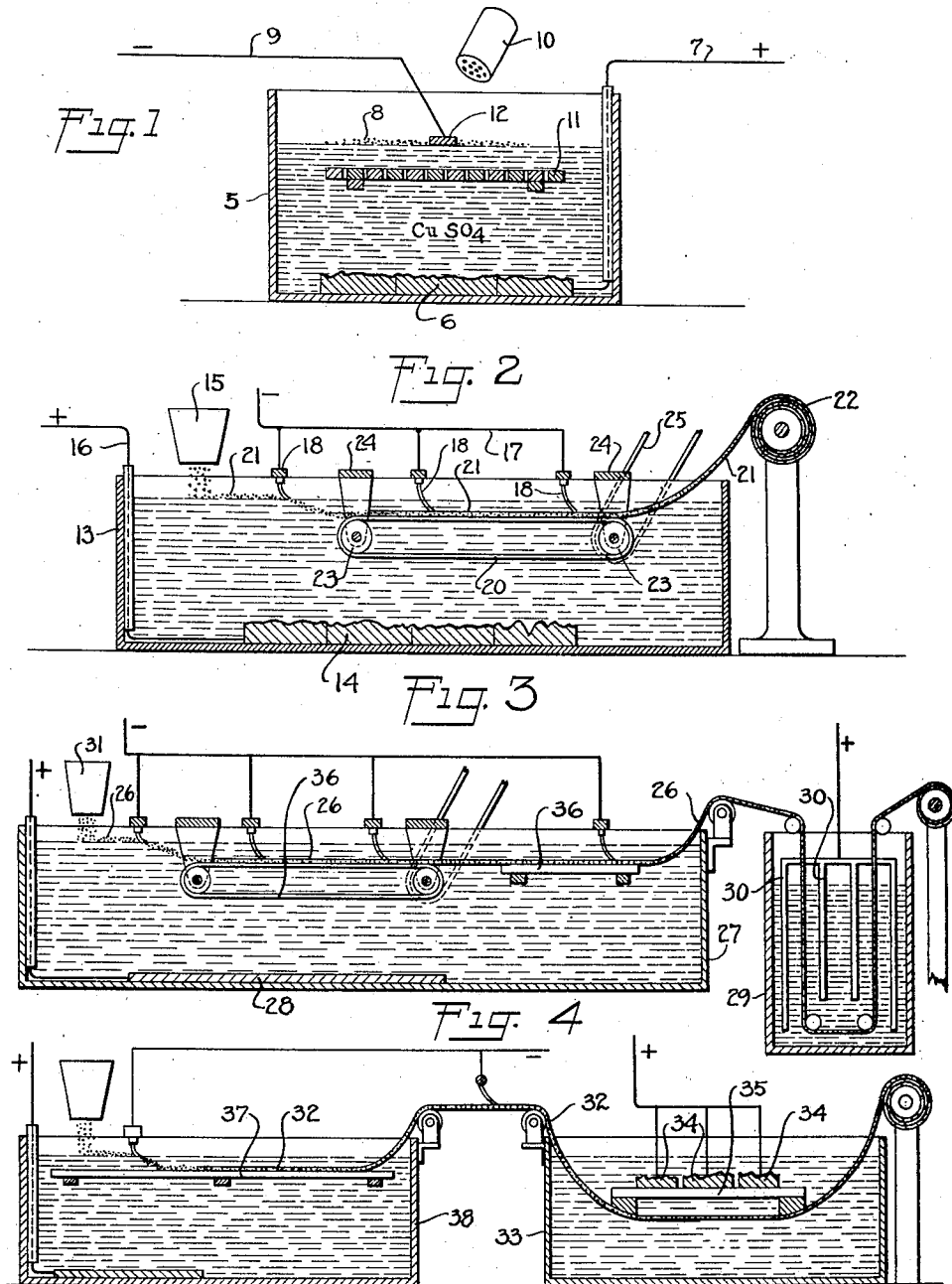


F. D. CRANE.
ELECTROLYTIC REFINING OF METALS.
APPLICATION FILED DEC. 18, 1920.

1,394,147.

Patented Oct. 18, 1921.



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UNITED STATES PATENT OFFICE.

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ELECTROLYTIC REFINING OF METALS.

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To all whom it may concern:

Be it known that I, FREDERICK D. CRANE, a citizen of the United States, and a resident of Montclair, in the county of Essex and State of New Jersey, have invented certain new and useful Improvements in and Relating to the Electrolytic Refining of Metals, of which the following is a full, clear, concise, and exact description, such as will enable others skilled in the art to which the invention relates to make and use the same, reference being made therein to the accompanying drawing, which forms a part of this specification.

My invention relates to the art of depositing metals from a bath or solution in which a salt of the metal to be deposited is dissolved, upon an electrode, by causing a current of electricity to flow through the bath, whereupon the metal the salt of which is dissolved in the bath will be deposited upon the negative electrode or cathode; and particularly to the art which contemplates the purification or refining of metals by electrolytic methods and wherein the impure metal to be refined forms the anode, and the bath contains a salt of the metal in question in solution; whereupon and when a current of electricity is caused to flow through the solution pure metal will pass from the anode into the solution, and will be deposited in a pure state upon the cathode, all in accordance with well known electrolytic phenomena.

My invention contemplates both an improved electrolytic process and a device, mechanism, or apparatus whereby the process may be worked or performed and the advantages of my invention secured, as well also as an electrode as an article of manufacture made in accordance with my invention, and the principal objects of my invention are two in number, although other objects to be attained thereby will appear in the following specification; one of said objects having for its end in view the production of an electrode as a separate article of manufacture from a large number of separate particles of a conducting material consolidated by a metal deposited electrolytically upon and about them, while the other of said objects contemplates the re-

fining of an impure metal as above pointed out; in which last mentioned case the metal to be refined is deposited electrolytically upon the electrode above referred to, and which is produced in accordance with my invention regarded in its less comprehensive aspect.

In the carrying out of my invention in practice I preferably combine the electrode producing and the metal refining ideas above expressed, in which case I use an anode of the impure metal to be refined and a bath containing a salt of that metal in solution, and, after forming an electrode in accordance with one of the objects of my invention, subsequently deposit the metal to be refined upon the same used as a cathode and in accordance with the second and more comprehensive object of my invention.

In the procedure above outlined there is or need be no hiatus, no actual break or interruption of the continuity of the metal refining process contemplated in my invention regarded in its more comprehensive aspect; and the step or process characterized by and the object of which is the production of an electrode becomes the initial step of the more comprehensive process the object and result of which is the refining of an impure metal by electrolytic methods.

The process above outlined may, however, be properly regarded and performed as two separate processes; the first terminating with the production of an electrode, while the second, instead of stopping when the formation of the electrode is accomplished, makes use of the electrode thus produced as a cathode; after which pure metal derived immediately from the bath, but ultimately from the anode, is deposited upon the cathode in question.

In working the more comprehensive electrolytic metal refining process of my invention a single bath is preferably used, and the metal derived therefrom to form the cathode is the same metal as the refined metal subsequently deposited upon the said electrode. I may, however, first form the electrode by the use of one bath or solution, and therefrom place the same in another bath to complete the process and in which second bath the metal to be refined is depos-

ited upon the electrode in question; and it necessarily follows that the two baths may contain a salt of one and the same metal in solution, in which case the metal refined or purified is the same as the metal from which the electrode is formed, or, the baths may contain salts of different metals, in which case the electrode may be made from a metal different from the metal to be refined and which is subsequently deposited thereupon.

The drawing accompanying and forming a part of this specification illustrates an apparatus suitable for performing the process included in and forming a part of my invention, and at the same time illustrates the preferred embodiment of my invention regarded as a device or apparatus for performing the said process; my invention, as hereinbefore stated, being regarded by me as including an improved method or process, an apparatus, mechanism, or device for performing the same, as well also as an electrode made in accordance with said process and by the use of said apparatus, or the equivalent thereof.

In the drawing Figure 1 is a schematic view illustrating my invention. Fig. 2 is a view illustrating an apparatus comprehended by and suitable for carrying out my invention, and in which a single bath is employed. Fig. 3 is a view illustrating a modified form of apparatus in which two separate baths or solutions are employed. Fig. 4 is a view illustrating further modifications of my invention.

Referring first to Fig. 1 of the drawing, the reference numeral 5 designates a suitable tank or receptacle designed to contain a liquid from which a metal may be deposited by electrolytic action, the liquid assumed to be present therein being water in which copper sulfate is dissolved; although the solution or bath employed in performing my process may contain any salt of any metal, so long as the conditions are such that the salt or compound made use of will be dissociated by the liquid employed and in which it is dissolved.

Located within the container 5 is a positive electrode or anode 6, which may be connected with a suitable source of electricity by a leading in conductor 7. This anode is shown as a mass of copper, in which case and when a current of electricity is caused to flow through the solution metallic copper will pass from the anode thereinto, and a corresponding amount of metallic copper will be deposited upon the negative electrode or cathode, in accordance with well known electrolytic deposition phenomena. I may, however, employ a non-metallic anode, such as one made from carbon, or graphite, in the production of an electrode in accordance with my invention; in which case metal derived from the solution will be deposited at

the negative electrode so long as any remains in the solution; although in such a case the refining idea of my invention is obviously not present, as there is no crude metal present to be refined, and the deposition at the negative electrode necessarily stops when all the copper has passed from the solution.

In the practical and commercial operation of my invention the anode comprises a mass of copper matte, or similar metal to be refined, in which case the refining step of my invention follows the formation of the cathode in the manner next explained, the electrode forming and the metal refining steps together constituting a single continuous and uninterrupted process.

The reference numeral 8 designates the negative electrode or cathode to which current is conducted through a suitable conductor 9. This electrode is preferably produced by supplying a finely divided conducting material in the form of a powder to the surface of the liquid, as by means of a shaker 10 or functionally equivalent device, in such a way that the particles thereof form a thin layer of comparatively large area; after which and as the current flows through the bath the metal contained therein will be deposited electrolytically upon and about the particles which form the layer, thus presently consolidating the separate particles and producing a unitary electrode.

The finely comminuted powder or material employed is necessarily one which will conduct electricity, as stated, although it need not be metallic; for, although I prefer to use a metallic powder, because it is a better conductor of electricity, my process may be performed by using carbon, graphite, or other conducting substance in a finely divided form.

The finely divided material employed and the method of applying it to the solution or bath are preferably such that the layer made up of the particles thereof will rest upon the surface of the solution, and be supported by the surface tension thereof at the beginning of the formation of the electrode. In this connection I have found that the surface tension of the bath is adequate to support a layer, even of metallic particles, when the material is finely comminuted, and that the electrode formed by consolidating the particles which constitute the layer will ordinarily be supported by the surface tension until a unitary electrode has been produced. Eventually, however, the electrode becomes too heavy to be held up by the surface tension of the liquid, whereupon it settles onto a support or grating 11 provided below the surface of the liquid to receive it; said support being in the form of a plurality of parallel bars or slats, or a plate having openings, or being otherwise of such a structure as to reduce the resistance en-

countered by the current in passing through the bath to a minimum.

It will, therefore, be appreciated that in producing an electrode in accordance with my invention I first form a thin layer or film of conducting material upon the surface of the solution, which layer, being very thin and of slight weight, is, at the beginning of the electrode forming process, supported upon the surface of the liquid by the surface tension thereof; after which metal derived from the solution is deposited upon the conducting layer until it has attained sufficient strength and rigidity for use as an electrode, commonly in an electrolytic metal refining process in accordance with my invention regarded in its more comprehensive aspect.

In order to secure a more rapid building up of the cathode, especially at the beginning of such action, the conductor 9 preferably terminates in a plate 12 which contacts with the layer of conducting material, and the effect of which is obviously to reduce the resistance to the current at the point where the same passes from the layer to the conductor.

It will be appreciated that at the time the electrode settles onto the support 11 it may be completely formed, or only partially formed, as metal derived from the solution will be deposited upon and about the particles and upon the growing electrode so long as the current flows; from which it follows that the process may be arrested whenever an electrode sufficiently solid and resistant for the use to which it is to be put has been built up, or may be continued through or past the point at which the electrode may be regarded as formed; the process then becoming an electrolytic refining process, assuming the presence of crude metal at the anode, which may be continued so long as may be desired and until the weight of the cathode has attained any predetermined amount.

The electrode may, however, be removed from the solution when it has acquired sufficient strength, and used as a cathode in another bath if it is to be used for electrolytic metal refining purposes; in which case the metal deposited electrolytically upon the conducting layer or surface to build up the electrode, and the metal subsequently deposited thereupon, may be different metals, as will be appreciated.

Although I have referred to the use of a copper matte anode, it will be appreciated that crude metal in any form and of any kind may be used as an anode; and in this connection I wish to point out that my invention may be used in extracting the metal from crushed ores or sands in which the metal occurs in the native form, as an example of which the recovery of native cop-

per from ores carrying too little metal to pay to extract by ordinary smelting process, may be cited.

In the apparatus illustrated in Fig. 2 the receptacle 13 contains a solution of a suitable salt of the metal involved in the process, and the anode 14 is a mass or matte of the said metal to be refined; the view showing an embodiment of my invention in which the cathode is formed, and in which refined metal is afterward deposited thereupon to produce an "electrolytic" metal, electrolytic copper, for example.

The finely divided conducting material is supplied to the solution by means of any suitable device, shown conventionally at 15; and the layer of particles thus formed is consolidated by metal deposited upon and about them electrolytically; the current being supplied through conductors 16, 17, the latter of which is provided with one or more brushes or equivalent terminals 18 which contact with the layer of particles and with the electrode, as many such being used as may be deemed necessary or desirable.

The electrode being formed soon settles, as above explained, and a support 20 in the form of a traveling belt is provided to receive it; the electrode being indicated by the numeral 21, and the mass thereof per unit area increasing progressively as the same moves toward the right. The electrode as it acquires sufficient thickness is shown as wound into a roll 22 at the right of the tank, the same obviously comprising electrolytically refined metal of the same kind as that of the anode.

This construction provides a scheme whereby the electrode is progressively moved out of the vicinity of the means 15 for supplying the finely divided material used for starting the same, and provides for a continuous operation of the mechanism shown; and it obviously follows that if the same kind of metal is used as a powder to start the electrode as the metal afterward deposited thereupon, then the product is a pure metal, while if another metal or a non-metallic substance is used to start the electrode the final produce is contaminated to that degree.

The traveling belt 20 is shown as passing about rollers 23 supported by brackets 24, and as operated by a driving chain or belt 25; although the electrode 21 may, if desired, be advanced by force communicated to it from the roll 22 upon which it is wound.

Fig. 3 illustrates an apparatus in which the electrode 26 is produced by metal deposited electrolytically from a solution contained in a tank containing an anode 28, which electrode is then passed into a second tank 29 wherein a multiple anode 30 of impure metal to be refined is contained. In this case the metal deposited upon the con-

ducting particles supplied by the powder supplying mechanism 31, and the metal plated off from the impure anodes 30 and onto the cathode provided by the electrode 26, may obviously be different metals.

The same statement as to diversity of metals used to form the electrode, and subsequently deposited in a refined form thereupon, applies to the form of apparatus illustrated in Fig. 4, although in both Fig. 3 and Fig. 4 the same kind of metal may obviously be deposited in both tanks. In Fig. 4 the electrode 32 is produced by apparatus substantially identical with that illustrated in Fig. 3, after which the same passes into a second tank 33 and beneath an anode 34 supported by a rack or grating 35. In both Fig. 3 and Fig. 4 the electrode is guided in its forward movement by suitable rollers, as shown, and in both suitable supports 36 and 37 are provided onto which the electrodes sink when they become too heavy to be supported by the surface tension of the liquids within the receptacles 27 and 38.

I claim:

1. The process of forming an electrode which consists in providing a solution from which a metal may be deposited electrolytically, supplying a finely divided conducting material to said solution and causing the same to assume the form of a thin layer made up of the particles thereof, and causing a current of electricity to flow through said solution and said finely divided material; the direction of flow being such that said layer forms the cathode, whereby metal derived from said solution will be deposited upon and about said particles and a continuous electrode thus produced.

2. The herein disclosed electrolytic deposition process which consists in providing a solution from which a metal may be deposited electrolytically, supplying a finely divided conducting material to said solution and causing the same to assume the form of a thin layer made up of the particles thereof, causing a current of electricity to flow through said solution and said finely divided material in a direction such that said layer forms the cathode whereby metal derived from said solution will be deposited upon and about said particles and a continuous electrode thus produced, and electrolytically depositing a metal upon the electrode produced as aforesaid.

3. The herein disclosed electrolytic deposition process which consists in providing an anode made of a metal to be refined, and submerging the same in a solution containing a salt of the said metal; supplying a finely divided conducting material to said solution and causing the same to assume the form of a thin layer made up of the particles thereof; and causing a current of electricity to flow into said solution through said anode,

through said solution, and out therefrom through said finely divided material as a cathode; whereby metal derived from said solution is deposited upon and about said particles to thereby produce a continuous electrode, and upon the electrode thus produced subsequent to the formation thereof.

4. The process of forming an electrode which consists in providing a solution from which a metal may be deposited electrolytically, supplying a finely divided conducting material to the surface of said solution in such a way as to cause the same to assume the form of a thin layer made up of the particles of said material and resting upon the surface of said solution, and causing a current of electricity to flow through said solution and said finely divided material; the direction of flow being such that said layer forms the cathode, whereby metal derived from said solution will be deposited upon and about said particles and a continuous electrode thus produced.

5. The herein described electrolytic deposition process which consists in providing a solution from which a metal may be deposited electrolytically, supplying a finely divided conducting material to the surface of said solution in such a way as to cause the same to assume the form of a thin layer made up of the particles of said material and resting upon the surface of said solution, causing a current of electricity to flow through said solution and said finely divided material in a direction such that said layer forms the cathode whereby metal derived from said solution will be deposited upon and about said particles and a continuous electrode thus produced, and electrolytically depositing a metal upon the electrode produced as aforesaid.

6. The herein disclosed electrolytic deposition process which consists in providing an anode made of a metal to be refined, and submerging the same in a solution containing a salt of the said metal; supplying a finely divided conducting material to the surface of said solution in such a way as to cause the same to assume the form of a thin layer made up of the particles of said material and resting upon the surface of said solution; and causing a current of electricity to flow into said solution through said anode, through said solution, and out therefrom through said finely divided material as a cathode; whereby metal derived from said solution is deposited upon and about said particles to thereby produce a continuous electrode, and upon the electrode thus produced subsequent to the formation thereof.

7. In a device for performing an electrolytic process, a receptacle adapted to contain a solution from which a metal may be deposited electrolytically; means located

above the surface of the solution in said receptacle for supplying a finely divided conducting material to said solution in the form of a thin layer made up of particles of said material; and means for causing a current of electricity to flow into said solution, through the same, and out therefrom through the layer aforesaid of finely divided conducting material.

8. In a device for performing an electrolytic process, a receptacle adapted to contain a solution from which a metal may be deposited electrolytically; means located above the surface of the solution in said receptacle for supplying a finely divided conducting material to said solution in the form of a thin layer made up of the particles of said material; means for causing a current of electricity to flow into said solution, through the same, and out therefrom through the layer aforesaid of finely divided conducting material; and means located beneath the surface of the said solution for supporting the electrode formed by the deposition of metal upon and about the particles of conducting material which form said layer.

9. In a device for performing an electrolytic process, a receptacle adapted to contain a solution from which a metal may be deposited electrolytically; means located above the surface of the solution in said receptacle for supplying a finely divided conducting material to said solution in the form of a thin layer made up of the particles of said material; means for causing a current of electricity to flow into said solution, through the same, and out therefrom through the layer aforesaid of finely divided conducting material; and means for moving the electrode formed by the deposition of metal upon and about the particles of conducting material which form said layer out of the vicinity of the means aforesaid for supplying said finely divided conducting material.

10. In a device for performing an electrolytic process, a receptacle adapted to contain a solution from which a metal may be deposited electrolytically; means located above the surface of the solution in said receptacle for supplying a finely divided conducting material to said solution in the form of a thin layer made up of particles of said material; means for causing a current of electricity to flow into said solution, through the same, and out therefrom through the layer aforesaid of finely divided conducting material; means located beneath the surface of said solution for supporting the electrode formed by the deposition of metal upon and about the particles of conducting material which form said layer; and means for moving the electrode thus formed out of the vicinity of the means aforesaid for supplying said finely divided conducting material.

11. The process of forming an electrode which consists in electrolytically depositing a metal from a solution containing a salt thereof upon a layer of conducting material resting upon the surface of said solution.

12. The process of forming an electrode which consists in producing a layer or film of conducting material sufficiently light to be supported by surface tension upon the surface of a solution containing a salt of a metal, and depositing metal from said solution upon said layer by electrolytic action.

13. The process of forming an electrode which consists in producing a layer or film of conducting material upon the surface of a solution containing a salt of a metal, and causing a current of electricity to flow through said solution and said film; the direction of flow being such that said layer or film forms the cathode, whereby metal derived from said solution will be deposited thereupon.

In testimony that I claim the foregoing, I have signed my name hereto.

FREDERICK D. CRANE.