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ELECTROLYTIC APPARATUS FOR THE RECOVERY OF METALS

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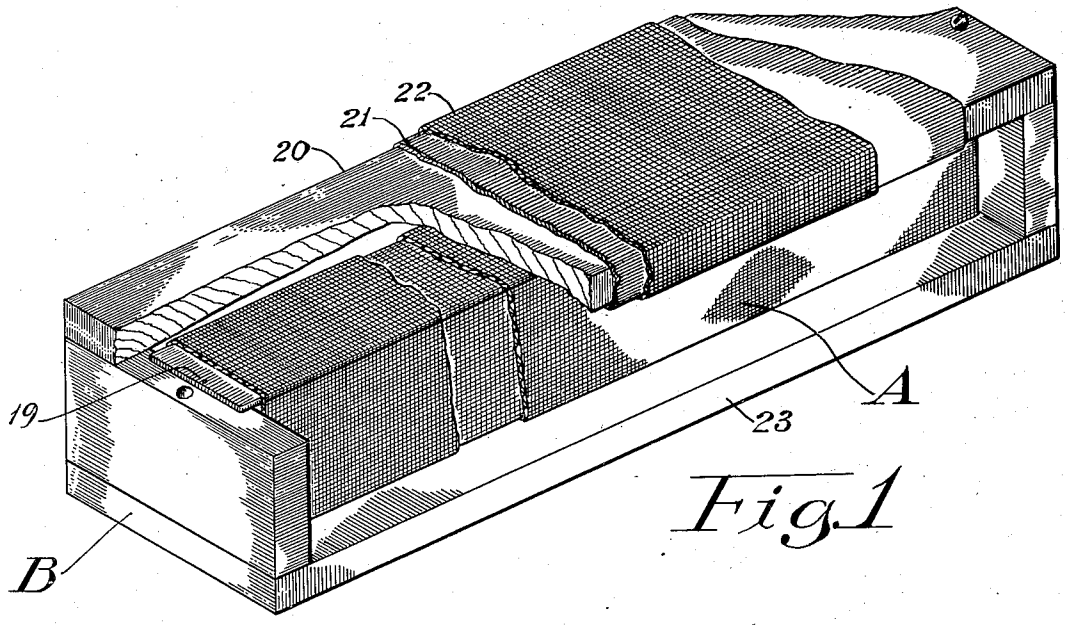


Fig. 1

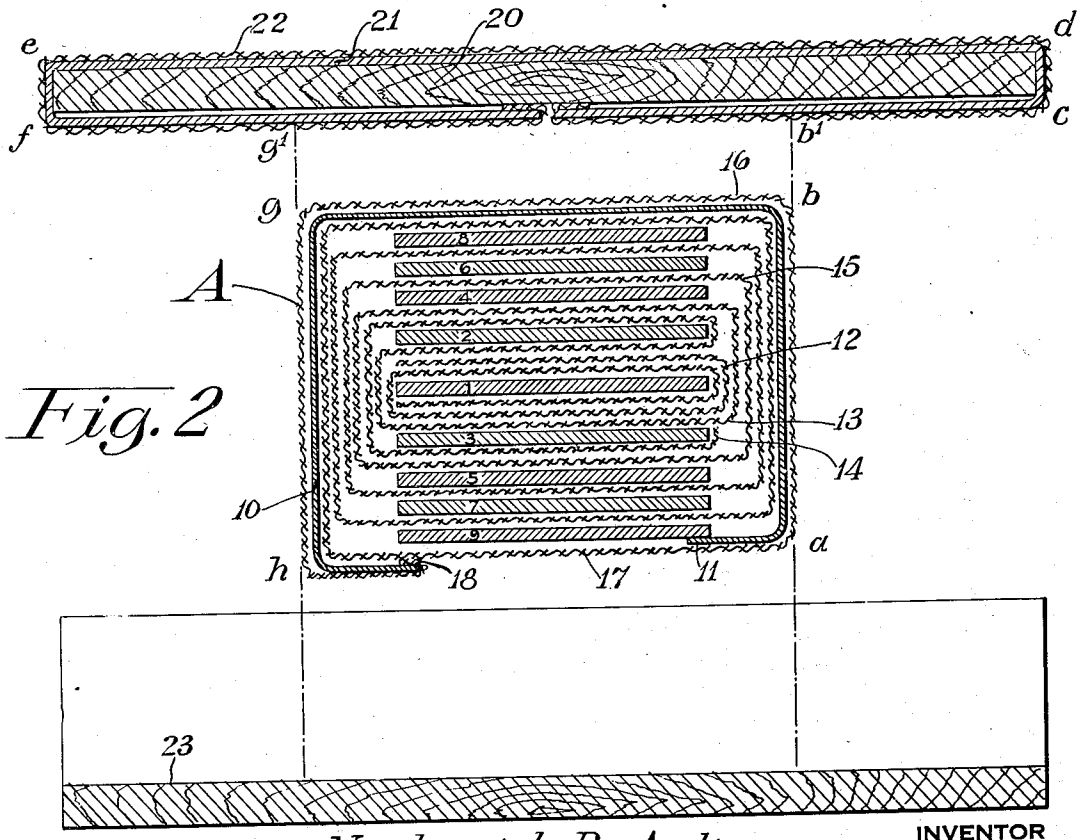


Fig. 2

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ELECTROLYTIC APPARATUS FOR THE RECOVERY OF METALS

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6 Claims. (Cl. 204—248)

This invention relates to apparatus for the electrowinning of metals from aqueous solutions of electrolytes and is directed to new and useful improvements in self-contained immersion units for the electrowinning of metals from such solutions comprising an electrocouple adapted to be energized by the electrolyte of the solution and when so energized to deposit metal from the solution. More particularly, this invention relates to the recovery of silver from photographic solutions and is directed to new and useful improvements in apparatus of the type disclosed in my prior Patent 1,425,935 granted August 15, 1922.

As described in this patent I had earlier found that the silver ordinarily lost in the developing and processing of photographic films could be recovered simply and inexpensively by maintaining a suitably designed electrocouple immersed in the photographic bath. By the electrochemical action of the electrolytes in such baths on the copper and zinc elements of the electrocouple a low voltage potential was built up which caused deposition of silver on the exposed surfaces of the copper elements. I have found, however, that the arrangement of the copper and zinc elements in this unit results in a device that is relatively inefficient and moreover has a deleterious effect on the photographic bath.

Thus I have found that with the zinc strips arranged flatwise with the edges in contact with two similarly arranged copper strips, as shown in my prior patent, the zinc disintegrates most rapidly at the line of contact with the copper and has the effect of gradually separating the zinc from the copper. The units, therefore, have a high initial potential which gradually drops off in proportion to the disintegration of the zinc along the edges adjacent the copper so that the unit becomes less and less efficient the longer it is allowed to remain in the photographic bath. Moreover, I have observed that the high initial potential so formed may in many cases be so high as to cause disintegration of the bath with the formation of an undesirable sludge which makes the bath unsafe to use. Also I have found that the deposit obtained lacks cohesiveness and tends to crumble in the bath making it difficult to recover the silver as a compact mass.

Now, this invention is particularly directed to overcoming these disadvantages and has for an object the provision of a more efficient unit which by virtue of its increased efficiency may be made smaller and thereby better suited for use in commercial photographic tanks. A further object is to obtain a more uniform rate of deposition throughout the life of the unit. A still further object is to prevent disintegration and sludging in the bath. Another object is to obtain a more cohesive and more easily recoverable deposit. Further objects will be apparent as the description proceeds.

These objects are accomplished by devices substantially as illustrated in the accompanying drawing in which

Figure 1 is a perspective view with parts broken away to show interior details, and

Figure 2 is a sectional view which has been slightly exploded to show more clearly the interior arrangement of the unit.

The device as illustrated comprises a core A located in a suitable insulating housing B. The core A which is the essential operative part of the device is built up of a plurality of zinc and copper plates assembled in face-to-face relation to form a stack, each of which is separated from the plate adjacent thereto by one or more layers of fabric netting which insulates one from the other and yet allows infiltration of electrolyte between adjacent plates. Each copper plate acts as a positive element of an electrocouple and is coupled with two or more zinc plates. For example, zinc plates 1, 2, 4, and 6 may be considered as forming a negative element which together with copper plate 8 forms one electrocouple; and zinc plates 1, 3, 5, and 7 as forming another negative element which forms an electrocouple with the positive copper plate 9. While there is some coupling between copper plate 8 and zinc plate 3, it is relatively small as compared with the coupling between copper plate 9 and zinc plate 3.

At least one of the positive plates should have a free surface exposed to the solution to provide a plating surface on which the metal is deposited; that is to say, it should have but one of its faces adjacent a zinc plate. Each copper plate should form a couple with at least two zinc plates or, more simply, none of the zinc plates should have both faces adjacent a copper plate. Thus a copper plate may be located at either or both sides of a plurality of zinc plates. It may also be located in the middle provided it is extended beyond the zinc plates to form a plating surface as and for the purpose presently to be described.

I have found that the greater the area of positive plate exposed freely to the electrolytic solution the more cohesive is the deposit. Thus better to obtain a more compact and easily recoverable deposit I increase the surface area of copper plate 9 which is exposed to the electrolyte by

means of the brass covering 10. If this brass covering 10 contacts copper plate 9 as illustrated at 11 or is closely adjacent thereto, it will assume the potential of the positive element so that reduction of the silver ions will take place on the surface of plate 10. This brass plate 10 is wrapped around the stacked copper and zinc elements to form a casing therefor.

I have found also that disintegration of the zinc elements is more intense the closer the couple between the zinc and copper and that this can be avoided by maintaining a proper spacing between the zinc elements so that the electrolyte is more freely accessible to the zinc elements more remote from the copper. Thus, as illustrated in Figure 2, the spacing between any two remote plates (for example, zinc plates 1 and 2, or 2 and 4) is greater than the spacing between any two zinc plates less remote (for example, zinc plates 2 and 4, or 4 and 6). This permits the electrolyte to circulate more freely between the zinc plates more remote from the copper plates and thus compensates for the greater distance between the copper and zinc plates.

This construction and arrangement of the core A may be better understood by reference to the following description of the manner in which it is assembled. The zinc plate 1 is wrapped in a small piece of net fabric 12 sufficient to provide two layers of netting on each side. So wrapped, it is placed on a second strip of net fabric 13 about three widths of the plate from the end 14. The free end 14 of the netting cloth is folded over zinc plate 1 to provide three widths of netting on each side and to provide a double thickness of netting of sufficient length to inclose zinc plates 2 and 3. With the successive and appropriate addition of the remaining plates the remaining single thickness 15 of the netting is wound around zinc plates 4, 5, etc. to provide single thicknesses between zinc plates 6 and 4, between zinc plates 5 and 7, between copper plate 8 and zinc plate 6, and between copper plate 9 and zinc plate 7. The wrapping is then continued around copper plate 8 and copper plate 9 to provide the single thicknesses shown at 16 and 17. A thin brass sheet 10, suitably about 36 gauge, is then laid on the remaining netting with one edge underlying copper plate 9 as illustrated at 11. The two together, that is, the brass strip and the netting, are then wrapped around the unit as shown and the free end of the netting is folded under and retained by the free end of the brass sheet as shown at 18. This gives a unit in which the desired spacing between the zinc plates is maintained thruout the active life of the device by reason of the multiple wrapping of netting and the inclosure in the brass covering.

The unit thus formed may be suspended in a photographic tank and when so suspended will effect deposition of silver on the exposed surfaces of the positive covering 10. When so used it serves two functions in that it prolongs the life of the photographic bath and reclaims silver therefrom which would otherwise be lost. The silver recovered averages approximately .970 fine and requires only melting for further use in industry. The silver is not deposited as a plate but rather as a thick uneven mass. It does not adhere strongly to the plating surface and may easily be removed. The covering of netting over the plating surface not only facilitates its removal but also aids in retaining the mass on the plating surface.

While the unit just described may be employed alone, it is preferable to inclose it in an insulating casing as shown in Figure 1, especially if the photographic tank is made of metal. Otherwise the silver may be deposited on the exposed surfaces of the tank which either by contact or close proximity to the positive plating surface 10 will assume the same low potential. As illustrated, the casing B is made in the form of an open-sided box so as to provide free access of the electrolyte to the plating surface 10. Wood, suitably waterproofed with paraffin or other material, has been found entirely suitable as an insulator. By making the copper plate 8 longer than the zinc plates, the core A may be simply and effectively secured in the casing as illustrated at 19.

The casing B may be made to form a still further function, namely that of providing a support for additional plating surface. Thus the top board 20 as illustrated in Figure 2 may be covered with a brass sheet 21 which serves as an extension of the plating surface 10. This sheet likewise is covered with netting as shown at 22 to provide for improved adherence of the deposited silver. It is not necessary to have the brass sheet 21 contact the brass sheet 10 since though two layers of netting separate the two plates the electrolyte forms an adequate electrical connection between the two plates. By this arrangement I provide an effective plating surface ranging from *a* to *b*, *b'* to *C*, *c* to *d*, *d* to *e*, *e* to *f*, *f* to *g'*, and *g* to *h* on which the silver builds up over the top board 20. This has the advantage of causing the silver to deposit away from the walls of the photographic tank. For example, if the bottom board 23 is placed adjacent a sidewall of the tank or on the bottom of the tank, the silver deposits away from the sidewall of the bottom. This avoids any possible short circuit which would lead to deposition of silver on the walls of the tank.

While I have illustrated and described my invention with reference to the recovery of silver from photographic baths and with reference to particular materials of construction, namely copper, zinc, and brass, it is to be understood that the apparatus described is not limited in any of these respects but that it may be used for the recovery of other metals from aqueous solutions of electrolyte; that the electrocouple may be formed of metals other than copper and zinc, certain of which have been mentioned in my prior patent and others of which will be readily apparent to those skilled in the art of electrochemistry; and that other metal or alloys may be used to form a suitable plating surface.

The plating surface should, of course, have a solution potential of the same order as that of the positive element (copper) of the electrocouple. In order words, both the plating surface and the positive element of the electrocouple should be electropositive to the negative element. Thus a plating surface of iron, lead, copper, nickel, etc. can be used in place of brass. The latter, which is the ordinary yellow brass of commerce, however, is readily available on the open market in the form of thin sheeting most suitable for the purposes of my invention. Moreover, brass, being composed essentially of copper and zinc (about two-thirds copper and one-third zinc) introduces no metals which are not also introduced by the elements of the electrocouple.

I claim:

1. Apparatus adapted to be immersed in and to deposit metal from aqueous solutions of elec-

trolytes comprising a couple formed of electronegative and electropositive plates assembled in face-to-face relation to form a stack containing at least one unit composed of a plurality of said electronegative plates separated one from the other and from one of said electropositive plates by insulating means pervious to the solution of electrolyte, said unit being characterized in that the separation between any two adjacent electronegative plates remote from the electropositive plate is greater than the separation between any other two adjacent electronegative plates less remote, and an electropositive metallic plating surface substantially enclosing said stack.

2. Apparatus adapted to be immersed in and to deposit metal from aqueous solutions of electrolytes comprising a couple formed of electronegative and electropositive plates assembled in face-to-face relation to form a stack containing at least one unit composed of two electropositive plates separated by a plurality of electronegative plates by insulating means pervious to the solution of the electrolyte, said unit being characterized in that the separation between any two adjacent electronegative plates remote from the nearest electropositive plate is greater than the separation between any other two adjacent electronegative plates less remote from said last named electropositive plate, and an electropositive metallic plating surface substantially enclosing said stack.

3. The apparatus of claim 2 in which the electropositive plates are copper, the electronegative plates are zinc, and the metallic plating surface is brass.

4. Apparatus adapted to be immersed in and to deposit metal from aqueous solutions of electrolytes comprising a couple formed of electronegative and electropositive plates assembled in face-to-face relation to form a stack containing at least one unit composed of two electropositive plates separated by a plurality of electronegative plates by insulating means pervious to the solution of the electrolyte, said unit being characterized in that the separation between any two adjacent electronegative plates remote from the nearest electropositive plate is greater than the separation between any other two adjacent electronegative plates less remote from said last named electropositive plate, and an electropositive metallic plating surface substantially enclosing said stack, said couple being enclosed in a housing composed of two parallel non-conducting members which project beyond said couple at least one of which is wrapped in an electropositive metallic plating surface.

5. The apparatus of claim 4 in which the electropositive plates are copper and the electronegative plates are zinc.

6. In apparatus for the recovery of metals from aqueous solutions of electrolytes, an immersion unit constructed and arranged to be activated by the electrolyte of the solution in which it is immersed comprising a couple formed of a plurality of electronegative and at least one electropositive plate assembled in face-to-face relation to form a stack and insulating means pervious to said electrolyte separating said plates and maintaining them out of direct electrical contact, and an electropositive metallic plating surface substantially enclosing all the surfaces of electronegative plates exposed to said electrolyte and insulating means pervious to said electrolyte maintaining said metallic plating surface out of direct electrical contact with said electronegative plates.

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