G. O. SEWARD & F. VON KÜGELGEN.

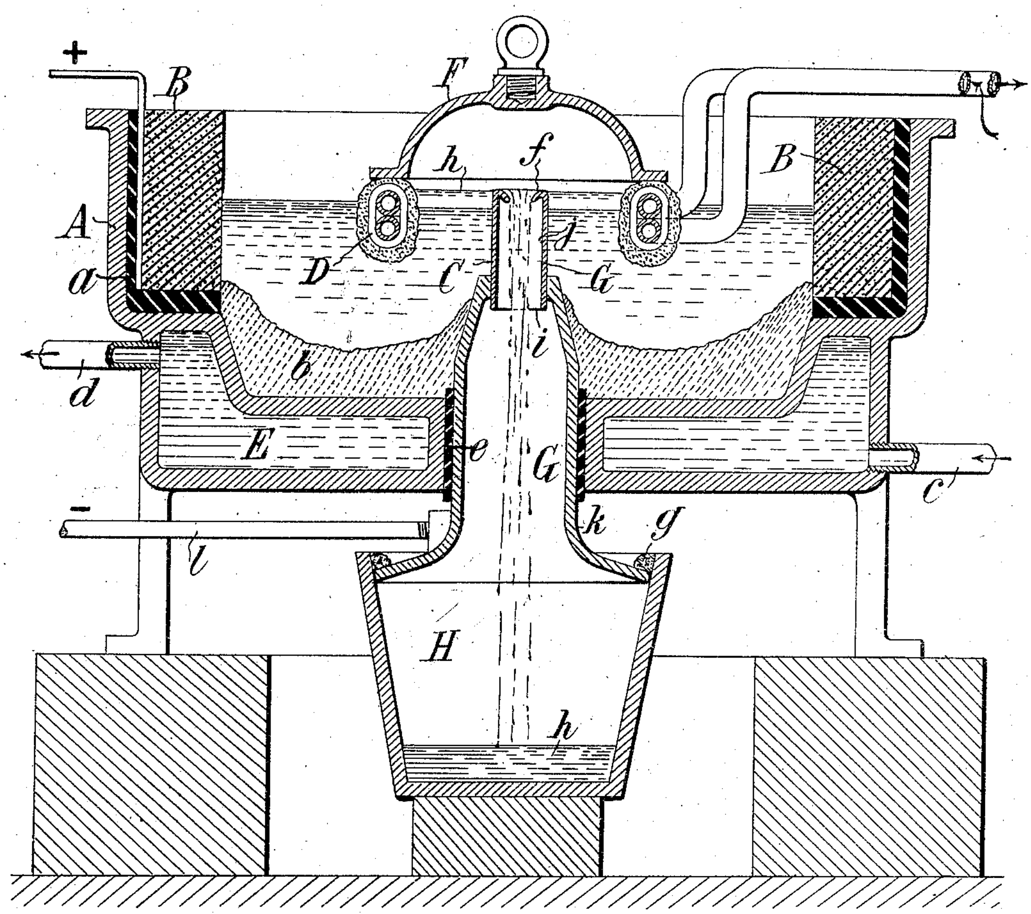
ELECTROLYTIC APPARATUS.

APPLICATION FILED APR. 23, 1906. RENEWED MAY 10, 1910.

1,007,897. Patented Nov. 7, 1911.

2 SHEETS—SHEET 1.

FIG. 1.



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2 SHEETS—SHEET 2.

FIG. 2.

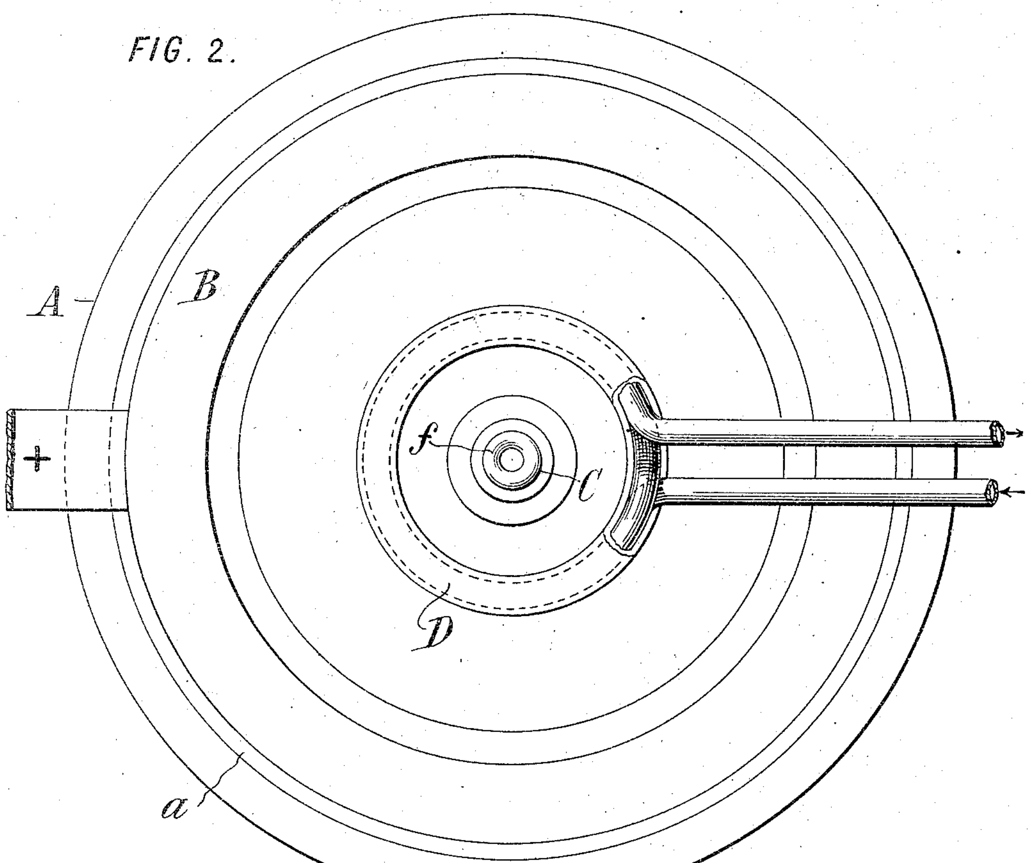
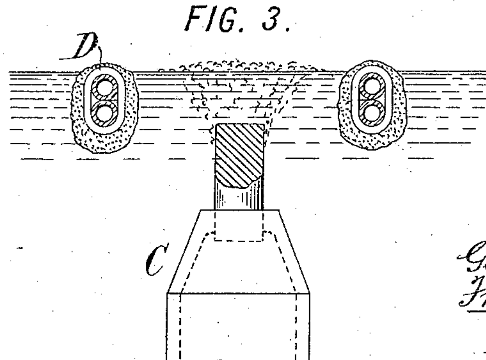


FIG. 3.



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UNITED STATES PATENT OFFICE.

GEORGE O. SEWARD AND FRANZ VON KÜGELGEN, OF HOLCOMBS ROCK, VIRGINIA, ASSIGNORS TO VIRGINIA LABORATORY COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

ELECTROLYTIC APPARATUS.

1,007,897. Specification of Letters Patent. **Patented Nov. 7, 1911.**

Application filed April 23, 1906, Serial No. 313,129. Renewed May 10, 1910. Serial No. 560,462.

To all whom it may concern:

Be it known that we, GEORGE O. SEWARD, a citizen of the United States, and FRANZ VON KÜGELGEN, a subject of the German Emperor, both residing at Holcombs Rock, in the county of Bedford and State of Virginia, have jointly invented certain new and useful Improvements in Electrolytic Apparatus, of which the following is a specification.

This invention relates to an electrolytic cell or vessel for the production of metals lighter than their electrolytes.

In the production by electrolysis of those metals and alloys which have a less specific gravity than the molten electrolytes from which they are separated, a source of difficulty is the collection of the metals in such a way that they cannot come in contact with the gases set free at the anode, with which they would otherwise combine.

The present invention is designed to render possible and easy such isolation of the separated metal or alloy by providing a combination of a cathode projecting up from the bottom of the electrolytic vessel through the electrolyte, and a chilled salt-incrusted collecting partition located above the cathode in such a way that the metal is confined as soon as separated and can be allowed to collect within the chamber or space bounded by such partition, from which it may be removed as convenient.

In the production of sodium, which remains fluid at the temperature of the electrolyte, difficulty is presented in discharging the metal from the cathode chamber into a suitable receiving vessel, by reason of the congealing of the metal upon the walls of the conduit which becomes clogged thereby.

The present invention provides for the ready discharge of such fluid metal by providing a vertical conduit into which the metal flows from the cathode chamber over a spout or lip which causes it to fall freely through the conduit without touching its walls, or touching only those portions of its walls which are adequately heated. This conduit is preferably formed integral with the cathode by making the latter hollow.

Figure 1 of the accompanying drawings shows in vertical mid-section the preferred form of apparatus embodying our invention as adapted to the production of sodium; Fig. 2 is a plan thereof partly in horizontal section; Fig. 3 is a fragmentary section answering to the central part of Fig. 1, and showing a modification better adapting the cell to the production of calcium or magnesium.

The cell is constructed of any suitable outer vessel A, and provided with an anode B, preferably of carbon or graphite, a cathode C, and an intermediate salt-incrusted partition D. In the construction shown the cell is of circular form, the cathode C is arranged in the center, the partition D is forced as a water-cooled ring inclosing it concentrically, and the anode B is made as a larger ring fitted within the outer wall of the vessel A, but preferably insulated from it by a layer *a* of suitable insulating material. Since the cell is designed to be used with an electrolyte of molten salt, it is important to insulate the vessel and protect it from the electrolyte by making provision for a layer *b* of chilled salt covering its bottom. This is most certainly accomplished by the provision of a water-cooled jacket E into which water may be introduced through a pipe *c* and discharged through a pipe *d*. The provision of a cooling jacket is needless, however, if the cell is sufficiently large so that the salt in the layer *b* is so far removed from the heating action of the current as not to be fused thereby.

The cathode C is made to project up through the bottom of the vessel A, being insulated from it in any suitable way. A layer *e* of insulating material is shown, and in addition the chilled electrolyte *b* serves as further insulation. The cathode projects to a height which will vary according to the material to be produced; for sodium, it should project slightly above the surface of the electrolyte; for calcium or magnesium, it may terminate considerably below the surface as shown in Fig. 3.

The cathode chamber or collection chamber in which the metal separated at the cathode collects, is formed by the chilled salt-incrusted partition D. The partition may be made of a coil of copper pipe of one or more convolutions, through which cold water or any refrigerant is circulated in order to chill upon its surface a layer of the salt or salts forming the electrolyte, whereby it is insulated from the electric current and protected from the action of the electrolyte. The partition is located at the surface of the electrolyte, and projects sufficiently beneath the surface to effect an adequate separation between the anode and cathode, so that the flow of the current through the electrolyte takes place beneath the partition. The partition may project more or less above the surface of the electrolyte. In the production of metals which oxidize in contact with the air, a cover F is provided whereby to inclose the cathode chamber.

The apparatus is particularly designed for the manufacture of the metals of the alkali and alkali-earth groups and their alloys, by the electrolysis of their molten salts or mixtures of salts.

For the production of sodium or other metals which are fluid at the temperature of the electrolyte, the cathode is made tubular and extends up to or above the surface of the electrolyte, being open at its upper end as shown in Fig. 1, and having an inturned spout or lip *f*, so that the sodium as it rises above the electrolyte may overflow, and falling over the lip, may drop freely through the hollow in the cathode, which forms a vertical conduit. This conduit, which is functionally distinct from the cathode, although conveniently constructed in one piece therewith, is lettered G. Beneath the conduit is placed any suitable collecting receptacle or receiver H. To exclude air, the conduit may have a flaring or trumpet mouth making a close joint with the walls of the receptacle H, which joint may be packed by a luting *g* of clay or the like. In Fig. 1, *h h* designate the layers of sodium in the cathode chamber and receptacle H respectively. The conduit G is preferably enlarged downwardly in order that the falling drops of sodium may fall wholly clear of its walls. The inturned spout or lip *f* at the top, is designed normally to insure that the sodium shall drop free from the walls of the cathode or conduit, it being preferable that for the entire distance the sodium shall fall through space, and shall not run down the walls. The exposed surface of the cathode where the current density is greatest, is kept adequately heated thereby, so that if the lip should fail to discharge the sodium through space, but little incrustation of sodium upon the walls would result from its flowing down these heated walls, since the temperature thereof should be sufficiently high to keep it fluid; but on descending below the active and highly heated cathode surface, provision is made for insuring the dropping free of any sodium which may have run down the cathode walls, that is to say, a second lip *i* is formed from which the descending sodium must drip directly through the enlarged lower portion of the conduit. In the construction shown the active portion of the cathode is formed preferably of a wrought iron pipe *j* of small enough diameter to give the requisite current density, which is screwed or otherwise fastened into a trumpet-shaped casting *k* beneath, to which latter the conductor *l* is connected.

The cathode will be modified to adapt it to the requirements of the particular electrolysis required. Where it is not desired to discharge the metal product through the cathode, the latter may be solid instead of hollow. For the production of calcium or magnesium, it is preferable to make the cathode terminate some distance below the surface of the electrolyte, so that the separated metal rises to the top, passing out of contact with the cathode. This construction is shown in Fig. 3. The anode chamber may be covered over for the collection of the anode gas, as for example in the electrolysis of molten chlorids.

The invention is not limited to the use of a circular vessel or a concentric arrangement of the parts, nor to the use of an annular anode. The cell may be made of various shapes and proportions, and may be enlarged to any desired size.

It is important that the cathode, which is preferably constructed to project vertically up through the bottom of the cell, have its active or exposed surfaces confined wholly within a vertical projection of the boundaries or horizontal configuration of the cathode chamber, so that the metal which disengages itself from the cathode shall, in rising through the electrolyte, be received within the cathode chamber and be prevented by the water-cooled partition from passing outside said chamber to recombine with the chlorin or other anion.

What we claim is:—

1. In an electrolytic vessel the combination with an anode and cathode, of a cathode chamber formed by a chilled salt-incrusted partition at and beneath the surface of the electrolyte, the cathode arranged to project upwardly within the electrolyte, with its active surface confined within a vertical projection of the boundaries of said chamber so that fused metal ascending from the cathode surfaces will collect within said chamber.

2. In an electrolytic vessel the combination with an anode and cathode, of a cathode chamber formed by a chilled salt-incrusted partition at and beneath the surface of the electrolyte, the cathode arranged to project upwardly within the cathode chamber with its active surface confined within the vertical projection of the boundaries of said chamber, so that fused metal ascending from the cathode surfaces will collect within said chamber.

3. In an electrolytic vessel the combination of an anode, a cathode, a cathode cham-

ber into which rises the fused metal liberated at the cathode, and a discharge conduit from said chamber extending vertically downward and having a lip adapted to cause such fused metal overflowing from said chamber to fall free of the wall of the conduit below such lip.

4. In an electrolytic vessel the combination of an anode, a cathode, a cathode chamber into which rises the fused metal liberated at the cathode, and a discharge conduit from said chamber extending vertically downward and having a lip at its top to cause such fused metal overflowing from said chamber to fall free of the wall of the conduit.

5. In an electrolytic vessel the combination of an anode, a cathode, a cathode chamber into which rises the fused metal liberated at the cathode, and a discharge conduit from said chamber extending vertically downward and enlarged below, and having a lip above such enlargement to cause such fused metal overflowing from said chamber to fall free of such enlargement.

6. In an electrolytic vessel, the combination of a cathode chamber formed by a chilled salt-incrusted partition at and beneath the surface of the electrolyte, an anode exterior thereto, and a cathode projecting up vertically into said chamber and made hollow to form a discharge conduit from said chamber extending vertically downward.

7. An electrolytic vessel having means for cooling its lower portion, an anode, a cathode, a cathode chamber, and a discharge conduit from the latter extending vertically downward through and opening beneath the vessel, and enlarged where it traverses the cooled portion thereof.

8. In an electrolytic vessel, the combination of an anode, a cathode chamber, and a cathode projecting up vertically into said chamber, made hollow to form a discharge conduit from said chamber extending vertically downward, and formed with a lip to cause the metal to fall free of the wall of the conduit.

9. An electrolytic vessel comprising a central cathode, an annular chilled salt-incrusted partition surrounding said cathode, and an anode exterior to said partition, with means for removing from the cathode chamber formed by said partition fused metal which is liberated from the cathode.

In witness whereof, we have hereunto signed our names in the presence of two subscribing witnesses.

GEORGE O. SEWARD.
FRANZ VON KÜGELGEN.

Witnesses:
J. H. WEBB,
P. O. HARDING.