E. ANDRE.

Separating Metals by Electrolysis.

No. 214,344. Patented April 15, 1879.

Fig. 3.

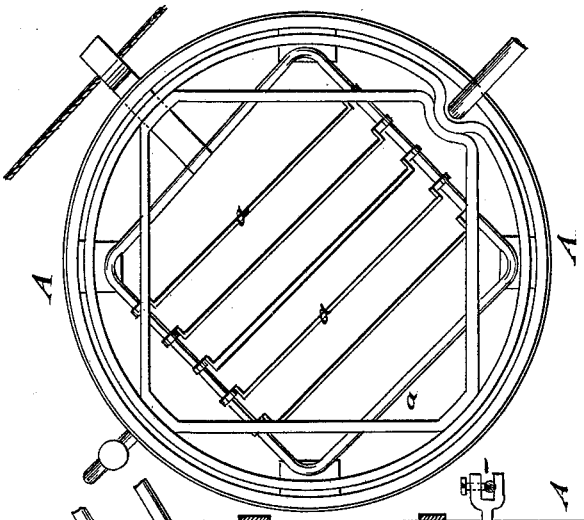


Fig. 1.

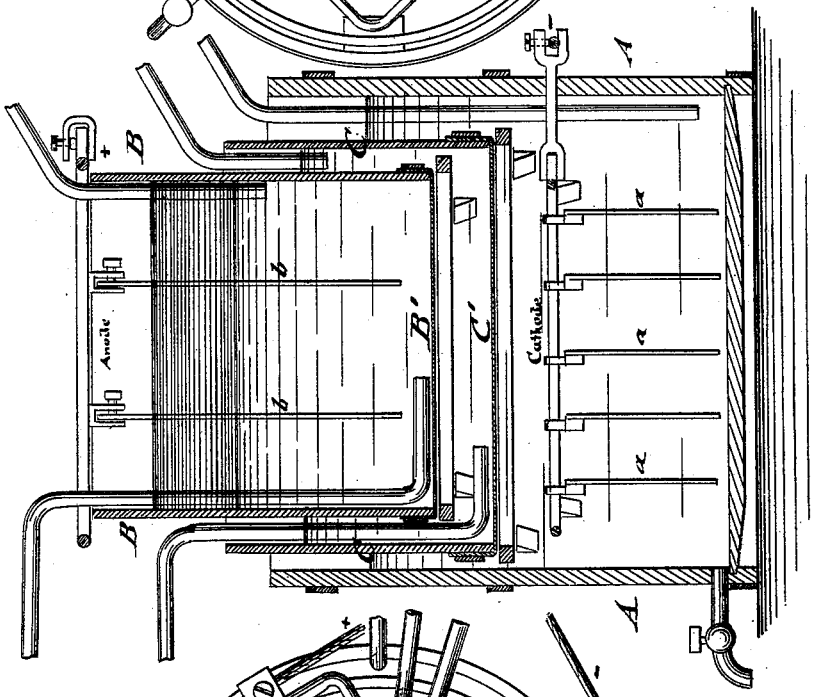
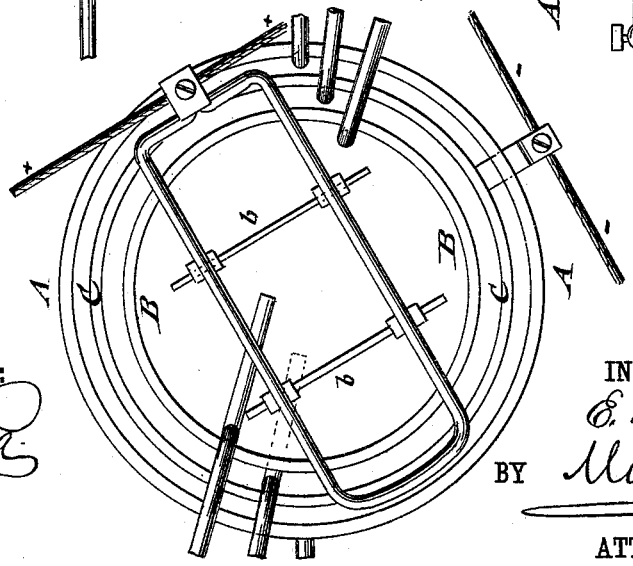


Fig. 2.



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EMIL ANDRE, OF EHRENBREITSTEIN, GERMANY, ASSIGNOR TO PAUL HOLDER, OF NEW YORK, N. Y.

IMPROVEMENT IN SEPARATING METALS BY ELECTROLYSIS.

Specification forming part of Letters Patent No. **214,344**, dated April 15, 1879; application filed April 18, 1878.

To all whom it may concern:

Be it known that I, EMIL ANDRE, of Ehrenbreitstein, Germany, have invented certain Improvements in the Process and Apparatus for Refining and Separating Base Alloys by Electrolysis, of which the following is a specification.

It is the object of my invention to effect the refining and separating of base alloys and base metals by electrolysis. This object I effect by subjecting anodes composed of the base alloys or metals to be operated upon to the action of an electrolytic bath which is a solvent of the coarser metal or metals present in the anode, and which is contained in two cells or compartments, one for the anode and the other for the cathode, separated from each other by a porous diaphragm which is impermeable to the undissolved fine metal or metals, and also impermeable to the precipitate of a fine metal which may have been dissolved, and which, by reason of its porosity, serves to electrically connect the two cells. By means of my porous diaphragm I am enabled to effect the separation of the fine metal or metals from the base metal, either by precipitating such fine metal as may have been dissolved, and allowing the dissolved base metal to pass through the diaphragm into the cathode-cell, or by removing the solution from the anode-cell as fast as the metals are dissolved, and thus retaining in the anode-cell such fine metal as is not soluble in the solution employed. In this way, in working upon the largest scale, it is easy to decompose by electrolysis anodes composed of several metals, and concurrently to separate the fine metal or metals from the base metal or metals.

My invention, therefore, consists in the combination, in the same electrolytic bath, of the operations of decomposing an anode of base alloy by dissolving only the coarser metals present in the anode, and of separating the undissolved fine metal from the dissolved base metal present.

It will, of course, be understood that the composition of my electrolytic bath or solution will be varied according to the various metals which may be contained in the alloy which is to be refined, and that the size and form of the cells containing the solution may be determined at the will of the constructer, and with reference to the magnitude of the operations contemplated; my invention being present when a porous diaphragm, separating the cells and affording a path for the electric current, is employed to detain in the anode-cell an undissolved fine metal, while one or more coarser metals which have been dissolved are removed from the anode-cell.

As the subject of electrolysis is well understood, it will be sufficient for me to describe my process as applied to the refining of an alloy composed of gold, silver, and copper.

I prefer to employ as the source of electricity a dynamo-electric machine, as I have found that such machines afford the most economical means of generating the very strong currents of electricity which I use.

In applying my process to the purpose of refining a gold, silver, and copper alloy, I use for my electrolytic bath a saturated solution of sulphate of copper, containing, say, from three to five per cent. of free sulphuric acid.

My anodes are formed by casting the alloy into ingots of suitable form and size, and I employ a copper cathode or cathodes whose combined area equals that of the anodes. With such a solution the copper contained in the anode is first dissolved, and the solution then dissolves the silver. When the silver and copper are both dissolved the gold falls to the bottom of the cell in the form of slime, being prevented from passing into the cathode-cell by my porous diaphragm. I may remove the solution of copper and silver from the anode-cell and collect the gold slime therefrom; or I may precipitate the silver which has been dissolved, and remove only the copper solution. For the precipitation of the silver I employ any of the known agents for this purpose, as, for example, the protoxide of iron. The removal from the anode-cell of the metals in solution may be effected by allowing them to pass through the porous diaphragm into the cathode-cell, or they may be removed by means of a pump or siphon. When the silver is precipitated in the anode-cell I collect it, together

with the gold slime, after the removal of the copper solution, and separate the silver precipitate from the gold slime by redissolving the silver, using for this purpose any of the known solvents of silver. I then have remaining the pure gold which was originally contained in the alloyed anode. When the silver and copper solutions are removed together from the anode-cell I precipitate the silver by introducing the mixed solutions into a vat containing fine granulated copper. I then pour the remaining copper solution into my cathode-cell, where the copper from the solution is deposited in metallic form upon the cathode, the deposit of the copper upon the cathode leaving the solution perfectly clear and fit to be again used.

A convenient apparatus suitable for the practice of my invention is illustrated in the accompanying drawings, in which Figure 1 is a vertical central section of an apparatus consisting of two cells, one above the other, separated by two parallel diaphragms of porous material, establishing an intermediate chamber between the cells. Fig. 2 is a top view of the upper cell, and Fig. 3 a plan of the lower cell.

The apparatus represented in the drawings consists of the lower cell, A, which is a vat made of wood or other suitable material, and in which are suspended from a suitable frame the plates *a*, that form the cathode. These plates are made of copper, plastic carbon, or other well-known material, according to the metal to be reduced.

At suitable height above the bottom of the lower or cathode cell, A, is another vat, B, which is the anode-cell, in which the anodes *b* are suitably suspended.

The frames of the anode and cathode are, respectively, connected with the opposite poles of a dynamo-electric machine or other source of electricity.

The bottom of the anode-cell B is made of a diaphragm, B′, made of animal membrane or of porous clay, or some other material which is impermeable to the undissolved metal, but sufficiently permeable to the solution to make it a conductor of electricity, and thus afford a free passage of the electric current from the solution in the anode-cell to the solution in the cathode-cell.

The dissolved metals in the solution may be separated from the undissolved metal by being allowed to pass through the diaphragm from the anode-cell into the cathode-cell, or they may be removed by a siphon or pump. In the latter case, as one diaphragm might not be sufficient to prevent the passage of the dissolved metals into the cathode-cell, a third intermediate vessel, C, is employed, the bottom of which is also a porous diaphragm, C′.

The intermediate space between the two diaphragms is kept filled with a constantly-running solution, that takes up and removes any of the solution which may have escaped from the anode-cell through the upper diaphram.

The surface of the anode is made equal to the surface of the cathode, so that, more or less, the same area is brought into action at both electrodes.

The vats are provided with suitable rubber or other tubes, that supply the solutions or baths, and with siphons or outlet-pipes for removing the same.

When gold, silver, and copper are to be severally separated from their alloys, such as gold or silver coins, base bullion, scraps, &c., these impure alloys are cast into ingots, which are suspended in the anode-cell in the usual saturated solution of sulphate of copper, containing a small percentage of free sulphuric acid. Under the influence of the electrical current the copper and silver in the anode are successively dissolved, while the gold remains undissolved.

The anode and cathode plates may be arranged either in vertical position or in horizontal, inclined, or other position.

The dissolved metals may be drawn off continuously from near the bottom of the anode-cell, and fresh diluted acid added, as may be proportionately required.

The solution containing the dissolved copper and silver is conducted, preferably by gravity, to a conveniently-placed trough of suitable length, which is filled, in part, with granulated copper, on which the silver will be precipitated. The remaining solution, thus freed from silver, is conducted into a lower vat, in which the copper is precipitated in the usual manner. The remaining free acid is then drawn off into a still lower vat, and diluted preparatory to being again used in the anode-cell, as at first.

The top vat or anode-cell is supplied either with diluted acids or salts, according to the metals to be treated, and the liquid kept passing between the diaphragms is diluted acid or slightly acidulated water.

The arrangement of the baths or solutions and of the anode and cathode, and the materials employed, may, of course, be altered according to the different metals.

The apparatus may be worked with different solutions in the top and bottom vats for dissolving one metal, ore, or combination in the acid solution of the top vat, while at the same time precipitating some other metal or salt from an ammoniacal or alkaline solution in the bottom vat.

I claim as my invention—

1. The process of refining and separating base alloys or base metals herein described, which consists in subjecting such alloys as anodes to the electrolytic action of a solution which is a solvent of the coarser metals present, and in preventing the escape of the undissolved fine metals into the cathode-cell by interposing between the anode and cathode

cells a porous diaphragm impermeable except to the metals in solution, and in removing the dissolved metals from the anode-cell and afterward collecting the fine metal therefrom.

2. In apparatus for conducting the herein-described process of refining and separating base alloys, the combination of an anode and a cathode cell with two porous diaphragms, separating the cells and establishing between them an intermediate chamber, through which a current of liquid is maintained for the purpose of carrying off any portion of the solution from the anode-cell which may have penetrated such chamber, and thereby preventing such portion of the solution from entering the cathode-cell.

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