

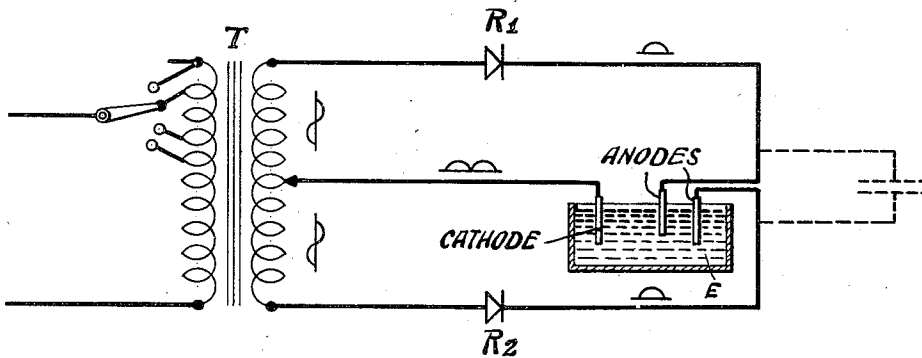
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ELECTRODEPOSITION, METHOD AND APPARATUS

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ELECTRODEPOSITION, METHOD AND APPARATUS

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This invention relates to a process and apparatus for the electro-deposition of two or more metals.

The art shows that much work has been done on the electroplating of alloys, for example, brass and non-tarnishable silver compositions. The inherent limitation to continuous use of the electrolyte solution has been that of maintaining a continuous anodic dissolution at the same rate as the cathodic deposition so as to continuously maintain the metal content in solution.

Practical requirements necessitate the maintenance of a composition of solution which at the temperature and current density will produce the desired deposit. One of the basic requirements in the case of brass plating is that the copper and zinc should dissolve from the anode in approximately the same proportion in which they are deposited in order to avoid continual addition of metal salts to balance the solution to the desired composition.

In practice it has been found difficult to obtain this with alloy electrodes due to variations in free cyanide which cause the potential of the copper to surpass that of zinc. A further difficulty is the formation of sludge and other compounds which vary the relative rates of dissolution of the alloy.

Another basic requirement is that the potentials of the metals to be plated should be as close as possible. In the case of brass, the normal potential of copper is +0.34 volt and the normal voltage of zinc is -0.76 volt. By use of double cyanide solutions having an excess of cyanide of proper concentration, the potentials are made to approach each other due to the more rapid reduction of copper than zinc in a cyanide solution.

Thus, the problem of alloy plating, as shown in the case of brass, is to utilize an electrolyte which as far as possible will equalize the potentials of the copper and zinc so that the deposition will be that of the metal content in solution, and to provide means for dissolving the copper and zinc in the same proportion they are deposited. At present alloy electrodes are used but the electrolyte solutions have very limited life and the electroplating is more for color effect than for bringing about a substantial alloy deposition.

It is an object of this invention to remove the inherent limitations now experienced in alloy plating; to provide and maintain a closely controlled dissolution of the plating metals into the solution at whatever respective rate is desired.

This is accomplished by using two separate metal anodes corresponding to the metal composition it is desired to deposit and intermittently charging one then the other at current densities corresponding to the proportion of metal desired in the solution.

This in turn is accomplished by use of a pair of rectifiers to convert the alternating current into two half waves in the same direction and applying one half wave to one metal anode and one half wave to the other metal anode to be dissolved. The article to be plated receives the full wave so that the deposition is continuous.

If one ampere hour is applied to a copper electrode and to a zinc electrode and assuming a 100% efficiency, 2.37 grams of copper and 1.22 grams of zinc will be dissolved. Thus, if an anode dissolution of 100 grams is desired to maintain an alloy deposition of 80% copper and 20% zinc, 33.8 ampere hours on the copper electrode from one rectifier and 16.4 ampere hours on the zinc electrode from the other rectifier with a total of 50.2 ampere hours applied to the cathode is required as a full wave.

A suitable brass solution of the following composition can be used:

	G./e.
Copper cyanide, CuCN -----	27
Zinc cyanide, $\text{Zn}(\text{CN})_2$ -----	9
Sodium cyanide, NaCN -----	54
Sodium carbonate, Na_2CO_3 -----	30

The temperature of the solution should be about 40° C. with current density of 3 amperes per square foot.

The rectifiers for the source of current can be of any type such as the dry disc type utilizing a magnesium copper-sulphide junction, the copper-cuprous oxide type, nickel iron-selenium, vacuum or vapor thermionic tube type, mechanical type, rotary or synchronous vibratory switch, etc.

In order to more completely describe this invention reference is made to the accompanying drawing which illustrates the method and connections.

In the drawing is a transformer T which has a tapped primary so as to allow variation in secondary output voltage and a variable center tap secondary S which allows a variation in voltage applied to the rectifiers so that any ratio of current can be had between the two rectifiers. The rectifiers R_1 and R_2 block each half wave so that in relation to the variable center tap both halves of the alternating current flow in the

same direction in respect to the cathode, which together with the two anodes, are immersed in electrolyte E.

Where rectifiers are used having a leakage component which might heat the solution, a capacitance such as 1000 mfd. can be connected across the anodes as indicated by the dotted lines.

In operation, the alternating current from the secondary is applied to each of the rectifier junctions through the plating bath to the center tap of the transformer. Each rectifier allows only one half cycle to pass and as they are in the same relation to the center tap on reversal of the A. C. polarity, they apply to the cathode a continuous potential in the form of a pulsating direct current. The anodes are alternately energized, the rate of dissolving or dissolution being governed by the relative potential applied to them in each half cycle as governed by the center point control on transformer secondary. In view of the fact that when one anode is charged the other is practically disconnected, except for negligible leakage, no cross effects are obtained similar to those which would be experienced if two dissimilar anodes were used at a potential difference. The respective voltages applied to the anodes from each rectifier may also be controlled by a series resistor or reactance.

While the method has been described for use with brass, this is only as a specific example; the principle, method and apparatus apply to deposition of other metals such as silver-lead, lead-tin and alloys and compositions of various other metals. The proportions of the metals deposited are determined by the metal in solution and control of anode dissolution, the potentials and current density applied corresponding to the desired relative rate of dissolution.

The areas of the anodes are also a factor, and control at a specific voltage can be obtained by control of relative anode areas, if desired, to operate within a restricted voltage range.

While a sixty-cycle A. C. source is satisfactory for most commercial applications, it may be desirable with some metals to raise or lower the frequency.

The method described provides a practical and economical way to substantially simultaneously electro-deposit two or more metals, allows the production of metal bodies formed of two or more elements which normally alloy, as well as those which do not, and allows a practically unlimited number of metal compositions to be produced, suitable for decorative work, table ware, electrical current carrying members such as contacts, welding electrodes, and switches, thermostatic metals, bearings, structural parts, and other industrial and ornamental purposes.

What is claimed is:

1. In an alloy electro-deposition system, the combination with a source of alternating current of a transformer having a tapped primary and a center tapped secondary, two half wave alternating current rectifiers, the input of each being connected to the ends of said secondary and the outputs being connected respectively to two anodes in an electroplating bath so as to alternately charge said anodes in the same direction, a cathode in said electroplating bath, said cathode being connected to the center tap of said secondary and thereby being adapted to be charged by a pulsating direct current.

2. An alloy electroplating system comprising a plating bath containing salts of two metals to be electrodeposited, a pair of plating anodes therein

formed respectively of said metals, a cathode therein for receiving the alloy electrodeposit, and an A. C. power supply system comprising an A. C. source and a transformer fed thereby, the secondary of said transformer having a pair of end terminals connected respectively to said plating anodes and an intermediate tap terminal connected to said cathode, and a pair of half-wave electric current rectifiers in series, respectively, with the two anode circuits thus formed, said rectifiers being connected to supply positive current to their respective plating anodes.

3. An alloy electroplating system comprising a plating bath containing salts of two metals to be electrodeposited, a pair of plating anodes therein formed respectively of said metals, a cathode therein for receiving the alloy electrodeposit, and an A. C. power supply system comprising an A. C. source and a transformer fed thereby, the secondary of said transformer having a pair of end terminals connected respectively to said plating anodes and an intermediate tap terminal connected to said cathode, and a pair of half-wave electric current rectifiers in series, respectively, with the two anode circuits thus formed, said rectifiers being connected to supply positive current to their respective plating anodes, and means to vary the relative current strength supplied to said anodes.

4. An alloy electroplating system comprising a plating bath containing salts of two metals to be electrodeposited, a pair of plating anodes therein formed respectively of said metals, a cathode therein for receiving the alloy electrodeposit, and an A. C. power supply system comprising an A. C. source and a transformer fed thereby, the secondary of said transformer having a pair of end terminals connected respectively to said plating anodes and an intermediate tap terminal connected to said cathode, and a pair of half-wave electric current rectifiers in series, respectively, with the two anode circuits thus formed, said rectifiers being connected to supply positive current to their respective plating anodes, said intermediate tap terminal being adjustable in position to vary the relative current strength supplied to said anodes.

5. An alloy electroplating system comprising a plating bath containing salts of a plurality of metals to be electrodeposited, a plurality of plating anodes therein comprising at least one anode formed of each metal to be electroplated, a cathode therein for receiving the alloy electrodeposit, and an A. C. power supply system having a common current return conductor connected to said cathode and a plurality of other conductors corresponding in number to said anodes connected respectively to said anodes, and half-wave rectifiers connected in series with each of said other conductors with the cathodes of said rectifiers connected to said plating anodes.

6. An alloy electroplating system comprising a plating bath containing salts of two metals to be electrodeposited, a pair of plating anodes therein formed respectively of said metals, a cathode therein for receiving the alloy electrodeposit, and an A. C. power supply system having a common current return conductor connected to said cathode and a pair of other conductors connected respectively to said anodes, and half-wave rectifiers connected in series with each of said other conductors with the cathodes of said rectifiers connected to said plating anodes.

7. An alloy electroplating system comprising a plating bath containing salts of a plurality of

metals to be electrodeposited, a plurality of plating anodes therein comprising at least one anode formed of each metal to be electroplated, a cathode therein for receiving the alloy electro-deposit, and an A. C. power supply system having a common current return conductor connected to said cathode and a plurality of other conductors corresponding in number to said anodes connected respectively to said anodes, and half-wave rectifiers connected in series with each of said other conductors with the cathodes of said rectifiers connected to said plating anodes and means for regulating the relative current densities supplied to said anodes.

8. An alloy electroplating system comprising a plating bath containing salts of two metals to be electrodeposited, a pair of plating anodes therein formed respectively of said metals, a cathode therein for receiving the alloy electro-deposit, and an A. C. power supply system having a common current return conductor connected to said cathode and a pair of other conductors connected respectively to said anodes, and half-wave rectifiers connected in series with each of said other conductors with the cathode of said rectifiers connected to said plating anodes and means for

regulating the relative current densities supplied to said anodes.

9. The method of substantially simultaneously electrodepositing a plurality of different metals upon a body which comprises making said body the cathode in a plating bath containing, in addition to said cathode, a plurality of anodes corresponding to said different metals, applying alternating current in different phase to half-wave rectifiers connected respectively to said anodes, so that said anodes are sequentially charged to positive polarity, and applying pulsating negative direct current voltage to said cathode.

10. The method of substantially simultaneously electrodepositing two different metals upon a body which comprises making said body the cathode in a plating bath containing, in addition to said cathode, two anodes corresponding to said two different metals, applying alternating current in opposite phase to two half-wave rectifiers connected respectively to the two anodes so that each of said anodes is alternately charged to positive polarity and applying a pulsating negative direct current voltage to said cathode.

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