Aug. 19, 1969 T. E. GANNOE 3,462,350

LOCALIZED FLOW PLATING

Filed Dec. 1, 1966 2 Sheets-Sheet 1

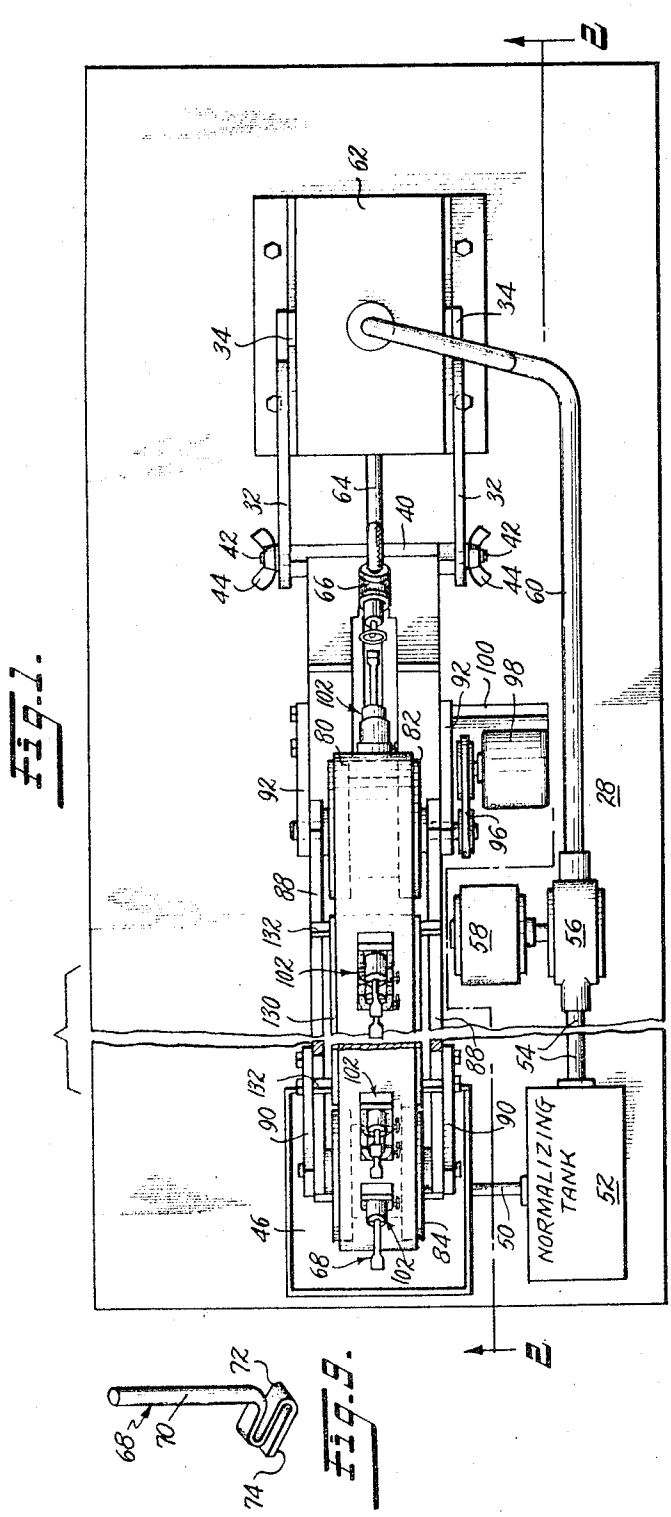


Fig. 1.

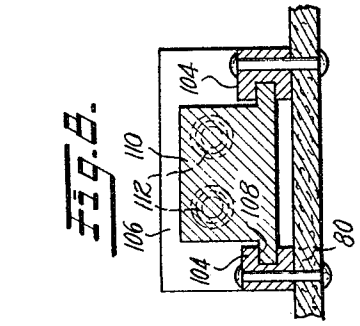


Fig. 8.

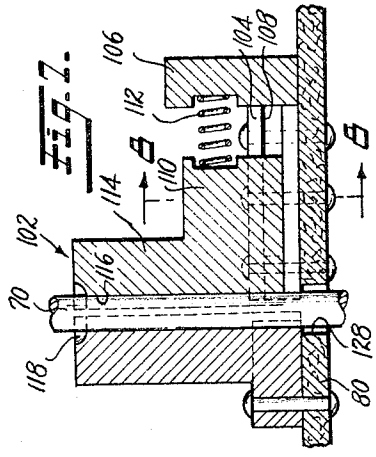


Fig. 7.

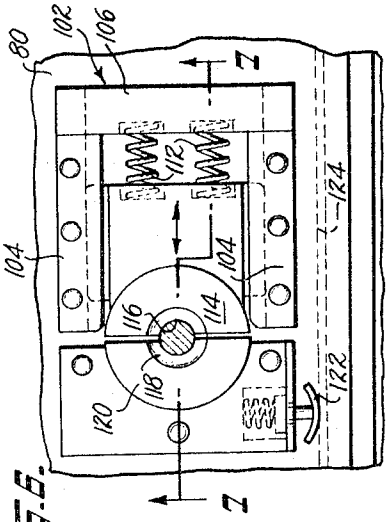


Fig. 6.

Fig. 9.

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FIG. 2.

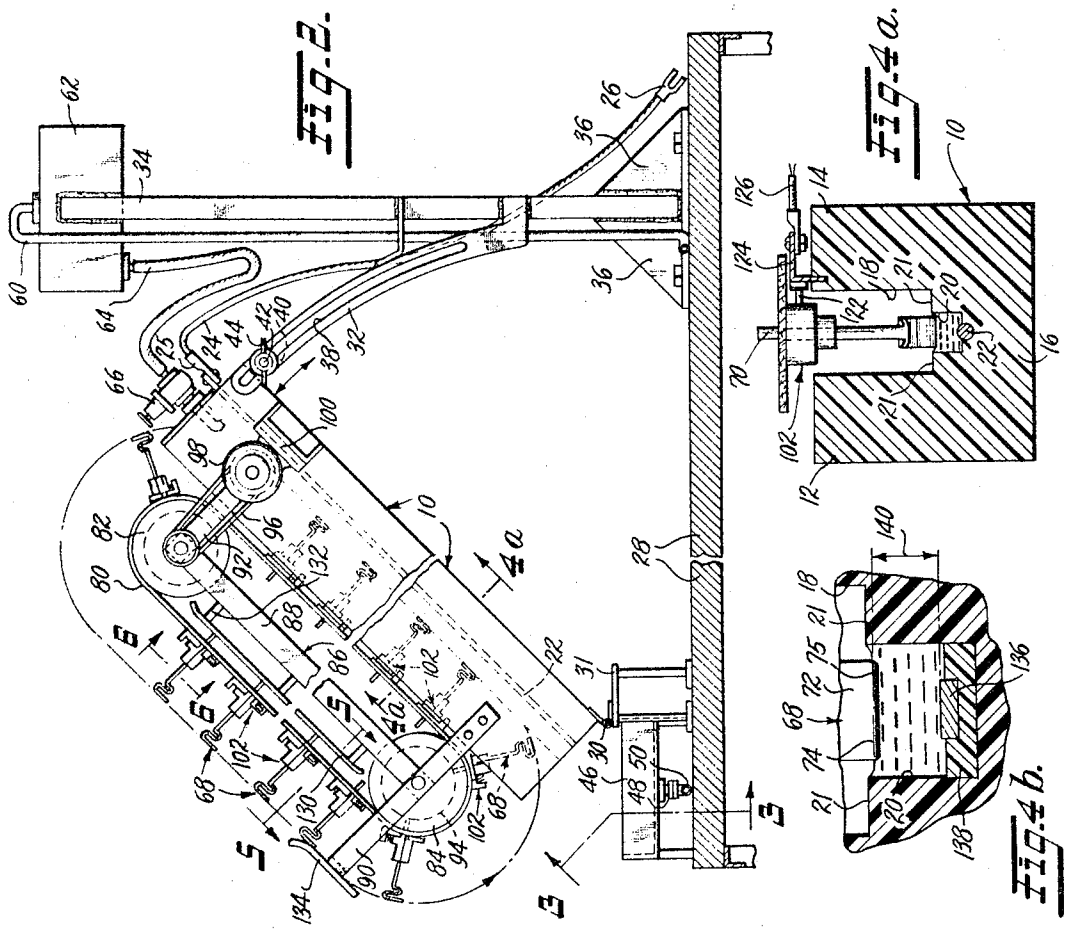


FIG. 4a.

FIG. 4b.

FIG. 3.

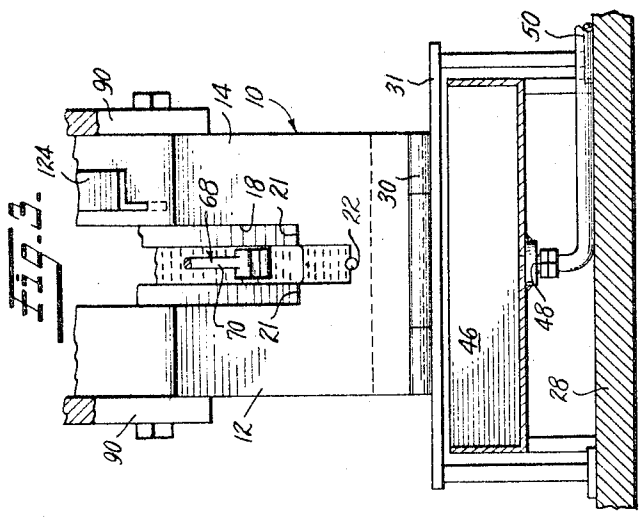
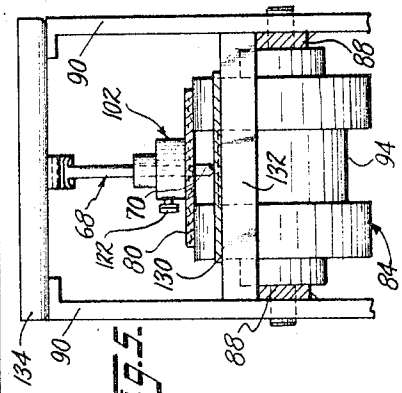


FIG. 5.



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LOCALIZED FLOW PLATING

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ABSTRACT OF THE DISCLOSURE

There is described an accelerated electroplating procedure and an apparatus for accomplishing the same whereby metal plating is disposed on a discrete surface area of a moving metal article. An inclined channel having an anode conductor in the bottom thereof has electrolyte flowing therein of a constant and optimized depth. The article to be plated is made electrically negative and positionally moved relative to the flowing electrolyte in a plane parallel therewith in a manner whereby the desired article surface makes contact with the moving surface of the electrolyte.

This invention relates to the rapid electrical deposition or plating of a metal or alloy of metals on an isolated area of an article to provide desired characteristics in that isolated area, and more particularly the invention relates to a method and means for effecting the electrical plating of an article with precious metals thereby making it imperative that the plating be substantially confined to a desired surface area on the article.

Previous methods of accomplishing localized plating have been by dipping or submerging an article in a plating solution, which was unsatisfactory for the reason that the plating material in the immediate vicinity of the article was soon spent and had to be replaced. Where brush plating was employed, a similar debilitation of the electrolyte would take place, resulting in a slow rate of deposition of the plating material on the article. Where methods involving the relative movement of the article and the plating bath were employed, the article was submerged in the bath resulting in coating all or substantially all of the article.

It is an objective of this invention to coat only a selected or discrete area of an article while there is relative motion between the article and the bath.

It is a further object of this invention to provide means whereby the major portion of the plating is applied to a selected area of an article by proper positioning of the article in close relation to an anode and associated plating bath as the article is transported through the plating bath.

For a better understanding of the present invention, together with other and further objects, advantages and capabilities thereof, reference is made to the following specification and appended claims in connection with the accompanying drawing, in which:

FIGURE 1 is a fragmentary top plan view of an apparatus for carrying out the present invention.

FIGURE 2 is a fragmentary side elevational view of the apparatus on a reduced scale and partly in section, and parts removed for the sake of clarity, taken on the line 2—2 of FIG. 1.

FIGURE 3 is an enlarged fragmentary end view of the apparatus of FIGURE 1 taken on the line 3—3 of FIGURE 2.

FIGURE 4*a* is an enlarged fragmentary vertical sectional view of the apparatus taken on the line 4*a*—4*a* of FIGURE 2.

FIGURE 4*b* is an enlarged fragmentary vertical sectional view of the apparatus showing a modified form of invention.

FIGURE 5 is a fragmentary vertical sectional view of the apparatus taken on the line 5—5 of FIGURE 2.

FIGURE 6 is an enlarged fragmentary top plan view, taken on the line 6—6 of FIGURE 2.

FIGURE 7 is a vertical sectional view, taken on the line 7—7 of FIGURE 6.

FIGURE 8 is a vertical transverse sectional view, taken on the line 8—8 of FIGURE 7.

FIGURE 9 is a perspective view of a terminal contact, a restricted lower portion whereof is to be plated with the apparatus of this invention.

Referring to the drawings in greater detail, at **10** is indicated a trough of a suitable plastic material having electrical insulative and corrosion resistant properties and being shaped with vertical sides **12** and **14** and a bottom **16** thereby forming a first channel **18**. In the bottom of the trough and extending medially of its length is a second and narrower channel **20**. The bottom of the first channel is formed by two planar ledges **21** parallel to which an article being plated may move. Symmetrically confined on the bottom of the narrower channel and in optimized proximity to a face or surface of an element to be plated, is an electrical conductor or anode **22** of a material such as platinum here shown in the form of a rod with the longitudinal portion exposed in the second channel **20** throughout the length of the channel. A lead-in wire **24** for connection with a positive pole of a D.C. supply is connected in any convenient fashion to the conductor **22**, as by a terminal lug **25** connecting it with the rear end of the conductor and providing a connector terminal **26** at the free end of the wire.

The trough is suitably mounted on a base, indicated as **28**, in a manner to permit desired inclination which is achieved by pivotal movement of one end of the trough about an axis transverse to the longitudinal axis thereof. A convenient and simple means for this purpose comprises, for example, a butt hinge **30** having one leaf fastened to the underside of the trough **10** and the other leaf fastened to a platform **31** rigid with the base. While various means may be employed to adjust the angularity of the trough with respect to the base, one type of simple means comprises an arcuate pair of straps **32** fastened to an upstanding plate **34** whose lower end is supported by base **28**. Reinforcing gussets **36** support the plate. Each of the arcuate straps is provided with a long slot **38** concentric with the axis of the hinge. A horizontal support bar **40** is fastened to the underside of the trough at the rear right hand thereof, as viewed in FIGURE 2. This bar has threaded ends **42** extending through the arcuate slots and each threaded end is supplied with a wing nut **44** which may be manipulated to adjust the angularity of the trough, as desired. At the hinge or forward end of the trough is a rectangular basin **46** suitably mounted on the table to receive a flow of electrolyte issuing from the second channel **20**.

A flow of electrolyte, for example, an acidulated solution containing gold salts, is maintained in the narrow channel **20** with the electrolyte substantially filling the channel. It is an objective of the user of the device to regulate a constant rate of flow of the electrolyte flowing in the channel and the tilt of the trough so that a substantially sustained level of electrolyte constituting a plane of surface thereof will be maintained in the second channel of the trough.

For the purpose of maintaining the desired supply of flowing electrolyte in the second channel and in order to maintain the electrolyte at a desired normalized concentration, a drain pipe **48** from the basin is connected via a conduit **50** to a normalizing tank **52** wherein automated means is provided for supplying gold salts, as needed, to

maintain a substantially constant normalized concentration in the solution. Further, a pipe 54 connects the adjusted electrolyte to a pump 56 driven by an electric motor 58. The pump delivers the electrolyte via a pipe 60 to a tank 62 supported at the upper forked end of upstanding plate 34. From tank 62 the electrolyte flows via an elongated flexible hose 64 to a point above the narrower channel 20, the pipe 64 being provided with a regulating valve 66 supported by the trough of the raised end thereof. Since the trough is inclined, the outlet from the valve is above the channel 20 in the trough.

Means are provided for conveying elements or articles to be plated. Said articles may be for example terminal contacts 68, such as may be used as electrodes in solid state devices. These are conveyed along the length of the trough with only selected discrete areas of the contacts in position to be plated electrolytically. Thus, an article to be plated may be of the form shown in FIG. 9 comprising a stem 70 having a generally S-shaped terminal portion 72 whereof it is desired to electroplate the lower face 74 with a thin coating of plating material 75. For this purpose the contact element 68, while connected to the negative pole of the D.C. supply is moved along with the face portion in contact with the electrolyte substantially on the plane of surface thereof at a predeterminately spaced distance from the anode at the bottom of channel 20 and preferably in a direction counter to the direction of flow of the electrolyte in the channel and parallel with the plane of surface thereof. When so conducted along the channel, the contact element will be plated most heavily in that area on face 74 which is directly opposite the anode conductor 22 with lesser plating elsewhere on the face portion. To best effect the desired plating the lower face will just contact the plane of surface of the eletcrolyte, see FIG. 4*b*. In the embodiment shown thereat, the anode conductor 136 having a considerable dimension across the width of the channel 20, will effect an even plating substantially across the whole under face of the contact 68.

With a proper level of electrolyte in the second channel, it is possible to slide an article of a width greater than the portion to be plated with the lower face thereof sliding along the ledges 21 or bottom of the first channel, the discrete surface portion of the face to be plated being in contact with the electrolyte in the second channel.

Various means may be utilized for transporting the elements which have first been cleaned. If desired they may be conveyed by hand, the elements being, of course, connected to the negative pole of a D.C. supply; or the elements may be ganged in a manually movable conductive holder connected to the cathode of the D.C. supply or by carriers on a belt.

A suitable form of transport mechanism comprises an endless belt 80 of any suitable material, such as leather or metal, trained tautly about a pair of longitudinally spaced-apart rollers 82 and 84 supported by frameworks 86, one on each side of the belt. Each of the frameworks comprises a longitudinal rail 88 parallel with the longitudinal axis of the trough and uprights 90 and 92 perpendicular to the rail 88 and with the lower ends fastened to the trough. The uprights 90 extends above the rails 88 for a purpose to be described. The rollers 82 and 84 are recessed, as indicated at 94 in FIG. 5 to allow protruding ends of stem portions 70 of contacts 68 to pass about the rollers without interference. One of the rollers, such as roller 82, is driven via belting 96 from an electric motor 98 mounted on a cantilevered base 100 fastened to a side wall of the trough.

The belt 80 has on it a number of equally spaced work holding chucks 102, each comprising a pair of ways 104 fastened to the belt in any suitable fashion, the ways being joined by a cross piece 106 fastened thereto, said ways being provided with slots 108 to accommodate the wings of a slide 110, spring pressed to the left, as viewed in FIGS. 6 and 7, by springs 112 compressed between the cross piece and the slide. The slide is provided with a jaw 114 having a recess 116 shaped to conform with the curvature of the stem 70 and a cup shaped recessed portion 118 to facilitate reception of a stem when inserted into the chuck, the chuck being provided with a cooperating jaw 120 fastened to the belt and provided with recesses to conform with the recesses in the jaw 114. The chucks are of electroconductive material and each of the jaws 120 is provided with a spring pressed shoe 122 which is adapted to engage a conductive angled rail 124 (FIG. 4*a*) mounted on and parallel to the upper face of wall 14 of the trough and electrically connected to the negative pole of the source of current supply by a cable 126. The rail extends along the trough substantially for the length of the lower run of the belt. It is not shown in FIGS. 1 and 2 for the sake of clarity.

As shown in FIG. 2, the upper reach of the belt runs from right to left in counterclockwise movement. The work pieces or terminal contacts to be plated are inserted into and the plated contacts removed from the chucks near the right-hand end of the upper reach. The belt 80 is perforated, as indicated at 128 in FIG. 7, below each chuck to enable a portion of the stem 70 to pass therethrough in positioning the work pieces in the chuck. In order to initially position the work pieces 68 for proper plating of the faces 74, a stop plate 130 is provided, intermediate the runs of the belt, this plate being supported by cross bars 132 fastened to the rails 88. The inserting movement of the work pieces is thus stopped by engagement of the lower ends of the stems 70 with the stop plate.

For attaining final adjustment of the work pieces, the upper ends of upright 90 are provided with a bridge plate 134 curved at its forward or receiving end, as shown in FIGS. 2 and 5, to finally position the work pieces as they move to the left so that all faces 74 are in the same plane when they reach the surface of the plating fluid. Thus, the plate 130 may be at such a height that initially the faces 74 of the terminal contacts or work pieces 68 extend too far above the chucks, the final adjusting being attained by the thrust action of bridge plate 134. The stop plate 130 terminates short of the bridge plate 134 so that the bridge plate can thrust the contacts 68 downward, when necessary.

After passage thru the plating bath, the contact elements may be processed by subjecting them to a cleaning bath, then dried and stored. Since these last elements form no part of the invention, they are not described.

In the embodiment shown in FIG. 4*b*, a rectangular anode conductor 136 is partially embedded in an insulative spacer 138 positioned along the bottom of channel 20. This facilitates optimizing the distance 140 between the top of the anode conductor 136 and the discrete surface area of the article to be plated, the normalized electrolyte filling the space or depth therebetween with the plane of surface of the electrolyte being in contact with the surface of the article to be plated. The spacer 138 may be exchangeable for one of a different thickness or shim means may be placed therebeneath to achieve the desired distance between the anode and cathode element. This distance can also be achieved by decreasing the depth of the electrolyte in the channel and positioning the article to be plated in accordance with the surface thereof. As mentioned, it has been found that there is an optimum distance or spacing relationship 140 between the anode and the plating-disposed-surface of the cathodic article whereby plating deposition is markedly accelerated—a phenomenon not evidenced in conventional plating. This critical plating-acceleration-distance is dependent upon the type and concentration of the electrolyte, the rate of flow of the normalized electrolyte, and the D.C. current density of the electrical energy supplied to the operation.

Thus, there is provided an improved apparatus and a method whereby a discrete surface of an article has a metallic plating disposed thereon in an accelerated manner.

While there has been shown and described what are at

present considered the preferred embodiments of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the scope of the invention as defined by the appended claims.

Having thus described the invention, what is claimed is:

1. An apparatus for electroplating at least one face of at least one element comprising:

a trough of electrical insulative and corrosion resistant material, said trough having side walls and a bottom and forming a first channel,

a depression at the bottom of said trough forming a second channel, narrower than said first channel, said depression extending longitudinally of the trough,

an anode conductor at the bottom of said second channel and extending longitudinally of the trough,

means for supplying said trough with flowing electrolyte, and

means in said first channel for moving said element to be plated in surface contact with said electrolyte in a direction counter to the flow of said electrolyte, whereby plating is disposed on at least one face of said element.

2. The apparatus of claim 1 wherein said conductor is partially embedded in the bottom of said second channel, with the upper portion of said conductor exposed through the bottom of said second channel.

3. The apparatus of claim 1 wherein said conductor is embedded in an insulating spacer body, said body resting on the bottom of said second channel.

4. The apparatus of claim 3 wherein said spacer body is removable to facilitate a change in the positioning of the top surface of said anode conductor with respect to the top surface of the electrolyte within the second channel, said conductor positioning being accomplished by substitution of spacers of different thicknesses.

5. An apparatus as set forth in claim 1 in which the bottom of the first channel is planar so as to slidably accommodate a face of an element being plated.

6. An apparatus as set forth in claim 1 in which said means for transporting at least one element along the trough is an endless belt spaced above the trough, at least one element receiving chuck being spaced along the length of the belt and means being provided for supplying an electric current to the element supported in said chuck.

7. The apparatus of claim 6 wherein means are provided for adjusting the position of the elements in the chucks so that all the faces of the elements to be plated may be positioned in a common plane and parallel to the plane of surface of said electrolyte in the channel, when said elements are in contact with the electrolyte.

8. An apparatus as set forth in claim 1, in which means is provided for pivoting said trough about a horizontal axis perpendicular to the longitudinal axis of the trough and means to adjust the trough about said horizontal axis.

9. An apparatus as claimed in claim 8 in which said means for moving said element through the trough is supported by said trough, whereby the element moving means will be in the same position relative to the trough in all adjusted positions of the trough.

10. A method for achieving accelerated plating of a discrete surface of an article moving relative to an electroplating apparatus utilizing an inclined longitudinal trough-like channel with an anode conductor symmetrically positioned lengthwise at the bottom thereof, said method comprising the steps of:

flowing normalized electrolyte of a desired concentration at a substantially constant rate in said channel, said flowing electrolyte having a plane of surface defining an optimum spacing depth relative to said anode conductor to facilitate subsequent accelerated plating deposition;

positioning said article in a manner that the surface to be plated will be substantially on said plane of surface of said electrolyte;

moving said article relative to said moving electrolyte in a manner parallel to said plane of surface thereof, said article surface and said electrolyte plane of surface being in contact therebetween; and

applying D.C. electrical energy in a manner that said anode conductor is at a positive potential and said article a negative potential, said energy being of a current density related to said spacing depth and said electrolyte concentration to provide accelerated plating deposition on said surface.

11. A method for plating a discrete surface of a moving article according to claim 10 wherein the movement of said article is in a direction counter to the flow of said electrolyte.

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