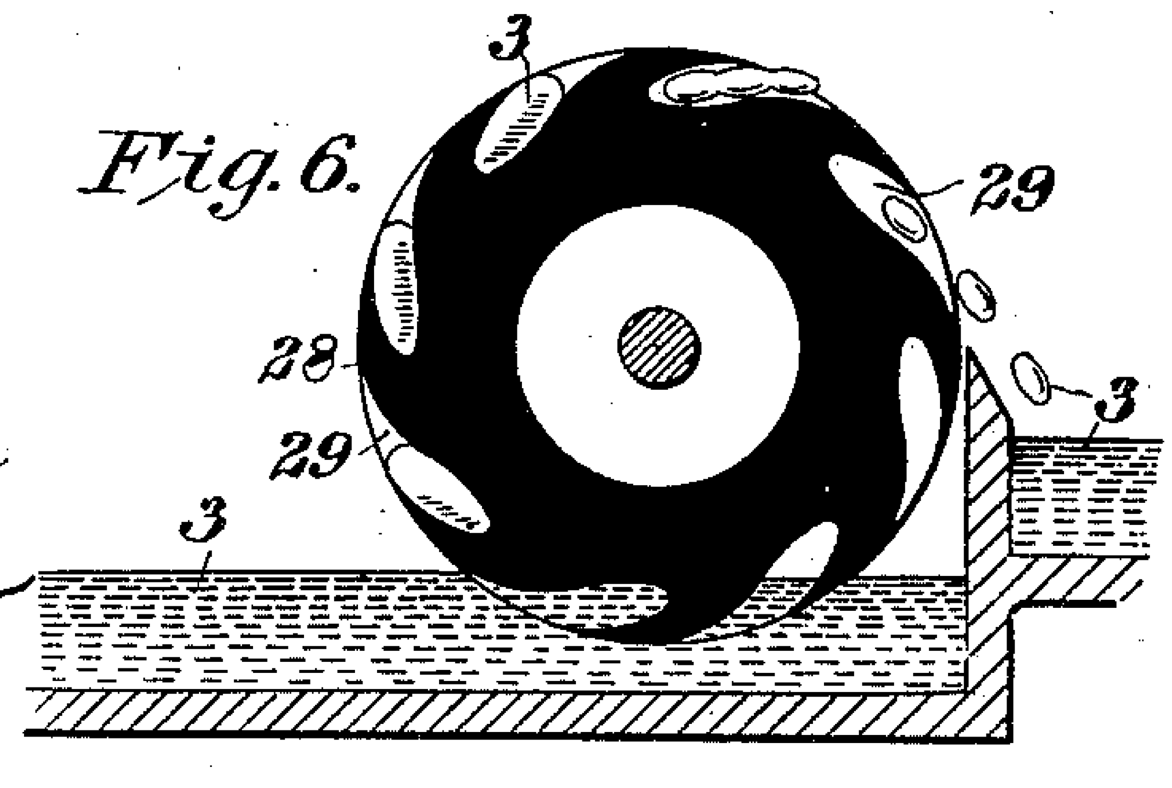


Fig. 6.



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ELECTROLYTIC APPARATUS.

SPECIFICATION forming part of Letters Patent No. 699,415, dated May 6, 1902.

Application filed August 1, 1901. Serial No. 70,537. (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, of which the following is a specification.

My invention relates to electrolytic apparatus, and particularly to such apparatus as employs mercury either alone or in conjunction with solid metal bodies as one of the electrodes.

The object of my invention is to promote the electrolytic action by providing a maximum exposure of the electrolyte to the mercury in the electrolytic operation and to also promote the expeditious removal of the resulting amalgam.

With these ends in view I have devised the means shown in the accompanying drawings, in which—

Figure 1 is a sectional view of one form of apparatus suitable for practicing my invention. Fig. 2 is a sectional view of a modified form of apparatus, and Fig. 3 is a detail sectional view taken on line *x x* of Fig. 2. Fig. 4 is a detail side elevation of one of the metal electrodes shown in Fig. 2. Fig. 5 is a plan view of a series of cells, each of which is substantially like that shown in Fig. 3. Fig. 6 is a detail sectional view of a portion of the apparatus shown in Fig. 5.

Referring now particularly to Fig. 1, a receptacle 1 of suitable material is provided with a plurality of recesses or pockets 2 in its bottom, which are filled with mercury 3, the mercury being sufficient in amount to project above the tops of the pockets and form a continuous body across the receptacle. Above the mercury is a liquid electrolyte 4, the separation of which into its constituent elements may be effected by my present invention. Located in this electrolyte are a plurality of porous cups 5, the bottoms of which terminate above the mercury 3, and in each of these cups is located an electrode 6, of carbon or other suitable electronegative material. The liquid inside the cups is the same as that outside of them. Journaled in brackets 7, which are suitably supported upon the receptacle 1, is a shaft 8, having two pairs of arms 9, which support at their outer ends two bars or beams 10. Depending from each of the beams 10 is a set of rods 11, to the lower ends of which are fastened metal electrodes 12 in the form of plates. These arms 11 and the plates are so disposed along the beams 10 that as the shaft 8 is oscillated back and forth in its bearings by means of a suitable handle 13 each set of plates 12 is alternately dipped into the mercury in the cups 2 and raised into the electrolyte 4. Since the carbon electrodes 6 and the mercury 3 constitute the terminals of a suitable source of electrical energy 14, the current passing through the electrolyte will serve to decompose it, and the mercury will receive the metallic element or elements thus separated from the liquid. The resulting gaseous products which will collect in the porous cups 5 may be drawn off by means of a pipe 15 and branch pipes 16. The moving of the plate electrodes 12 into the mercury serves both to wash off the electrolytic deposit and also to provide a fresh coating of mercury to receive a new deposit when the plates are again raised from the mercury into the electrolyte. The amalgam in the pockets 2 may be replaced by mercury continuously or from time to time by means of suitable inlet and outlet pipes (not shown) or in any other convenient manner.

In the form of the invention shown in Figs. 2, 3, and 4 the receptacle 17 is provided with a plurality of channels 18, that communicate at their ends with open channels 19, the mercury 3 therein being above the lower edge of the sides 20 of the receptacle, so that it serves as a seal to prevent the escape of the electrolyte 4. Instead of the vertical reciprocating plate electrodes 12 (shown in Fig. 1) I here provide a plurality of disk electrodes 21, that are mounted upon a shaft 22, having suitable bearings in the sides of the receptacle 17. These electrodes 21, which may be provided with curved grooves or channels 23, are electrically connected by means of the shaft and are of such diameter as to dip into the mercury in the channels 18 as the shaft is rotated. The mercury will be thus taken up by the disks and through the action of the grooves or channels 23, that project inward from the peripheries nearly to the centers of the disks, the mercury will be evenly distributed over the surfaces of the disks as they rotate through the electrolyte and will receive the solid deposit resulting from its decomposition. The receptacle 17 may also be provided with a cover 24, having a flange 25, that projects into the electrolyte. Inside the flange 25 carbon or other suitable electronegative electrodes 26 project into the electrolyte 4 and between the electrodes 21. These electrodes 26 are all connected in parallel to the positive pole of the source of electrical energy 14.

For the purpose of drawing off the gaseous products of decomposition that collect within the flange 25 I provide a pipe 27, which may lead to any suitable receptacle for storing the gas, provided it is desired to preserve it.

Referring now to Figs. 5 and 6, I have shown apparatus suitable for employment in producing sodium hydrate and chlorin from aqueous solutions of sodium chlorid or for other kindred operations, the apparatus consisting of five cells suitably combined with each other and with other devices so as to secure the results desired. The reducing-cells I designate, respectively, as *a*, *b*, and *c* and the oxidizing-cells, respectively, as *d* and *e*. Each of these cells is shown as having electrodes of the same construction and arrangement as those shown in Figs. 2, 3, and 4, except that in this case each cell is provided with three metal disk electrodes and two carbon electrodes. A channel 19 at one side is here shown as common to the cells *a* and *d*, and cells *b* and *e* also have a common channel 19 at one side. The shafts 22 may, if desired, be all rotated by means of belts from a single counter-shaft connected to the pulleys 22ᵃ, and in order to provide a circulation of the amalgam resulting from the electrolytic process I provide a transfer device 28 in the form of a wheel of non-conducting material having a series of pockets 29, which dip into the mercury 3 in the channel 19 pertaining to each of the oxidizing-cells *d* and *e* and also into one of the channels 19 pertaining to the cell *c*, and as the wheel is rotated by means of a pulley 30, driven from the same counter-shaft as the other pulleys or from any other suitable source, the mercury is dipped out of the channel in which the transfer-wheel is located and is transferred in insulated portions over the adjacent partition into the next channel. The transfer of the mercury is so regulated as to maintain a continuous circulation without the transfer of electrical energy. The transfer of the electric current from cell *a* to cell *d* and from cell *b* to cell *e* is effected, however, by the mercury or amalgam as it flows between the cells in a continuous body. The amalgam may be transferred from the channel 31, into which it is thrown by the last transfer device 28 of the series, back to the cell *a* by means of a pipe 32 or other suitable conduit. This apparatus just described may be employed for the treatment of any decomposable electrolyte where the electrodes employed are suitable. The amalgam produced in the reducing-cells and transferred to the oxidizing-cells combines with the electrolyte and electrodes in the latter to form a battery which generates energy to supplement that supplied by the main source of energy 14, and thus renders the apparatus especially economical in its operation and in the results obtained.

In the apparatus shown in Figs. 1 to 4, inclusive, the battery action above referred to is not present, but the decomposition of the electrolyte, whether for the purpose of securing the constituent elements for use in other processes of manufacture or for regenerating the electrolyte for use in a battery, is particularly efficient by reason of the large amount of surface of mercury which is exposed to the electrolyte and the efficient and rapid removal of the resulting amalgam from the solid electrodes.

The apparatus may obviously be modified in many particulars without departing from the invention, and I therefore desire it to be understood that the invention is not limited to details as regards form, dimensions, or arrangement of parts, except in so far as limitations may be imposed by the state of the art.

I claim as my invention—

1. In an electrolytic apparatus, a receptacle or compartment containing a body of mercury and a body of decomposable liquid superposed thereon, in combination with one or more electrodes of electronegative material and one or more disk-shaped metal electrodes and means for moving said metal electrodes into and out of said body of mercury and within said receptacle or compartment to effect a distribution of mercury over the same.

2. In an electrolytic apparatus, the combination with a receptacle or compartment containing a decomposable liquid and a body of mercury, of one or more electrodes of electronegative material, one or more disk-shaped metal electrodes and means for moving the metal electrode or electrodes within said receptacle or compartment, into and out of the body of mercury and through the liquid to be decomposed.

3. In an electrolytic apparatus, the combination with a receptacle or compartment having a body of mercury and a body of superposed electrolyte, of a plurality of electrodes of electronegative material projecting into the electrolyte, a plurality of disk-shaped metal electrodes and means for moving the metal electrodes within said receptacle or compartment, through the electrolyte and into and out of the body of mercury.

4. In an electrolytic apparatus, the combination with a receptacle or compartment having a plurality of pockets containing mercury and a superposed liquid electrolyte, of a plurality of electrodes of electronegative material projecting into the electrolyte, a plurality

of metal electrodes located in the electrolyte and alternately disposed with reference to the electronegative electrodes and means whereby the metal electrodes may be moved within said receptacle or compartment, through the electrolyte and into and out of the mercury.

5. In an electrolytic apparatus, the combination with a receptacle having a plurality of open pockets containing mercury and having a body of liquid electrolyte above the mercury, of a plurality of plates of electronegative material projecting into the electrolyte, a plurality of metal disks alternating with the electronegative plates, a shaft on which the disks are mounted and means for rotating the shaft to move the edges of the disks into and through the mercury.

6. In an electrolytic apparatus, the combination with a receptacle having a plurality of open pockets containing mercury and having a body of liquid electrolyte above the mercury, of a plurality of electrodes of electronegative material projecting into the electrolyte, a plurality of metal disks provided with side channels, a shaft on which said disks are mounted and means whereby said shaft may be rotated to move the edges of the disks through the mercury.

7. In an electrolytic apparatus, the combination with a receptacle having a plurality of open pockets containing mercury and having a body of liquid electrolyte above the mercury, of a plurality of electrodes of electronegative material projecting into the electrolyte, a plurality of metal disks provided with side grooves extending from their peripheries toward their centers, a shaft on which said disks are mounted and means whereby said shaft may be rotated to move the edges of the disks through the mercury.

8. In an electrolytic apparatus, the combination with a receptacle having a plurality of open pockets containing mercury and having a body of liquid electrolyte above the mercury, of a plurality of electrodes of electronegative material projecting into the electrolyte, a plurality of metal disks provided with curved guides extending from their peripheries toward their centers, a shaft on which said disks are mounted and means whereby said shaft may be rotated to move the edges of the disks through the mercury.

9. In an electrolytic apparatus, the combination with a reducing-cell and an oxidizing-cell each of which is provided with a body of mercury, a superposed body of electrolyte, one or more stationary electrodes of electronegative material and one or more movable metal electrodes, of means for transferring the amalgam from the one cell to the other without thereby effecting a transfer of electric current.

10. In an electrolytic apparatus, the combination with a reducing-cell and an oxidizing-cell each of which is provided with a body of mercury, a superposed body of liquid electrolyte, one or more electrodes of electronegative material, one or more metal electrodes, of a transfer device and means for rotating the metal electrodes in contact with the mercury and the electrolyte and means for operating the transfer device to transfer the resulting amalgam from the one cell to the other without thereby effecting a transfer of electric current.

11. In an electrolytic apparatus, the combination with one or more oxidizing-cells and a greater number of reducing-cells each of which contains mercury, a superposed body of liquid electrolyte, one or more electrodes of electronegative material and one or more metal electrodes, of means for moving the metal electrodes through the electrolyte and the mercury to promote electrolytic action, an uninterrupted channel for the flow of amalgam between each reducing-cell and the next succeeding oxidizing-cell in the series and means for transferring the amalgam progressively from each oxidizing-cell to the next reducing-cell of the series without thereby transferring electric current.

12. In an electrolytic apparatus, the combination with a series of reducing-cells and oxidizing-cells, the former being greater in number than the latter, a single body of mercury located in and between each reducing-cell and the next oxidizing-cell in the series, a liquid electrolyte, one or more stationary electrodes of electronegative material and one or more movable metal electrodes in each cell and a non-conducting device for transferring the amalgam, produced by electrolytic action, from each oxidizing-cell to the next reducing-cell in the series without thereby transferring electrical energy.

13. In an electrolytic apparatus, a receptacle having an external, open channel along at least two of its sides and a plurality of wells in the bottom that communicate at their ends with said channel, a body of mercury in said channel and wells and a body of liquid electrolyte above the mercury, in combination with electrodes of electronegative material and metal electrodes and a cover having a sealing-flange that projects downwardly into the electrolyte.

14. In an electrolytic apparatus, a receptacle having a plurality of channels or wells in its bottom and two outside, open channels with which the ends of the interior channels connect and a cover having a sealing-flange that projects downwardly at a distance from the side walls.

15. In an electrolytic apparatus, the combination with one or more reducing-cells and one or more oxidizing-cells containing mercury and a liquid electrolyte and having external, open channels into which the mercury flows, of a non-conducting wheel having pockets and projecting into the mercury in one channel adjacent to its end wall and means for rotating said wheel to transfer mercury to the adjacent channel in insulated portions.

16. In an electrolytic apparatus, the combi-

nation with one or more reducing-cells and one or more oxidizing-cells containing mercury and a superposed electrolyte and having external, open channels into which the mercury flows but from which the electrolyte is excluded, a partition between each oxidizing-cell and the next reducing-cell in the series and a wheel having pockets and projecting into the mercury in each oxidizing-cell adjacent to the partition and means for rotating the wheel to transfer the mercury in insulated portions.

17. In an electrolytic apparatus, a plurality of reducing-cells, and a less number of oxidizing-cells each of which contains mercury and a liquid electrolyte, means for transferring the amalgam produced in the reducing-cells to the next oxidizing-cells in the series and thereby transmitting the electrical energy and means for transferring the amalgam from the oxidizing-cells to the next reducing-cells in series without thereby transferring electrical energy.

18. In an electrolytic apparatus, a plurality of oxidizing-cells and a greater number of reducing-cells each of which contains mercury and a liquid electrolyte, means for transferring the resulting amalgam from each reducing-cell to the next oxidizing-cell in the series as an unbroken mass and means for transferring the amalgam from each oxidizing-cell to the next reducing-cell in the series in insulated parts, thereby avoiding a transfer of the electrical energy.

In testimony whereof I have hereunto subscribed my name this 24th day of July, 1901.

CHARLES J. REED.

Witnesses:

J. C. MORSE,

BIRNEY HINES.