(No Model.)

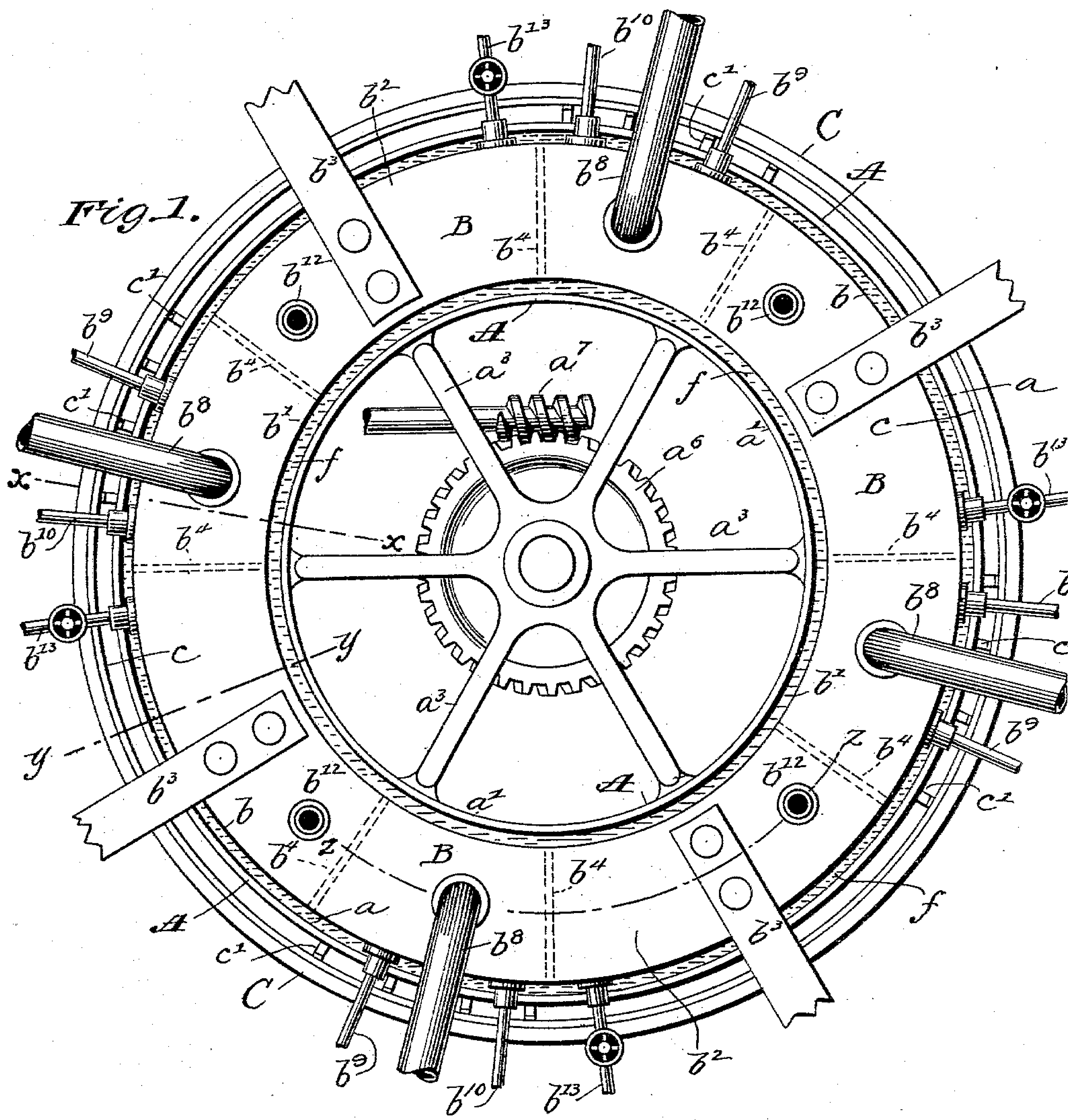
2 Sheets—Sheet 1.

W. A. ROSENBAUM.

ELECTROLYTIC APPARATUS.

No. 546,348. Patented Sept. 17, 1895.

Fig. 1.



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(No Model.)

2 Sheets—Sheet 2.

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Fig. 3

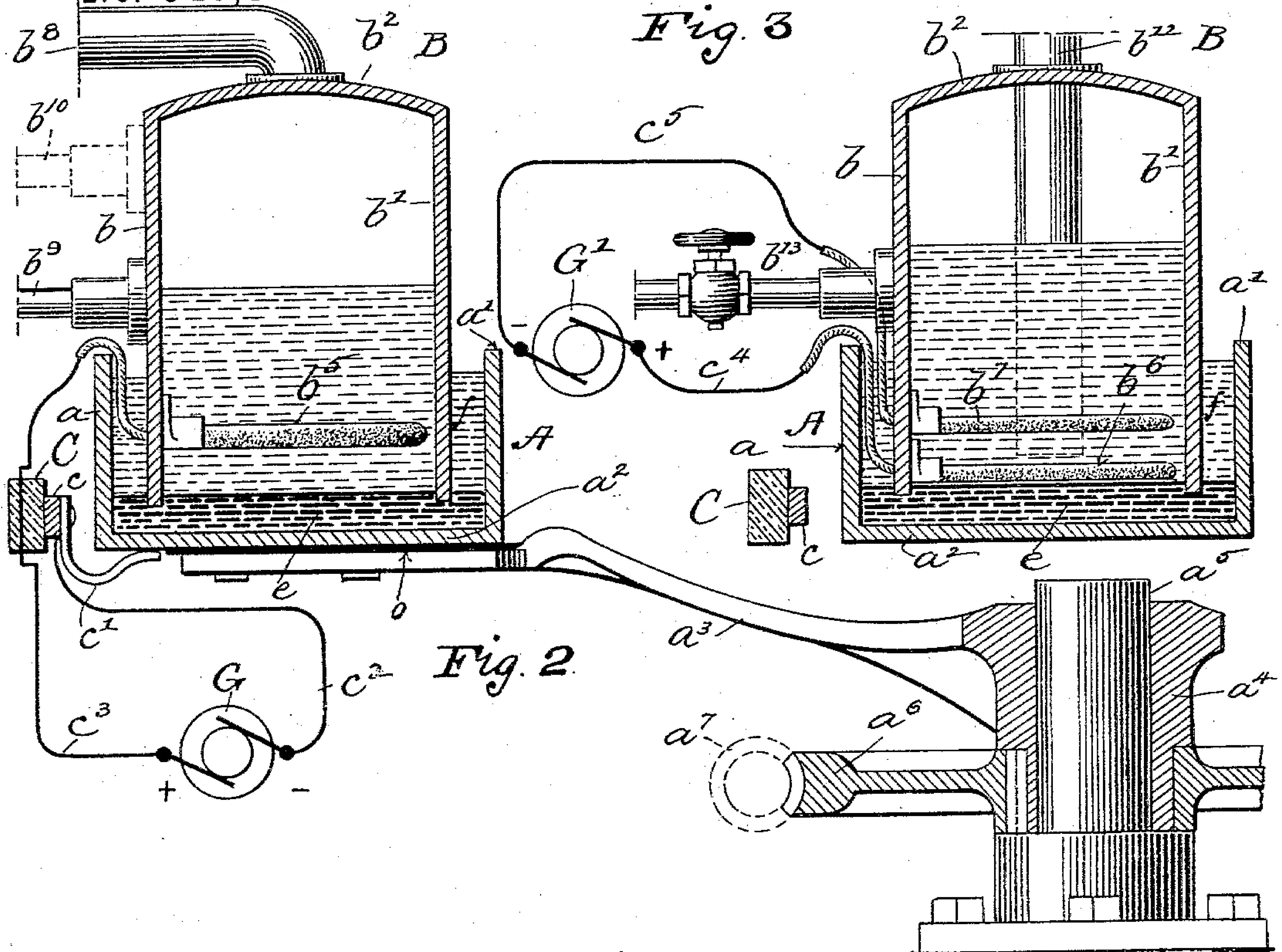
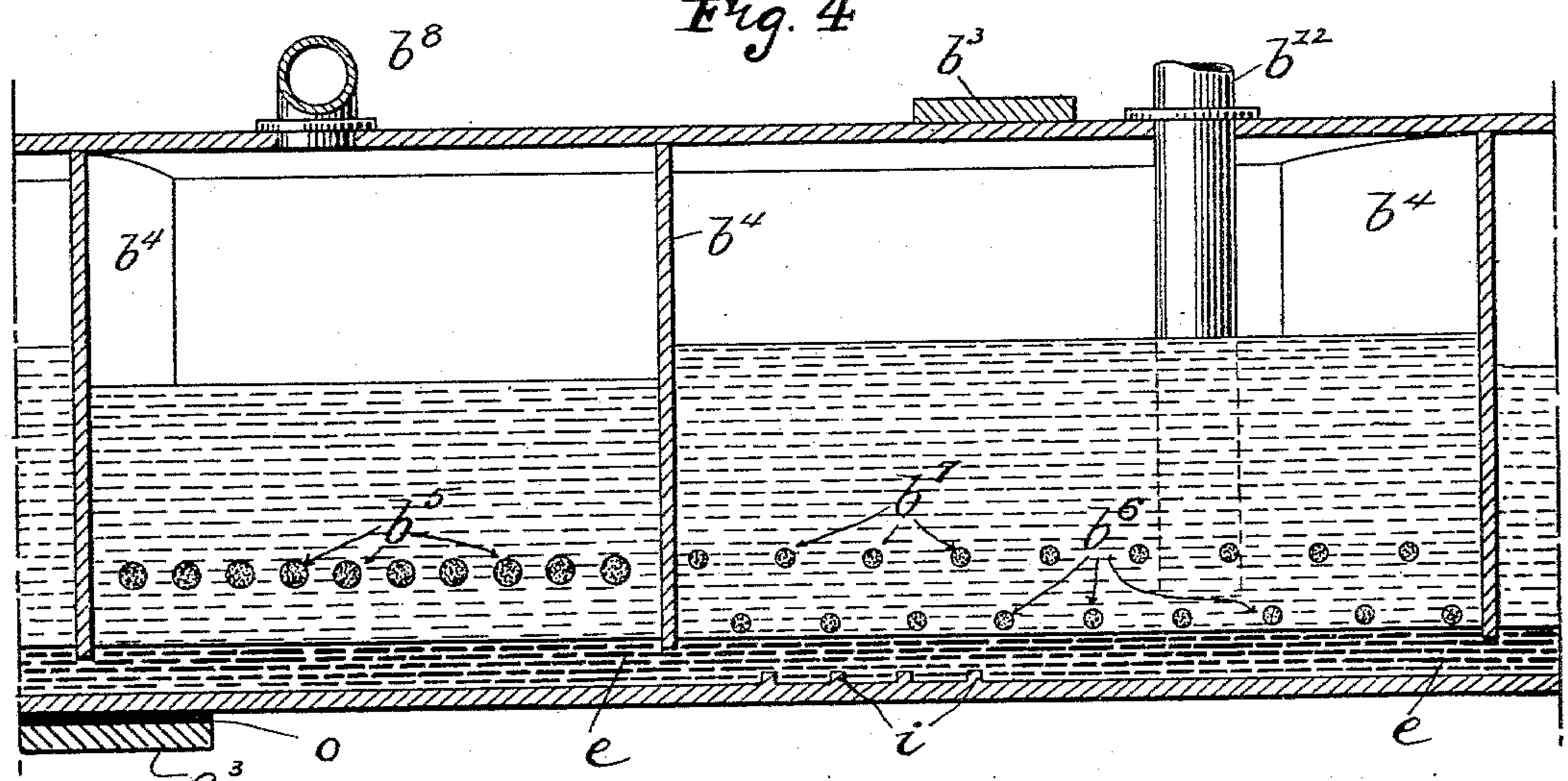


Fig. 2

Fig. 4



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UNITED STATES PATENT OFFICE.

WILLIAM A. ROSENBAUM, OF MONTCLAIR, NEW JERSEY, ASSIGNOR TO THE MATHIESON ALKALI WORKS, OF VIRGINIA.

ELECTROLYTIC APPARATUS.

SPECIFICATION forming part of Letters Patent No. 546,348, dated September 17, 1895.

Application filed December 20, 1894. Serial No. 532,440. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM A. ROSENBAUM, a citizen of the United States, residing at Montclair, in the county of Essex and State of New Jersey, have invented certain new and useful Improvements in Electrolytic Apparatus, of which the following is a full, clear, and exact description.

This invention pertains to the electrolytic decomposition of alkaline salts, the object being the economical electrical decomposition of alkaline salts in solution, and is particularly applicable to the production of pure alkaline hydrates and chlorine and hypochlorites from alkaline chlorides.

By my invention I am able to produce in a continuous operation from chloride of sodium pure caustic soda and chlorine or hypochlorites.

In my apparatus I dispense entirely with the use of porous partitions or diaphragms to separate the electrodes and consequent products of electrolysis.

Briefly stated, my invention consists in the employment of a body of mercury, which is subjected alternately to contact with the alkaline chloride undergoing electrolytic decomposition, to receive a deposit of metal, and to contact with an electrolyte capable of oxidizing the alkaline metal which has been deposited in the mercury and dissolving the oxide so produced. While receiving its deposit of metal the body of mercury acts as the cathode of an electric circuit, and for extracting the metal from the mercury by oxidation oxygen is produced by passing a current of electricity through the electrolyte between an anode and a cathode immersed therein and separate and distinct from the body of mercury or amalgam. The anode is located as close to the surface of the amalgam as possible, in order that the oxygen which is liberated at the anode may be brought into as intimate relation with the surface of the amalgam as possible, thereby to readily combine with the metal which has been deposited in the mercury.

The invention comprehends a stationary elongated structure in the form of a hood divided into a series of compartments by vertical partitions. The bottom of this hood is constructed open, but is closed by dipping into a tray, in the bottom of which is a layer of mercury, and inasmuch as the lower edges of the partitions and sides of the hood continuously project into and are covered by the mercury the compartments thereof will be effectually sealed from one another and the solutions contained within the comparments and resting upon the surface of the mercury will be prevented from mixing.

The invention also comprehends suitable mechanism for moving the tray containing mercury in the direction of the range of compartments of the cell, thereby transferring a given portion of the mercury from contact with the solution in one compartment of the cell to contact with the solution in the next succeeding compartment, and so on, alternately exposing the given portion of mercury to action in the two kinds of compartments of the cell. Suitable means are provided for mounting the electrodes and establishing the electrical connections for the circuits employed, and suitable ducts or pipes are provided for supplying a saturated solution of chloride to, and removing the spent portions thereof from, the chloride compartments, while other suitable passages are provided for supplying liquid to and removing it from the hydrate compartments.

It will be observed, therefore, that the invention provides for the continuous separation and production of the materials combined in an alkaline salt. In the passage of the mercury from one compartment to another it alternately receives and gives off the metallic element of the chloride, and as my invention comprehends a circular form for the chamber or cell the mercury in one passage around the circle may receive and give off a number of charges of metal, and for that reason the time which the mercury remains in any one compartment may be comparatively short, so that the amalgam produced in the chloride compartment will not be so rich as to lessen the efficiency in the use of current and cause the formation of by-products, which would be destructive to the electrodes. The tray carrying the mercury is in fact given a continuous slow motion, although, if desired, the tray may move intermittently a distance each time equal to the length of a compartment, the interval between the movements giving time for the deposit to be made into and extracted from the several portions or sections of the body of mercury.

In the accompanying drawings I have illustrated one form of apparatus in which my invention may be embodied.

Figure 1 is a plan of the complete apparatus. Fig. 2 is a vertical section of the apparatus taken on line $x\,x$ of Fig. 1 and passing through only one side of the circular apparatus. Fig. 3 is a similar section taken on line $y\,y$ of Fig. 1, the gearing being omitted, and Fig. 4 is a section taken on the curved line $z\,z$ of Fig. 1.

Referring to the drawings by letter, A represents a circular tray having outer and inner vertical sides a and a', respectively, and a bottom a^2. This is supported and carried upon the extremities of rotating arms or spokes a^3, attached to a hub a^4, mounted loosely upon a vertical axle or stud a^5. To the hub is attached a large worm-gear a^6, which is engaged and driven by a worm on shaft a^7, the power being applied in any desired manner and taken from any suitable source. Obviously, when shaft a^7 is rotated the tray A rotates around the center stud a^5. The tray is electrically insulated from the arms a^3 by non-conducting material o.

B represents a stationary circular hood, having outer and inner vertical walls $b\,b'$, respectively, and a curved top b^2. The bottom is open and the lower part projects downward into the tray A, but is supported at such an elevation as to leave a short space between the bottom of the tray and the lower edge of the vertical sides $b\,b'$. This hood is supported by framework of any suitable character. I have shown braces or brackets b^3, which, it will be understood, are attached to any fixed structure. The width of the tray is such that there will be an annular space outside and inside between the vertical walls of the tray and hood, as shown. The hood is divided circumferentially into a series of compartments by vertical transverse partitions b^4. The partitions are preferably so located that every alternate chamber or compartment will be somewhat larger circumferentially than the intervening compartments, for a purpose which will hereinafter appear, although under some conditions the compartments may all be of the same size. The partitions extend downward nearly, if not quite, to the lower edges of the sides $b\,b'$. In the smaller compartments, which I call the "chloride" compartments, will be mounted a horizontal row of carbon pencils b^5, attached in any suitable manner to the side of the compartment, and forming a single electrode (the anode) of an electrical circuit, hereinafter referred to. In the larger or hydrate compartments will be mounted two electrodes, an anode and a cathode, the former b^6, being preferably a row of carbon pencils similar to the pencils b^5. These will be located below the cathode b^7, and the latter may be of any material suitable for the purpose. The anodes and cathodes of the larger compartments are electrodes of an entirely separate circuit from that which includes the electrodes in the smaller compartments.

b^8 represents outlets from the chloride compartments for gaseous products.

b^9 and b^{10} respectively represent the inlets and outlets for liquids to and from the anode compartments.

b^{12} represents inlet-pipes for liquids extending downward to the lower portion of each of the larger compartments, and b^{13} represents outlets for liquid from the same compartments.

C is a stationary circular frame surrounding the tray A at its lower edge. It supports an electrical conductor c in the form of a band attached to its inner face. At points opposite the chloride-compartments of the stationary hood the conductor c has attached to it a number of metallic contact brushes c', which press against the bottom of the tray and drag along upon its surface when the tray rotates. To this conductor c is attached a wire c^2 leading from the negative pole of a source of electricity G. The positive pole is connected by wire c^3 with the anodes b^5 in the chloride-compartments of the stationary hood. Anode b^6 is connected by wire c^4 with the positive pole of a separate source of electricity G′, while the negative pole of this source of current is connected by wire c^5 with the electrode b^7.

When the apparatus is equipped for work the tray contains a shallow layer of mercury e of the same depth throughout the circle. This depth of mercury will be sufficient to immerse or cover the lower edges of the side walls $b\,b'$, and the partitions b^4 of the stationary hood. The small or chloride compartments will contain a body of material—such, for instance, as sodium chloride. The larger or hydrate compartments will contain a body of water or weak caustic solution. The partition being absolutely non-porous it will be observed that the mercury effectually seals the two solutions in the adjoining compartments from each other. In order to maintain the mercury at the same level both inside of the stationary hood and outside of it in the tray I place in the annular spaces between the hood and the tray a quantity of heavy oil or other material f, the weight of which will balance that of the liquids inside of the cell, and which may be kept cool if desired in any suitable way, such as circulating it through a refrigerating apparatus.

The operation is as follows: Power is applied to shaft a^7 at a speed to impart a slow rotary motion to the tray. The circuits of both sources of current G G′ are completed, and the separation of the elements of the chloride solution immediately commences. In the smaller compartments the current passes from the anode b^5 to the body of mercury e immediately beneath it, (which acts as a cathode,) thence through the bottom of the tray to the brushes c'. Electrolysis of the saline solution takes place, chlorine gas is liberated in the compartment above the surface of the liquid, whence it is drawn off through passages b^8. The sodium is deposited in the mercury, forming an amalgam, and as the tray rotates this amalgam is carried into the hydrate-compartments, where it comes in contact with the electrolyte therein. The action of the current in these compartments in passing from the anode below to the cathode above decomposes the electrolyte and liberates the oxygen at and around the anode. The anode being located as near to the surface of the amalgam as possible, the oxygen formed at that locality will immediately oxidize or combine with the sodium of the amalgam. The sodium oxide will then immediately dissolve in the water and form sodium hydrate or caustic soda. The mercury thus freed of its burden of sodium is then carried to the next compartments, (the chloride,) where it will receive another deposit of sodium, and thence to the hydrate-compartments, where the deposit will be given up, and so on continuously around the circle. The process will not be step by step, as perhaps indicated by the above description, but will be continuous. The speed of the tray will be such as to allow of a deposit of about two-tenths of one per cent. of sodium, and in the event that this quantity of sodium cannot be oxidized I have made the hydrate-compartments longer to expose the amalgam therein for a longer period than it is retained in the chloride-compartments. The hydrate-compartments are supplied with water through the pipes b^{12}, which, on entering the chamber at the bottom, forces the caustic solution to the top, whence it is drawn off through the pipes b^{13}. A saturated solution of chloride of sodium is supplied to the chloride-compartments through the inlet-pipes b^9, and, being heavier than the spent liquids containing the hypochlorites, it immediately goes to the lower portions of the chamber and forces the spent liquid to the top, whence it flows out through pipes b'. The lower edges of the partitions b^4 projecting into the mercury will tend to retard the mercury and prevent its moving at the same speed with the tray, but such retardation will take place equally around the circle and will not materially affect the process, but at any rate the partitions will cause a slight wave of mercury to form, which will tend to mix the sodium more intimately with the mercury, and it will, therefore, be carried more readily into the hydrate-compartment. If desired, I may place small ridges, as indicated at i in Fig. 4, transversely along the bottom of the tray. These will counteract any retarding movement which the edges of the partitions may create. Another way of overcoming any difficulty on this point is to run the tray in one direction for a short length of time and then reverse it. In case the tray is given a step-by-step movement, each movement being equal to the length of one compartment (the compartments then being all of the same length) there will be no appreciable retardation of the mercury with respect to the tray, for at the end of each short movement the tray will come to a rest and allow the mercury to settle.

Having thus described my invention, I claim—

1. In apparatus for the electrolytic production of hydrates of alkaline metals, the combination of a tank or cell provided with a compartment containing a layer of mercury which is adapted to receive a charge or deposit of the alkaline metal, an electrolyte in said compartment capable of oxidizing the alkaline metal and dissolving the oxide so produced, and an anode and cathode immersed in said electrolyte and separate and distinct from the mercury, substantially as described.

2. In apparatus for the electrolytic production of hydrates of alkaline metals, the combination of a tank or cell provided with a compartment containing a layer of mercury which is adapted to receive a charge or deposit of the alkaline metal, an electrolyte in said compartment capable of oxidizing the alkaline metal, and dissolving the oxide so produced, and an anode and cathode immersed in said electrolyte and separate and distinct from the mercury, the anode being located nearest to the surface of the mercury, substantially as described.

3. In electrolytic apparatus, a structure provided with compartments, in combination with a body of mercury, a receptacle therefor, the mercury and receptacle being stationary with respect to each other, and means for moving the receptacle to convey the mercury from one compartment to another of the structure, for the purpose set forth.

4. In electrolytic apparatus, a hood provided with a number of compartments, a tray movable with respect to the hood and closing the lower side thereof and containing a layer of mercury, said compartments being separated by partitions extending into the mercury, and means for transferring the mercury from one compartment to another.

5. In electrolytic apparatus, a hood provided with a number of compartments, a tray movable with respect to the hood and closing the lower side thereof and containing a layer of mercury, said compartments each containing an electrolyte and being separated by partitions extending into the mercury, and means for transferring the mercury from one compartment to another.

6. In electrolytic apparatus, a structure provided with two compartments separated by a partition under which there is a communicating passage, a layer of mercury extending from one compartment to the other beneath and immersing the lower edge of the partition, an electrolyte in each compartment resting upon the mercury, an anode in the elec-

trolyte of one compartment to which the mercury acts as the cathode, an anode and a cathode in the electrolyte of the other compartment, both separate and distinct from the mercury contained therein, and two separate sources of electricity of which the electrodes in each compartment are respectively the circuit terminals.

7. In apparatus for the electrolytic decomposition of the salts of alkaline metals, a vessel containing a circular or endless body of mercury, means for imparting thereto movement in a line substantially parallel to its circumference, in combination with a series of communicating compartments arranged along the line of movement of the mercury, each compartment containing an anode and a cathode and the compartments alternately containing a solution to be decomposed, and a solution capable of oxidizing alkaline metal and dissolving the oxide so produced.

In testimony whereof I subscribe my signature in presence of two witnesses.

WILLIAM A. ROSENBAUM.

Witnesses:
FRANK S. OBER,
C. V. EDWARDS.