Dec. 7, 1954 J. F. BEAVER, JR 2,696,466

METHOD OF ELECTROPLATING

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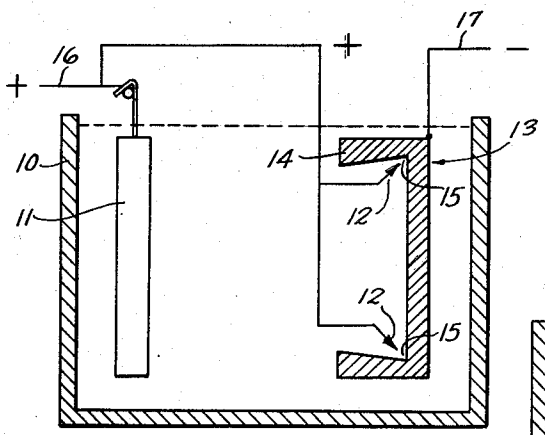


Fig.-1

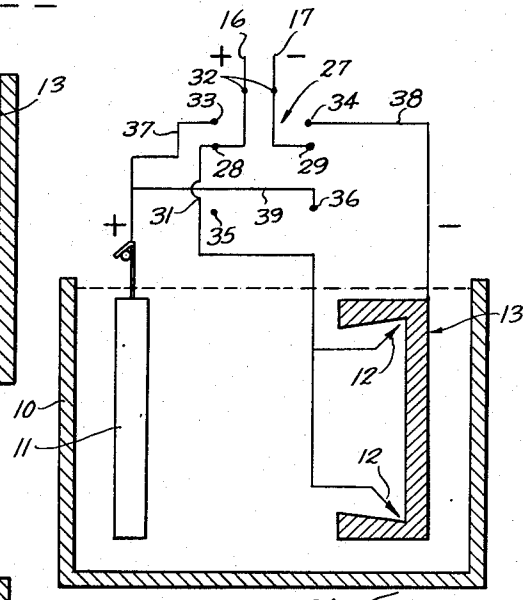


Fig.-4

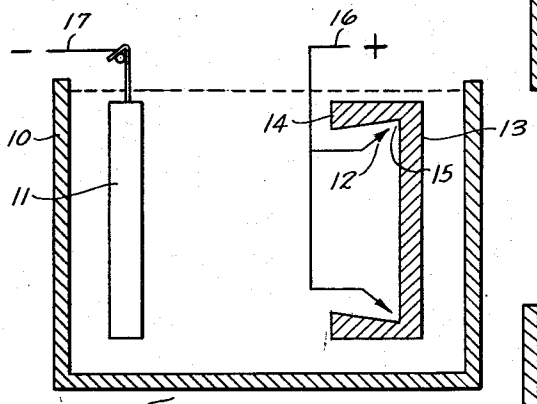


Fig.-2

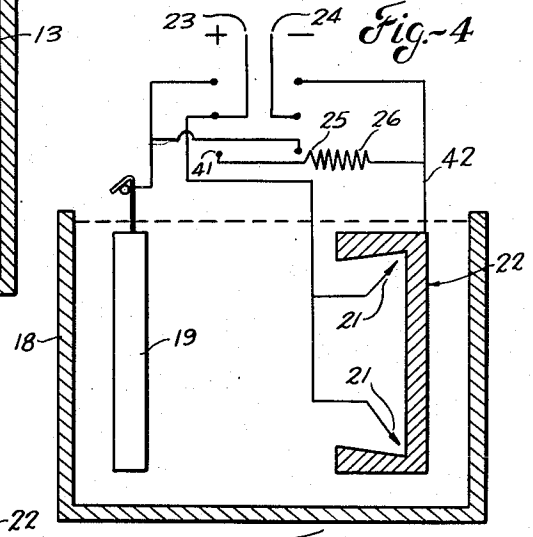


Fig.-5

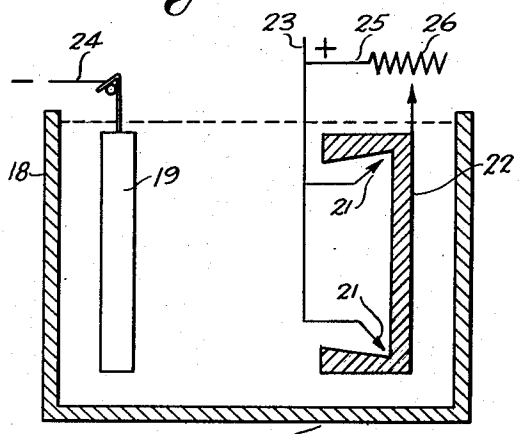


Fig.-3

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METHOD OF ELECTROPLATING

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4 Claims. (Cl. 204—23)

This invention relates to electroplating processes and apparatus, and more particularly to a means and method of plating recessed, hard to plate, objects, although not necessarily limited thereto.

The electroplating of articles of complicated design, presenting crevices and other recessed surfaces, ordinarily is not attempted, particularly when a relatively heavy metal deposit is required. This is because in conventional plating methods prominent areas of the object become heavily plated while the recessed areas receive little if any of the metal deposit.

The object of the invention is to simplify and improve the method as well as the means and mode of electroplating recessed objects, whereby such objects may not only be economically manufactured, but will be more satisfactory, having a better deposit of plate thereon, such plate being substantially evenly deposited over the surface area of the object.

A further object of the instant invention is to advance the electroplating art by bringing objects of complicated design readily within the practice of the art.

Another object of the invention is to provide a method of and apparatus for evenly distributing a metal deposit of any desired thickness over a surface of irregular or complicated design.

A further object of the invention is to provide generally conventional electroplating apparatus incorporating an alternatively usable ability to plate objects having recessed, hard to plate areas.

Still another object of the invention is to present a new method of electroplating wherein there may simultaneously be carried out the steps of removing excess metal from heavily plated areas and of redistributing the removed metal over more lightly plated areas.

A still further object of the invention is to provide simplified apparatus for practicing the foregoing method.

A still further object of the invention is to introduce, and render practicable, the principle of bi-polarity of the object being plated.

A further object of the invention is to provide a method and apparatus for plating objects possessing the advantageous features, the inherent meritorious characteristics and the mode of operation herein mentioned.

With the above primary and other incidental objects in view as will more fully appear in the specification, the invention intended to be protected by Letters Patent consists of the features of construction, the parts and combinations thereof, and the mode of operation, as hereinafter described or illustrated in the accompanying drawings, or their equivalents.

In carrying out the above and other objects of the invention, a method of and apparatus for electroplating have been achieved involving use of one or more auxiliary anodes in the customary electroplating system, plus the use of adjustable polarity control means operable to produce in a first stage of operation a common polarity in the main and auxiliary anodes and an opposed polarity in the object and operable in a second stage to produce opposed polarities in the main and auxiliary anodes and in conjunction therewith to induce a bipolar condition in the object. In the practice of the invention, therefore, during the first stage of the operation the object is plated in substantially the usual manner and as a result prominent areas acquire a heavy metal deposit while areas of lesser prominence are lightly coated, if at all. Then during the second stage of operation some of the metal previously deposited on the prominent areas is removed therefrom and redistributed over the recessed areas until both areas are evenly plated.

Referring to the accompanying drawing, wherein is found the preferred but obviously not necessarily the only form of embodiment of the invention,

Fig. 1 is a partly diagrammatic view of an electroplating installation electrically connected in accordance with the first stage of an operating cycle;

Fig. 2 is a view similar to Fig. 1, showing the parts electrically connected according to the second stage of the cycle;

Fig. 3 is a view similar to Fig. 2, showing an alternative connection to the object in the second stage of operation;

Fig. 4 is a view of an electroplating installation, showing the wiring diagram for obtaining the results in Figs. 1 and 2; and

Fig. 5 is a view similar to Fig. 4, showing the wiring diagram embodying the alternative connection of Fig. 3.

Like parts are indicated by similar characters of reference throughout the several views.

Referring to the drawing, in the practice of the invention apparatus is utilized which includes a tank **10** substantially filled, as indicated, with an electrolytic solution. Immersed in the solution are a main anode **11** and one or more auxiliary anodes **12** made of the metal being deposited or any suitable conductor. An object to be plated is indicated at **13** and shown immersed in the solution. The object is an example of hard to plate articles, presenting prominent portions **14** projecting toward the main anode **11** and relatively remote recessed areas or corners **15**. In setting up the apparatus for operation, the auxiliary anodes **12** are located in or close to the recessed areas while the main anode is spaced a conventional distance from the object.

Electrical conductors to connect the anodes and the object to be plated in an electrical circuit are provided, and in accordance with the instant invention, there is further provided polarity control means for initiating the successive stages of an electroplating cycle.

For illustrative purposes, the two alternating stages of the cycle are separately shown in diagrammatic form in Figs. 1 and 2. As shown in Fig. 1, in the first stage the main anode **11** and auxiliary anodes **12** are both connected to a conductor **16** leading from a suitable source of electrical current and representing the positive side of such current source. Object **13** is connected to a conductor **17** leading from the same current source and representing the negative side thereof. According to the first stage of operation, therefore, a substantially conventional electroplating operation takes place in response to closing of the electrical circuit.

The elements **11** and **12** function as anodes and the object **13** as the cathode with the result that metal is deposited on the object. The first operational stage is continued for a period of time sufficient to produce a substantial deposit of metal on the prominent surfaces of the object. Then the circuit is opened, interrupting the plating action, and adjustments of polarity made to condition the apparatus for second stage operation, as shown in Fig. 2.

According to this arrangement, the main anode **11** is connected to negative conductor **17**, auxiliary anodes **12** remain connected to positive conductor **16** and object **13** is disconnected from the source of current. In consequence of this arrangement, the object **13** becomes bi-polar, the recessed areas **15** thereof being cathodic with respect to the auxiliary anodes **12** and the prominent areas **14** thereof being anodic with respect to the main anode **11** which, in this second stage of the cycle functions as the cathode. In response to closing of the circuit, therefore, a portion of the heavy deposit on the prominent areas is removed and the deposit on the recessed areas **15** is increased. It is believed that the action which takes place in this stage is one of redistributing metal taken from the prominent surfaces and a deposit of metal on the recessed surfaces.

The second operational stage is discontinued after a determined interval and may be repeated, if necessary, until an even plating of desired thickness is obtained over the entire surface of the object. The time of each

stage of the cycle is varied according to plating thickness desired and the structural detail of the object being plated, the second or bi-polar stage being usually of shorter duration, and with higher voltage, than the first stage.

In some cases, during the bi-polar stage of the cycle, it may be advantageous to connect the object being plated through a resistance to the positive side of the current source. The result obtained is to make the object more anodic to the cathode (normal anode **11**) without, however, altering its cathodic relationship to auxiliary anodes **12**. Such an arrangement is shown in Fig. 3 wherein a tank **18**, main anode **19**, auxiliary anode **21**, object **22**, positive conductor **23** and negative conductor **24** occupy the same relationship as the corresponding elements of the embodiment of Figs. 1 and 2. In this instance, however, in the second stage of operation, which is that shown, the object **22** is connected to positive conductor **23** by a lead **25** incorporating a variable resistor **26**.

Considering the means for changing polarity in the apparatus, such means may take the form of a double pole, double throw switch working in conjunction with suitable contacts and conductors. Arrangements of this kind are shown in Figs. 4 and 5 which refer respectively to the embodiments of Figs. 1 and 2 and of Fig. 3. Referring to Fig. 4, the positive conductor **16** and the negative conductor **17** terminate in the separate arms of a switch **27**. Through these arms positive conductor **16** is permanently connected to a contact **28** and negative conductor **17** is permanently connected to a contact **29**. A lead **31** extends from contact **28** to the auxiliary anodes **12** so that these anodes are continuously connected to the positive side of the current source. Contacts **32** on respective arms of switch **27** are alternatively engageable with a pair of spaced contacts **33** and **34** and another pair of spaced contacts **35** and **36**. Thus the contact **32** on that switch arm which is positive by reason of its connection with conductor **16** is alternatively engageable with contacts **33** and **35**. Contact **33** is connected by a lead **37** with the main anode **11**. Contact **35** has no electrical connection. Contact **36** is connected by a lead **39** with lead **37** and thereby to the main anode **11**.

In the operation of the apparatus, the switch **27** normally stands in an upright or neutral position and the electrical circuit is open. To initiate the first stage of the electroplating operation, the switch **27** is moved from neutral to a position engaging contacts **32** with contacts **33** and **34** respectively. A circuit thereby is closed from conductor **16** through parallel leads **31** and **37** to anodes **11** and **12**, through the electrolytic bath, object **13** and lead **38** back to negative conductor **17**. To discontinue the first stage of operation and initiate the second, switch **27** is returned to neutral position and its throw in that direction continued until the contacts **32** respectively engage contacts **35** and **36**. A circuit then is closed from positive conductor **16** through lead **31** to the auxiliary anodes **12**, through the bath to the recessed surfaces **15** of the object **13** and from the prominent surfaces **14** of the object through the bath to main anode **10** (now cathodic) and by way of lead **39** back to negative conductor **17**.

In the case of Fig. 5, the construction and arrangement of parts is identical to that of Fig. 4 with one exception, and so will not be individually described. The exception resides, as noted in the description referring to Fig. 3, in the connecting of the object to the positive side of the current source during the second stage of operation. In Fig. 5, therefore, a contact **41** is positioned to correspond to contact **35** of Fig. 4. Unlike contact **35**, however, which is electrically unattached in the system, contact **41** is connected by lead **25** incorporating resistor **26** to lead **42** connected to the object **22**. Accordingly, when the switch is thrown to initiate the second stage of operation, object **22** is directly connected through resistor **26** to the positive side of the current source.

It is to be noted that conventional plating can be carried out on the apparatus of the invention simply by omitting the second operational stage. The switch **27** then functions as a simple on-off control, moving between neutral position and a position engaging contacts **32** with contacts **33** and **34**.

From the above description it will be apparent that there is thus provided a device of the character described possessing the particular features of advantage before enumerated as desirable, but which obviously is susceptible of modification in its form, proportions, detail construction and arrangement of parts without departing from the principle involved or sacrificing any of its advantages.

While in order to comply with the statute the invention has been described in language more or less specific as to structural features, it is to be understood that the invention is not limited to the specific features shown, but that the means and construction herein disclosed comprise but one of several modes of putting the invention into effect.

Having thus described my invention, I claim:

1. A method of electroplating irregularly shaped objects, including the steps of immersing the object to be plated in an electrolytic bath, further inserting in the bath at least two anodes, one of said anodes constituting an auxiliary anode and being placed in a recessed area of the object, another of said anodes constituting the main anode and placed outside of the object spaced from said auxiliary anode and with the said auxiliary anode being positioned between the object and said main anode, connecting said anodes to a source of current on the positive side, connecting said object to the current source on the negative side, applying current through the circuit so established for a determined time interval, interrupting current flow, disconnecting said object from the current source, reversing the electrical connection of said main anode from the positive side to the negative side while maintaining the connection of said auxiliary anode to the positive side, and applying current through the circuit so established for a second determined time interval.

2. A method of electroplating objects presenting recessed, hard to plate, areas, including the steps of immersing the object to be plated in an electrolytic bath, further inserting into the bath at least two anodes, one of said anodes constituting an auxiliary anode and being placed in a recessed area of the object, another of said anodes constituting the main anode and placed outside of the object, spaced from said auxiliary anode and with the said auxiliary anode being positioned between the object and said main anode, and carrying out a two-stage electroplating cycle involving a changing of polarity, in the first of which stages said main and auxiliary anodes are anodic while said object is cathodic and in the second of which the main anode is cathodic, the auxiliary anodes are anodic and the object is bi-polar, the recessed areas being cathodic with respect to the auxiliary anodes and the more prominent parts of the object being anodic with respect to the main anode which in the second or reversed stage is the cathode.

3. Electroplating apparatus, including a tank to receive the object to be plated, main and auxiliary anodes mounted in said tank, means for suspending an object, said object to be plated in the tank, separate electrical conductors between each of said anodes and a current source and between said object and said current source, and switch means controlling flow through said conductors, settable to a first position to connect said anodes to the positive side of the current source and said object to the negative side of the current source and settable to a second position to connect said main anode to the negative side of the current source, the auxiliary anode to the positive side and to disconnect said object from the current source.

4. Electroplating apparatus, including a tank to receive the object to be plated, main and auxiliary electrodes mounted in said tank, means for suspending an object, said object to be plated in the tank, separate electrical conductors between each of said anodes and a current source and between said object and said current source, switch means controlling flow through said conductors settable from a first position in which said anodes are connected to the positive side of the current source and the object is connected to the positive side of the current source and the object is connected to the negative side of the current source to a second position in which the main anode is connected to the negative side, said auxiliary anode remains connected to the positive side, and said object is connected to the positive side,

and a resistor included in the electrical connection of said object to the current source in the said second position of said switch means.

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