(No Model.) 2 Sheets—Sheet 1.

D. TOMMASI.

APPARATUS FOR EXTRACTING, SEPARATING, AND REFINING METALS BY ELECTROLYSIS.

No. 546,364. Patented Sept. 17, 1895.

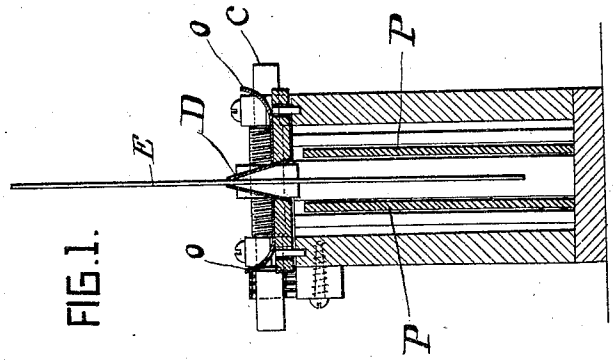

FIG. 1.

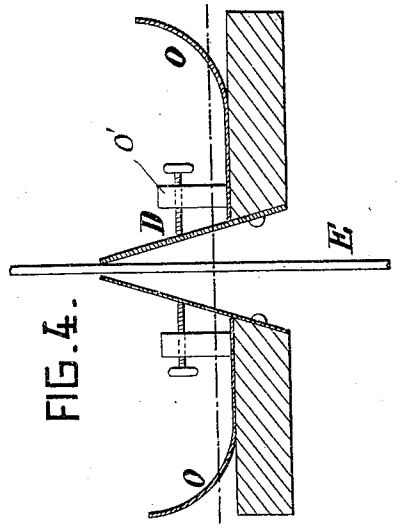

FIG. 4.

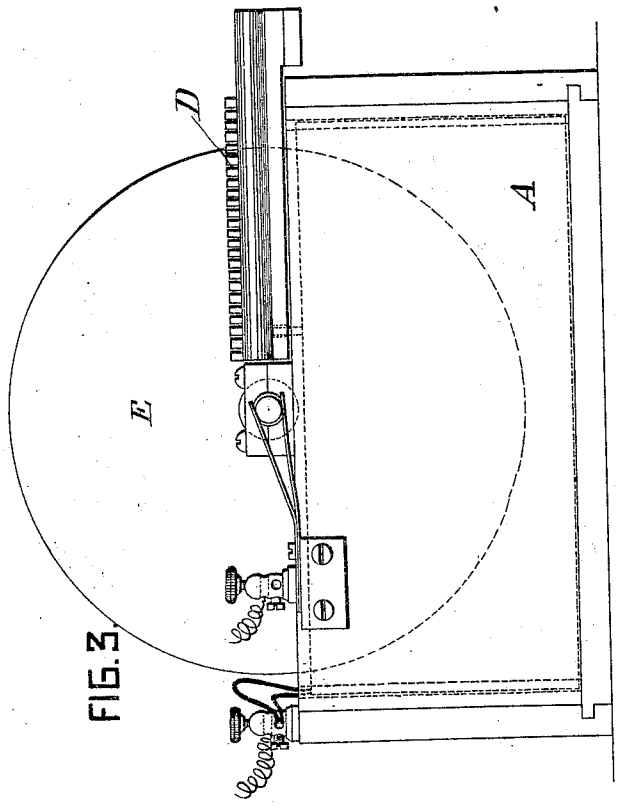

FIG. 3.

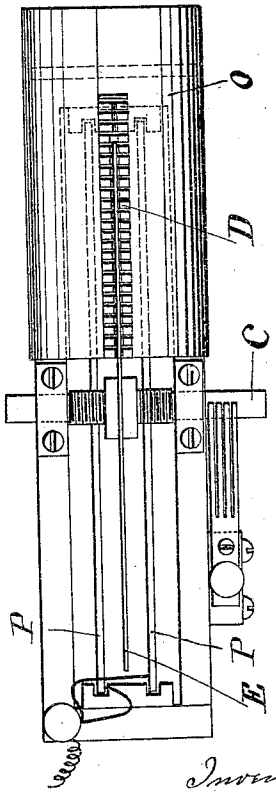

FIG. 2.

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(No Model.) 2 Sheets—Sheet 2.

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FIG. 7

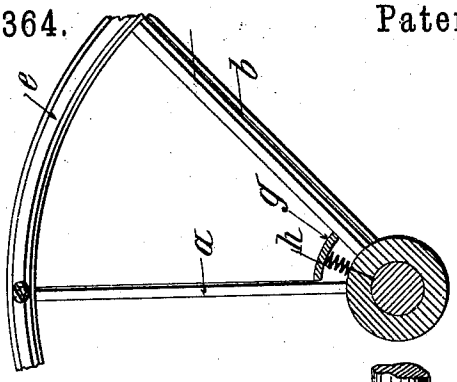


FIG. 6

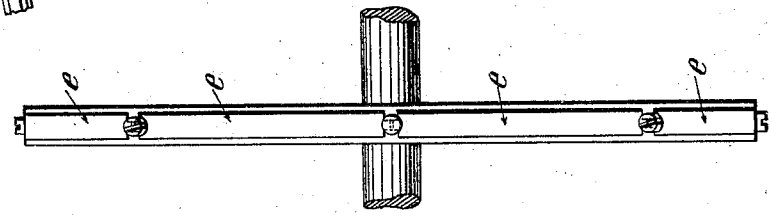
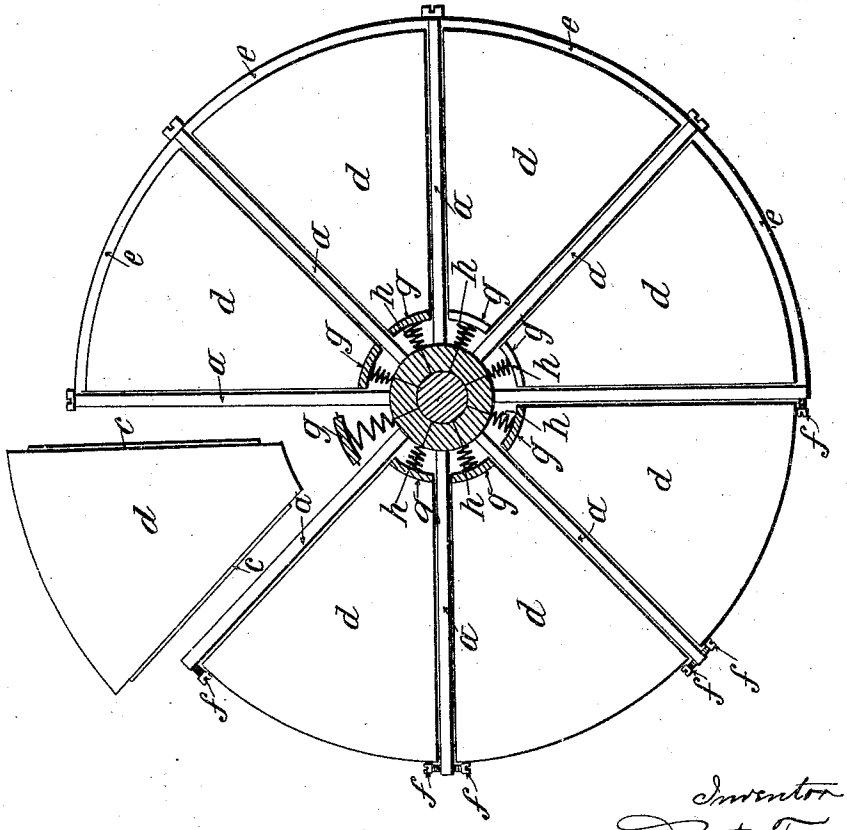


FIG. 5



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UNITED STATES PATENT OFFICE.

DONATO TOMMASI, OF PARIS, FRANCE.

APPARATUS FOR EXTRACTING, SEPARATING, AND REFINING METALS BY ELECTROLYSIS.

SPECIFICATION forming part of Letters Patent No. 546,364, dated September 17, 1895.

Application filed September 24, 1892. Serial No. 446,775. (No model.) Patented in France April 1, 1892, No. 220,580; in England April 1, 1892, No. 16,892, and May 21, 1892, No. 16,893; in Belgium August 19, 1892, No. 101,006; in Austria-Hungary May 3, 1893, No. 55,418 and No. 88,065, and in Spain September 16, 1893, No. 14,798.

To all whom it may concern:

Be it known that I, DONATO TOMMASI, of the city of Paris, France, have invented an Apparatus for the Extraction, Separation, and Refining of Metals by Electrolysis, (for which I have obtained Letters Patent in France April 1, 1892, No. 220,580; in Belgium August 19, 1892, No. 101,006; in Great Britain April 1, 1892, No. 16,892, and May 21, 1892, No. 16,893; in Austria-Hungary May 3, 1893, No. 55,418 and No. 88,065, and in Spain September 16, 1893, No. 14,798,) of which the following is a full, clear, and exact description.

This invention relates to an apparatus for the extraction, separation, and refining of metals by electrolysis, whereby the treatment is not only rendered more economical and practical, but I am also enabled, first, to prevent the polarization of the cathodes by making them in the form of disks of carbon alone or mixed with oxide of copper, causing them to revolve, so that their acting surfaces are alternately immersed in the bath and exposed to the air, and by subjecting said surfaces to the continuous friction of brushes for the purpose of freeing them from all adhering matters; second, to reduce to a minimum the electrical resistance of the electrolyte by bringing the electrodes closer together; third, to keep the electrolyte homogeneous by the agitation due to the revolving motion of the disks and of the bars or ingots above mentioned; fourth, to obtain the deposit in a compact state by constructing the cathode-disks of removable segments, as hereinafter described; fifth, and in other details of construction and processes of separation, more fully hereinafter described, and pointed out in the claims.

Reference is to be had to the accompanying drawings, forming part of this specification, wherein—

Figure 1 represents a longitudinal vertical section and Fig. 2 a plan view of a form of my apparatus more particularly intended for the recovery of metal in a spongy state. Fig. 3 represents a side elevation of the same, and Fig. 4 a detail view more particularly referred to hereinafter. Figs. 5, 6, and 7 represent face, edge, and cross-sectional views, respectively, of one of the cathode-disks constructed in segments for recovering the metal in a compact state.

The same letters of reference indicate the same parts in all the figures.

The apparatus may be modified according to the result which it is desired to obtain.

The apparatus represented consists of a trough A, in which rotate one or more disks E, mounted upon a revolving-shaft C and only partially immersed, so that every part of the acting-surface shall be alternately exposed to the air and to the electrolyte. The disk or disks pass between friction rubbers or brushes D, which are preferably made slitted, which not only remove the numerous bubbles of hydrogen adhering thereto, but also the metallic deposit which is received and collected in gutters O, by which it is conducted into receptacles for melting. To avoid the throwing off of the metallic particles by the rotation of the disks, the latter may be inclosed in a casing.

The vat A of the electrolyzers represented in Figs. 1, 2, 3, and 4 may be made either of stoneware, enameled iron, wood lined with india-rubber, ebonite, celluloid, or gutta-percha, &c., or coated with an insulating varnish unattackable by the agents employed. The cathode-disks E may be made of copper, zinc, lead, aluminium, &c., or of compressed carbon, either alone or mixed with oxide of copper, by which hydrogen is absorbed, thus avoiding the polarization which is so detrimental in electrolysis. The brushes or rubbers D are made of inoxidizable material and may be provided with means, such as adjusting-screws O′, for adjusting them to regulate the pressure upon the disks.

The cathode-disks are connected electrically through their shaft, which is connected to the negative conductor of the dynamo by any suitable means. The anodes may be made, as shown, in the form of plates P P, produced by casting the metal or ore in a suitable mold.

In order to recover the metal in a compact form, the cathode-disk is constituted of sector-shaped segments, whose edges are tongued and slide in grooves in their supporting-arms, as shown in Figs. 5, 6, and 7, in which—

a a are radial arms, made of insulating and unattackable material fixed to a hub, also of insulating material, keyed on the shaft.

b are the grooves in the lateral faces of the arms, in which are received the tongues *c* on the edges of the segments *d*, which are held in place either by screw-stops *f* or by strips of insulating material *e*, fixed by screws to the ends of arms *a*.

In order to obtain a constant contact and regular transmission of the current to each of the segments of which the cathode-disk is composed, a metal plate *g* is pressed against the inner ends of said segments by means of spiral or other springs *h*, connected to the conductive axis of the disk.

The advantages of this electrolyzer, as compared with those now in use, may be thus summarized.

First. Polarization is entirely prevented (*a*) by the continuous rotation of the disks forming the cathodes; (*b*) by the friction of the brushes or bands against the opposite faces of the disks, whereby the escape of the hydrogen is facilitated; (*c*) by the presence of oxide of copper, (when the cathodes are made of carbon,) which takes up the hydrogen and becomes reduced to a metallic state. The reduced copper, being in an extremely subdivided state, quickly takes up the oxygen of the air, especially in presence of carbon, and is converted afresh into oxide of copper, which in its turn is reduced by the hydrogen, and so on indefinitely by reason of the continual rotation of the disks, each portion of which is bathed alternately in the liquid and in the air.

Second. The metal precipitated upon the cathode-disks is removed as fast as it is produced, or in the case of a compact deposit it is removed in sections corresponding to each of the segments composing the cathode-disk, without completely dismounting the apparatus, it being only necessary to unscrew the covering-strips *e* or the screws *f*, as the case may be, which may be done whether the disks are in motion or at rest, whereupon the segment will be pressed outward by the spring *h*, and may thus be easily withdrawn, either for melting or otherwise, another segment being inserted if a fresh deposit of metal is required. Each segment can thus be removed at the moment it leaves the bath. The advantages attending this mode of operation are as follows: (*a*) the metal being continually withdrawn from the oxidizing action of the bath is no longer liable to be attacked and to form local couples whose current is inverse to the principal current; (*b*) diminution of the electrical resistance of the bath, inasmuch as the anodes may be brought quite close to the cathodes without the liability of short-circuiting; (*c*) economy of current due to the diminution of the resistance of the bath. Theoretically, the electrolytic refining of metals involves no expenditure of mechanical energy, as the quantity of heat disengaged by a molecule of any metal entering into solution is exactly equal to the quantity of heat absorbed by setting at liberty a molecule of the same metal from its corresponding compound. Mechanical energy is in fact only employed to overcome the resistance of the electrolytic solution and the polarization of the electrodes.

Third. The density of the several layers of liquid traversed by the current is the same throughout owing to the continual rotation of the disks by which they are kept constantly stirred, thereby preventing the liquid from becoming satuated toward the bottom and impoverished in the upper portion of the bath, as is always the case where the liquid remains at rest.

The arrangement represented in Figs. 5, 6, and 7 has the not less important advantage that when not required to work through the night, or for other prolonged period, the segments may be removed, whereby the oxidation of the deposit is avoided. When, as in the extraction of zinc, cadmium, lead, tin, antimony, &c., from their alkaline or other solutions, in order to obtain these metals in a spongy or compact condition, it is necessary to employ an anode which is insoluble in the electrolyte, a perforated holder of insulating material, such as celluloid, ebonite, gutta-percha, &c., is used, which is filled with metallic copper, lead, silver, &c., or other metal whose oxide is insoluble in the electrolyte and is reducible by electrolytic hydrogen, this metal being in a spongy or reduced state obtained by precipitation or other means and in the midst of which is placed a plate of carbon, copper, or other unattackable conducting material. This arrangement can only be employed when the electrolyte has no solvent action upon the metal of the anode, even under the influence of the electric current, and it has for object to enable the anode to take up the oxygen produced at the positive pole by forming an oxide which is insoluble in the electrolyte, and so preventing the polarization of the anode and the consequent diminution of the energy necessary for working. When the metal has been completely oxidized, these anode-holders are removed and placed in a fresh trough containing as electrolyte acidulated or alkaline water and connected with the negative pole, so as to form cathodes, the anodes in this case being formed either of platinized copper plates or of carbon or other unattackable conductive substance. Under the influence of the current, the water being decomposed, the hydrogen reduces the oxide to the metallic state, while oxygen disengages at the positive pole. This method possesses the advantage, besides preventing polarization, of enabling the same metal to be repeatedly employed as the anode, without the necessity of renewing it after each operation.

My electrolyzer may be employed with ad-

vantage for the electrolytic refining of copper, lead, zinc, nickel, silver, &c., for the recovery of the tin from tin-plate scraps, for treating argentiferous slags or skimmings, old coin, matte, speiss, &c., for extracting metals from their ores whether roasted or not, soluble, or otherwise, with or without soluble anodes, and particularly for the extraction of copper, zinc, lead, antimony, nickel, &c., and the preparation of certain chemical products, &c. It will be evident that the composition of the bath will be varied according to the electrolytic operation to be performed. Thus a sulphate of copper solution would be used for refining copper, a sulphate or acetate of zinc solution for the refining or extraction of zinc, a lead nitrate solution for extracting lead from galena, and so on. The composition of these various liquids being the same as usual needs no description. I would, however, remark that when the electrolyzer is employed for the extraction of silver from pig-lead, Pattinsonized lead, or argentiferous slags or skimmings the electrolyte would be of the following special composition of my invention: (*a*) a solution in one thousand grams of water of two hundred and fifty grams of caustic potash or soda, to which is added one hundred grams of acetate of soda or sulphate of sodium and about eighty grams of glycerine or other organic matters having reducing properties—such as sugar, glucose, milk-sugar, &c.—the former (the alkaline salts) diminishing the electrical resistance of the bath, and the second (the organic matters) preventing the formation on the anode of peroxide of lead, which might retard and even prevent its solution in the liquid traversed by the current; (*b*) a solution of neutral acetate of lead or rendered alkaline by an excess of caustic potash, to which is also added ten per cent. of glycerine or other organic reducing matters for the same purpose as before.

For extracting silver from argentiferous slags or skimmings to an electrolyte of the above composition is added a solution of neutral acetate of zinc, or rendered alkaline by an excess of caustic potash, together with organic reducing matters, as before.

I claim—

1. In an electrolyzer as herein specified a rotating cathode disk composed of a mixture of carbon and oxide of copper, as and for the purpose specified.

2. In a cathode disk the combination of a hub having radial grooved arms, spring pressed contact plates between the radial arms, sector shaped cathode segments having tongued edges adapted to fit in the grooves of the radial arms and held in place by screws at the periphery of the disk and by the pressure of the contact plates, substantially as described.

3. In a cathode disk the combination of a hub having radial grooved arms, spring pressed sector shaped cathode segments having tongued edges adapted to fit in the grooves of the radial arms, and means for retaining the segments in place against the tension of the spring, substantially as described.

The foregoing specification of my process and apparatus for the extraction, separation, and refining of metals by electrolysis signed by me this 27th day of August, 1892.

DONATO TOMMASI.

Witnesses:
R. M. HOOPER,
ALBERT MOREAU.