July 11, 1967 I. C. HEPFER 3,330,753

ELECTROPLATING BARREL FOR NON-CONDUCTIVE BUOYANT AND NEAR-BUOYANT ARTICLES

Filed March 16, 1964 4 Sheets-Sheet 1

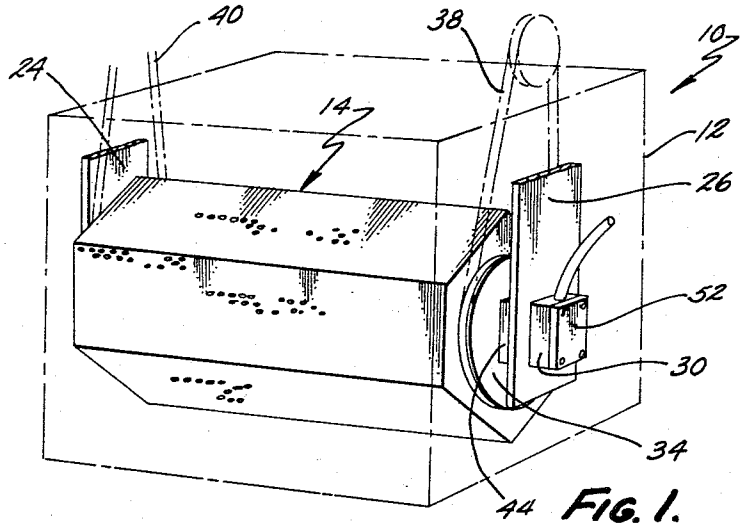


FIG. 1.

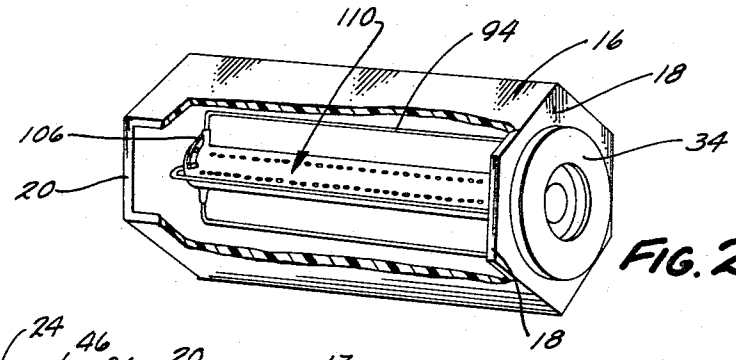


FIG. 2.

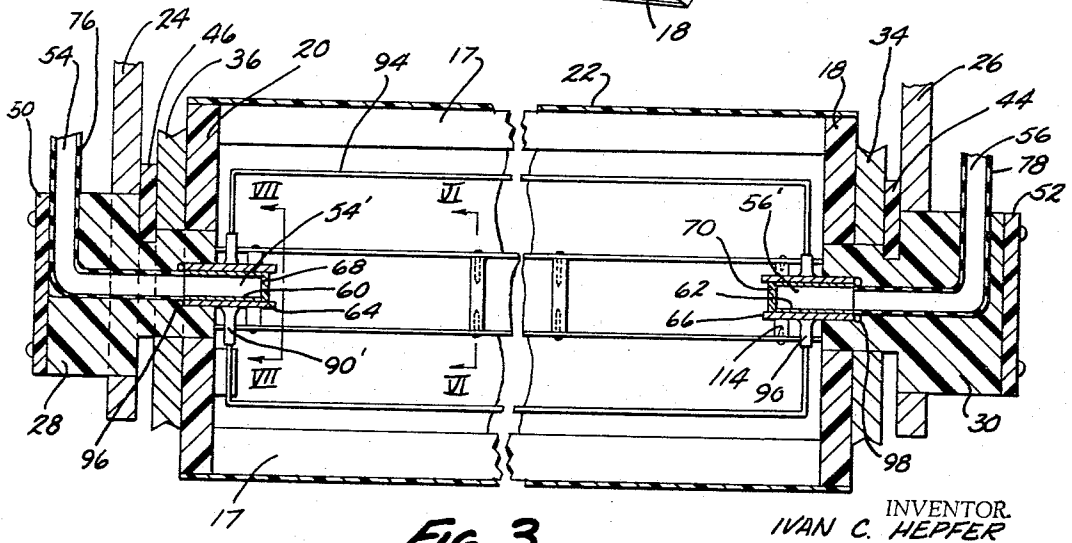


FIG. 3.

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Filed March 16, 1964 4 Sheets-Sheet 2

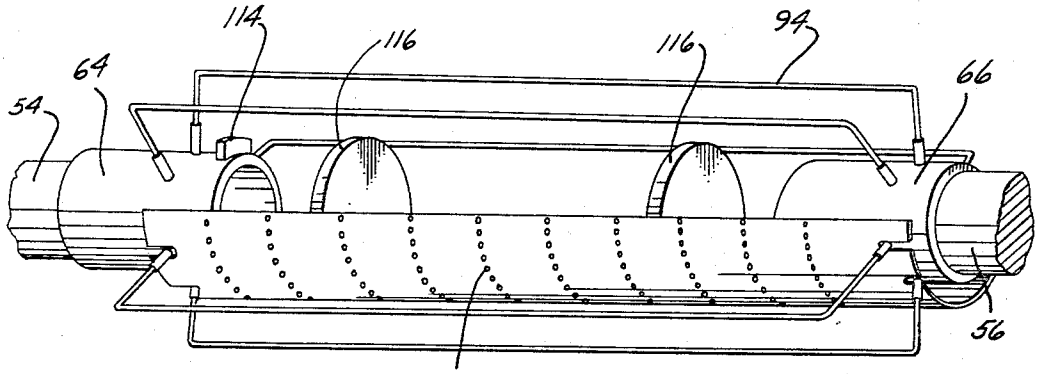


FIG. 4.

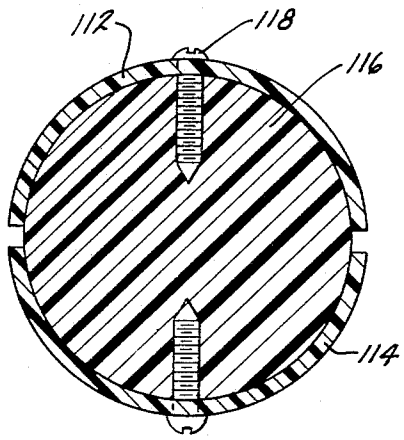


FIG. 6.

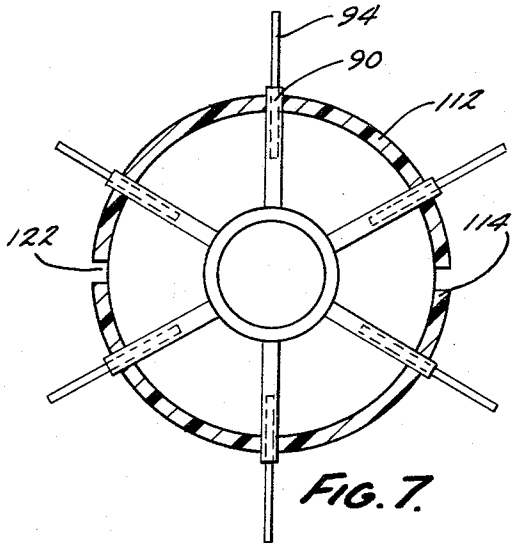


FIG. 7.

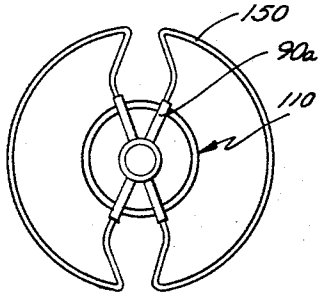


FIG. 10.

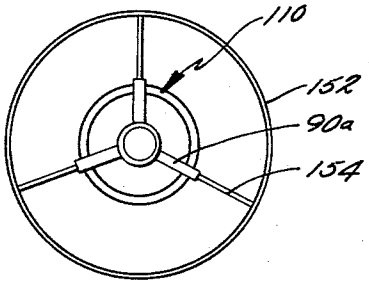


FIG. 9.

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July 11, 1967 I. C. HEPFER 3,330,753

ELECTROPLATING BARREL FOR NON-CONDUCTIVE BUOYANT AND NEAR-BUOYANT ARTICLES

Filed March 16, 1964 4 Sheets-Sheet 3

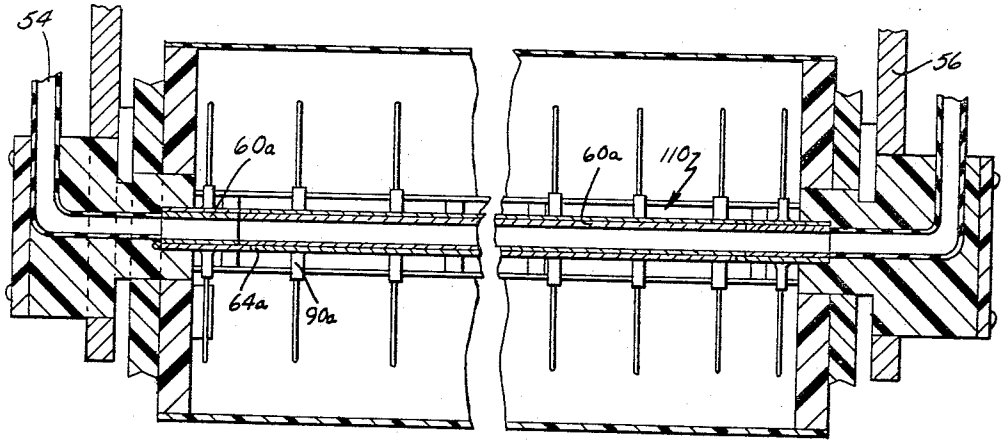


FIG. 8

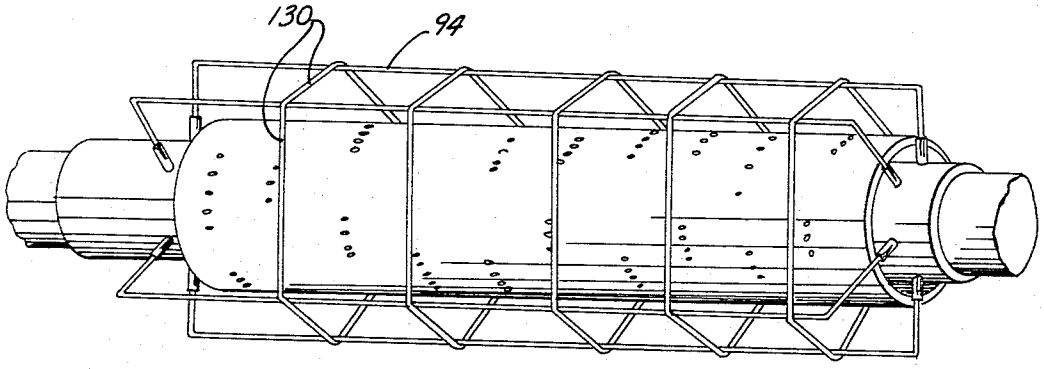


FIG. 11.

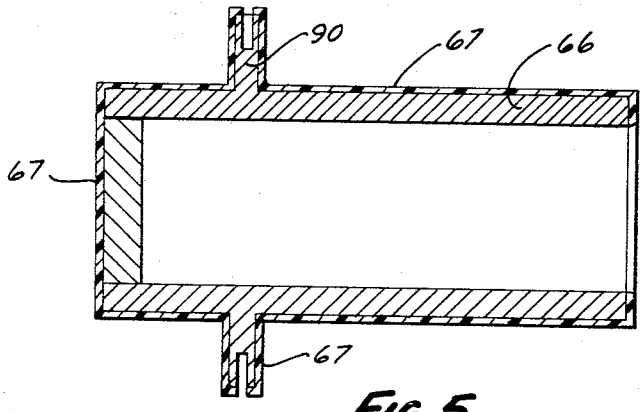


FIG. 5.

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ELECTROPLATING BARREL FOR NON-CONDUCTIVE BUOYANT AND NEAR-BUOYANT ARTICLES

Filed March 16, 1964 4 Sheets-Sheet 4

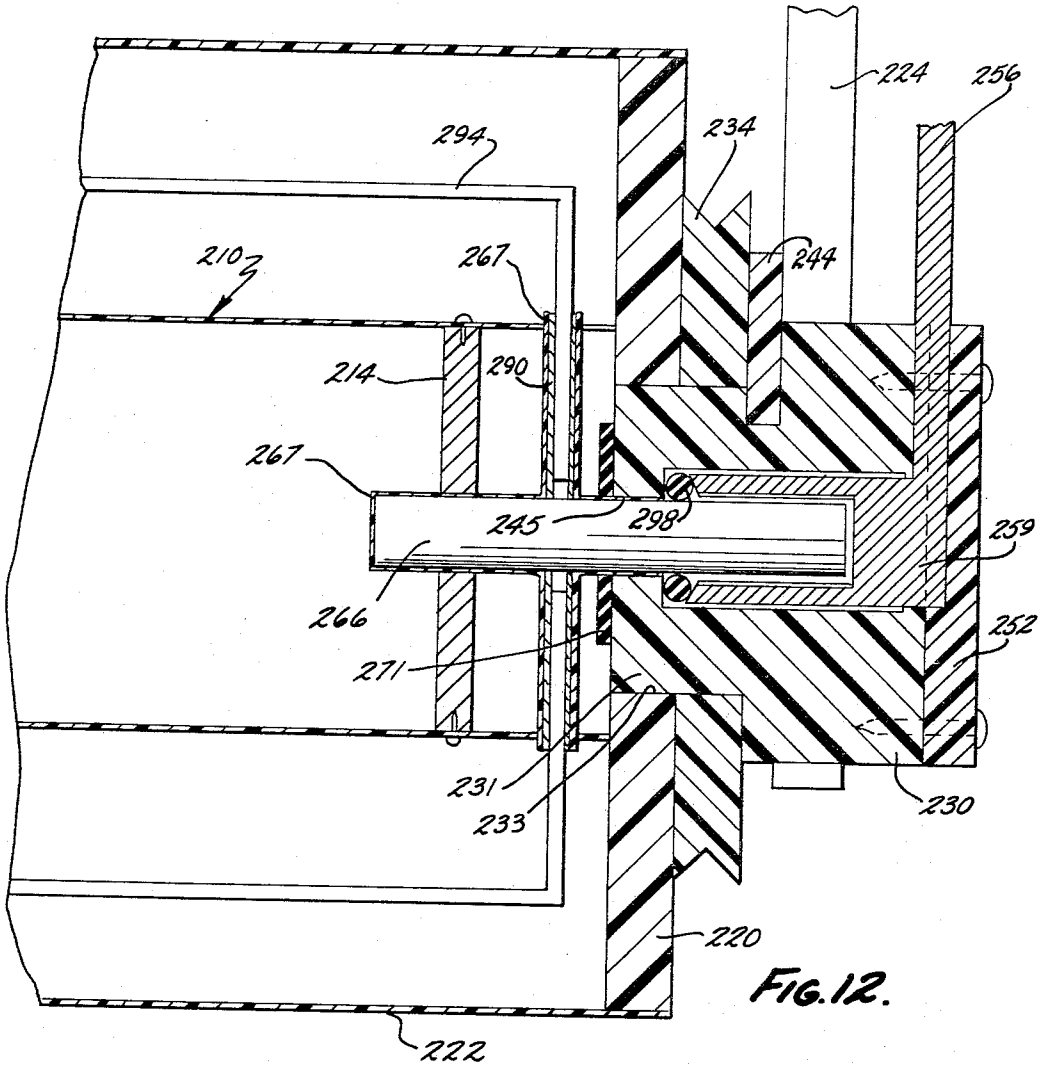


FIG. 12.

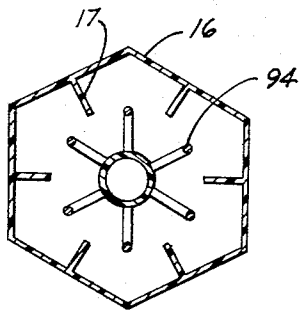


FIG. 13.

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United States Patent Office 3,330,753 Patented July 11, 1967

3,330,753

ELECTROPLATING BARREL FOR NON-CONDUCTIVE BUOYANT AND NEAR-BUOYANT ARTICLES

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Filed Mar. 16, 1964, Ser. No. 351,988
2 Claims. (Cl. 204—213)

This invention relates to electroplating, and more particularly to electroplating on non-conductive articles such as plastic, especially with a specific gravity either slightly greater than the specific gravity of the plating solution, or less than that of the plating solution.

Electroplating of small metal objects in a rotating plating barrel immersed in a plating solution is generally relatively easy to achieve. Continuous contact of the objects in the bottom of the barrel is readily made by dangling cathodic contacts or by electrode buttons on the inner barrel peripheral wall. Metallic objects are good conductors and tumble nicely in the bottom of the barrel as it rotates.

Recently, it has become desirable to electroplate metallic layers on non-conductive articles, such as those formed of plastic or resin based materials. Electroplating of small items such as knobs, screws, buttons and thousands of other like articles presents a considerable problem. The different physical and electrical characteristics cause conventional barrel plating techniques to be inadequate.

More specifically, since these non-conductive materials have a specific gravity less than or only slightly greater than the plating solution, e.g., about 0.9 to 1.8 they either float on the solution, or if they sink, remain in a semi-buoyant suspended state in the agitated solution. This creates several difficultices. Firstly, the lightweight articles fail to tumble and mix properly in the rotating barrel for uniform plating, but rather tend to remain in a suspended, freely moving state. Secondly, a small area of contact between the buoyant or near buoyant parts causes poor conductivity between the parts, even though they are provided with a thin metallized coating. Thirdly, the parts tend to float apart in their suspended or floating state, making only random contact with each other. Fourthly, the contact pressure between the lightweight suspended parts is extremely small, thereby further decreasing the electrical conductivity between them. Fifthly, the very thin initial metallic coating previously applied to the non-conductive articles is really not a good conductive surface, so that contact area and contact pressure must be very good to achieve quality plating. Sixthly, the lightweight parts do not sink against the normal barrel contacts, but remain suspended either in or above the solution. Seventhly, even when the articles do make contact with conventional barrel contacts, plate deposition is slow and accompanied by a scuffing off the plate during the relatively long process of completely covering the metallized surface with a continuous electroplated coating. In view of these factors and others, the mass plating of lightweight, plastic parts by barrel techniques is only practiced to a limited extent presently, and is plagued with production problems.

Currently, therefore, efforts are being made to barrel plate lightweight non-conductive plastic parts by filling the barrel almost full of parts, and then rotating the barrel partially out of the plating solution. The common heavy flexible danglers presently used to make cathodic contact to the work have a tendency to scuff off the thin metallized coatings on the plastic parts. Also, they do not make adequate electrical contact with a sufficient number of the plastic parts within the barrel at all times. Consequently the parts are slow in covering with the electrodeposit. The poor contact made, together with the poor surface conductivity of the metallized parts, cause electrical arcing and bipolar effects between the parts. The above factors cause a high percentage of rejected parts due to both bare spots and pitted or burned spots.

When using contacts on the barrel periphery (commonly termed contact buttons) the barrel must still be operated partially out of the plating solution. Although peripheral contacts do provide more contact area, they are deficient in that they attract the major share of the current, causing little current to be attracted to the parts because of their initial poor surface conductivity. These peripheral contacts also soon build up with "treed" electrodeposits so that little or no current gets to the work. In fact, the plate build-up is so extensive that the small holes in the barrel walls are soon plugged. Further, in operating a barrel only partially submerged in a plating solution, the volume of parts plated must be reduced to allow for a tumbling action. This reduces the production capacity of the barrel. Further, there is a slightly greater tendency to increase the scuffing action as the parts tumble outside of the plating solution.

It would be far preferable to have the barrel completely submerged in the plating solution to prevent oxidation of the parts during plating and to achieve maximum production rates, but this above process would not work in such an instance.

Additional efforts have been made to plate these troublesome articles by moving the contacts from the barrel periphery to the center axis of the barrel. When this is done, however, the electroplating process is characterized by arcing or "burning" of the electroplate, producing a pitted condition on the articles. Further, bipolar effects occur, causing stripping of plate off certain areas of the articles, and excessive build-up of plate on diametrically opposite areas.

Also, to be considered in the electroplating of these buoyant non-conductive parts is the distinct change of physical and electrical characteristics of the non-conductive buoyant articles after partial plating. The partially plated articles increase substantially in specific gravity and sink to the bottom of the plating barrel. Further, they become much more electrically conductive. Consequently, a proper barrel must be capable of accommodating these changes to complete the plating process in a quality manner.

The electroplating industry is, therefore, in great need of a production plating apparatus and method for lightweight, buoyant, or near buoyant parts which are essentially non-conductive in nature.

It is therefore, an object of this invention to provide a novel method and apparatus for electroplating non-conductive articles such as plastic materials which have a specific gravity less than or slightly greater than the plating solution.

It is another object of this invention to provide an electroplating apparatus capable of efficiently and effectively providing an electroplate layer of high quality on the metallized non-conductive buoyant or near buoyant articles without pitting, bipolar effects, scuffing off of plate, or oxidation of parts.

Still another object of this invention is to provide an apparatus for electroplating plastic parts that achieves excellent tumbling and mixing action, improved type of cathode contacts which result in improved contact with or between the parts to be plated, and increased contact pressure between the parts.

A further object of this invention is to provide an apparatus for electroplating buoyant non-conductive parts in a manner allowing the barrel to be completely immersed beneath the plating solution for maximum production rates and minimum oxidation, while still achieving uniform dependable plating of articles.

Still a further object of this invention is to achieve the above objects with an apparatus which can be formed from conventional plating barrel structures with a few significant but relatively inexpensive modifications and additions.

Further objects of this invention are to make possible efficient barrel plating: of thin metallized plastic or non-conducting materials which either float or sink in the plating solution; that does not cause damage to the thin metallized coating on the plastic parts as in conventional barrel plating where the heavy danglers often scratch off the thin metallized coating before the parts build up a substantial electrodeposit on the surface; that brings about a much faster coverage of the parts with the electrodeposit to thereby reduce rejects due to abrasion or bipolar effects, and also to thereby increase production; that enables consumable components (cathode contacts) to be readily removed and replaced when built up beyond a usable condition with electrodeposit material; that enables much larger loads to be processed compared to previous methods; that enables lower generator voltage to be used to effect complete and faster coverage as compared to conventional methods; that maintains the floating objects in intimate pressed contact with one another for optimum conductivity; that enables the barrel to be operated either totally submerged where there is less tendency of breaking electrical contact and less danger of oxidation, but also allowing partial submerged operation if desired; that achieves excellent mixing and tumbling with better coverage and plate distribution; that enables different sized and different specific gravity non-conducting parts to be readily accommodated in the same barrel in successive plating operations; that enables the non-conducting parts which change in physical and electrical characteristics to be quality plated both at the beginning and at the end of the operation; and that enables the equipment and procedure to be constructed similar to present electroplating equipment with only modest retooling expenditures and procedures.

These and several other objects of this invention will become apparent upon studying the following specification in conjunction with the drawings in which:

FIG. 1 is a perspective view of the plating barrel shown immersed in a plating solution illustrated in phantom;

FIG. 2 is a perspective view of a portion of the barrel in FIG. 1, shown with one hexagonal panel that serves as the cover removed and adjacent wall portions cut away;

FIG. 3 is an enlarged, elevational, sectional view of the barrel in FIGS. 1 and 2;

FIG. 4 is an enlarged, fragmentary, perspective view of the central portion of the barrel assembly in FIGS. 1 through 3;

FIG. 5 is an enlarged, sectional view of one end spider hub of the barrel assembly;

FIG. 6 is a sectional, enlarged view taken on plane VI—VI of FIG. 3;

FIG. 7 is a sectional, enlarged view taken on plane VII—VII of FIG. 3;

FIG. 8 is a sectional, elevational view of a second form of the invention;

FIG. 9 is a sectional, elevational view of one type of contactor structure of the apparatus in FIG. 8, taken on the plane IX—IX of FIG. 8;

FIG. 10 is a sectional view of a second type of contactor useful for the structure of FIG. 8;

FIG. 11 is a perspective, enlarged view of a central portion similar to that in FIG. 4, but slightly modified;

FIG. 12 is a fragmentary, enlarged, elevational, sectional view of a further modified end assembly; and

FIG. 13 is an end elevational view of the apparatus in FIG. 3.

Referring now specifically to the drawings, the first form of the plating assembly **10** shown includes a plating tank **12** (shown in phantom) and the barrel assembly itself **14**.

The barrel assembly includes a barrel **16** having a pair of end plates **18** and **20** and a peripheral shell **22**. It is

formed of a non-conductive material such as a high temperature acrylic, polypropylene, rigid polyethylene, etc. The peripheral wall sections of the barrel are perforated, containing a large number of openings of sufficient size for solution entry and drainage, but small enough to prevent article passage. The barrel is supported on a non-conductive holding frame, including suspension arms **24** and **26** on opposite ends of the barrel. These suspension arms have coaxial openings which receive a pair of non-conductive axles or barrel hubs **28** and **30**. These include means forming cable holders. Mounted to ends **18** and **20** of the barrel is a pair of non-conductive belt pulleys **34** and **36** operably associated with a pair of drive belts **38** and **40** (FIG. 1) to rotate the barrel. Slidably inserted between each of the pulleys and the end frame arms is a pair of non-conductive locking plates **44** and **46** of conventional construction, interfitting with slotted keyways in elements **28** and **30** to secure the assembly in its suspended condition.

Elements **28** and **30** include removable plastic end caps **50** and **52** to hold the metallic, electrically conducting pair of cables **54** and **56** into the cable holders **28** and **30**. These cables extend to an external bus bar connection (not shown) out of the tank above the barrel. The cables, usually of copper, are bent at right angles to extend into the pair of barrel hub assemblies on the rotational axis of the barrel. The inner ends **54'** and **56'** of these conducting cables have metallic, conductive sleeves **60** and **62** sweated thereon. The sleeves usually of stainless steel, form a sliding fit inside the annular axially elongated metallic spider hubs **64** and **66** of the assembly. A pair of plugs or caps **68** and **70** are fitted in the inner ends of the hubs to cover the ends of the sleeves and cables.

The copper cables **54** and **56** are coated over their length up to the hubs with rubber or equivalent electrical insulating jackets **76** and **78** to prevent plating thereon.

Projecting from each of the hubs and rigidly attached thereto as by welding is a plurality of radial spoke sleeves **90**. Each of these sleeves (FIG. 7) has a hollow outer radial end. Correspondingly aligned sleeves on opposite hubs receive the depending pair of legs of a U-shaped copper contactor rod **94**. In order to prevent the exposure of metallic conductive surfaces on the hub assemblies, the entire hub assembly including the exposed surfaces of the hubs **64** and **66**, the end plugs **68** and **70**, the radial finger holders **90** and **90'**, are all coated with a thin layer of electrically insulating jacket **67** (FIG. 5) such as an unplasticized vinyl chloride resin.

Also, to prevent plating build up on the ends of the conducting sleeves (**60** and **62**) and the spider hubs (**64** and **66**), a pair of annular resilient seals **96** and **98** are inserted into holders **28** and **30** immediately behind hubs **64** and **66**.

The U-shaped contactor rods are slidably inserted into the finger holders **90** and frictionally retained. The main rotational drive for the inner assembly with the barrel is achieved by one or more "dogs" **106** (FIG. 2) attached to the end plates of the drum between plastic holding elements **90** and **90'**. Thus, when pulleys **34** and **36** rotate the drum these dogs cause the entire hub assembly to rotate. Preferably only one dog held with one screw is used, so that, in case of a "jam," the screw will shear and act as a safety shear pin. This prevents damage to the cathode assembly in case of a bind. In some instances, it may be desirable to allow the hub mechanism to be "free wheeling" or alternatively rotationally fixed. In this instance these dogs are not employed.

The hubs are electrically connceted to the D.C. power source by the rotating spindle assembly to the cables. The cable conductors are connected to the source, and more specifically to the cathode terminal of the D.C. generator or rectifier with a variable voltage of about 6–15 volts. The contractor bars or rods are, therefore, cathodes in the plating solution. The electrical current flows from the anodes in the plating tank (not shown) outside

of the barrel through the plating solution to the articles to be plated and then from them to the bars. The electrical insulation material around the hub assemblies prevents plate build up or chemical attack of these parts.

The contact rods can be constructed of stainless steel in many plating applications, with the rod being about ¼ inch in diameter. When deposits build up on the rods they can be stripped in nitric acid for example. In the case of copper plating, however, it is advantageous to make the rods out of copper. Then when the rods build up with copper plating, they are removed and used as anodes in the plating bath.

The cathode contactor rods are placed somewhat near the outside wall of the barrel rather than the center. This shortens the distance that the electrical current has to travel from article to article to reach the cathode contactor rod. Thus, the electrical resistance is lowered and less voltage need be used. Less arcing and a faster covering of the parts with the electrodeposit will occur. If the contacting rods are placed too near the outside periphery of the barrel, it has been found that much of the current will be attracted to the rods and very little to the parts. On the other hand, if the contactors are placed too far towards the center of the barrel, the resistance of the electrical path increases and requires a higher plating voltage initially. This results in increased arcing and slower coverage, and also results in pronounced bipolar effects. Arcing will also cause burning which creates a pitted condition in the plate.

This invention has means for adjusting the radial length of the cathode rods to optimum conditions, by removing one U-shaped set of rods and inserting another. Consequently, the particular distance of the rods from the center of the assembly and from the periphery can be exactly adjusted to suit the particular buoyancy or specific gravity of the parts, the particular configuration and size of the parts, the loading of the barrel, the degree of immersion of the barrel in the plating solution, and any other variable factors which are normally encountered.

The number of contact rods employed can vary. The criterion is the circumferential area to be accommodated, or, i.e., the arcuate distances between the contact bars. For example, on a 10-inch barrel, the number of contacts is usually chosen to be equal to the number of sides of the barrel. Normally, a hexagonal shaped barrel is preferable for optimum tumbling conditions. Consequently, six rods are preferred. In a 14-inch barrel on the other hand, it is advisable to use peripheral supplemental contacts as in FIG. 11, or alternatively to use more contact bars. In a 16-inch barrel, it is advisable to use 12 contacts. The barrel can be made of other different configurations and can accommodate different numbers of the elongated, axially extending, generally parallel rods.

Another important feature of this invention, in addition to this contactor rod assembly intermediate the center and periphery of the barrel, is the central cylindrical tube assembly **110** which controls the location of the plastic parts between the barrel axis and its periphery.

The central positioner tube assembly **110** is formed of a pair of hollow, semi-cylindrical elements **112** and **114** (FIG. 7) of plastic, non-conducting and non-reactive materials such as a rigid vinyl polymer, or a polypropylene. These have their ends overlapping the two hubs **64** and **66**, and secured thereto on a plurality of bosses **114** (FIGS. 3 and 4) by screws. The sleeves are also secured together in their central portions by a plurality of intermediate plastic discs **116**, using screws **118** (FIGS. 4 and 6). The hollow interior of this tube includes drains to the outside, such drains being formed by a great number of peripheral openings **120** in the tube, and by slight spacing **122** between the two sections **112** and **114**. Consequently, the plating solution is free to move into and out of this tube assembly as necessary, while the articles to be plated cannot pass.

This coaxial elongated spacer in the center of the barrel keeps the plastic articles being plated pressed together toward the periphery so that much better electrical contact is maintained between the parts. The tube can vary in diameter according to the size of the plating barrel, it having been found that a 3-inch diameter tube performs excellent results in a 10-inch diameter plating barrel, as does a 6-inch diameter tube for a 16-inch barrel. The exact size has been found to be dependent upon article size, configuration, and density, as well as the type of plating, barrel configuration, barrel load, and others. For small loads of articles, it has been found that a large plastic cylinder should be used. The plastic tube maintains the parts out of the center of the barrel and forces them to the outside periphery where they are kept in contact with the novel cathode rods.

Still another function of the plastic cylinder is to distribute the load of parts more uniformly throughout the length of the plating barrel for a more uniform plate coverage. In other words, it prevents bunching and/or free floating. Its main function, however is to locate the plastic parts in the vicinity of the contactor rods, which in turn are located between the center of the periphery of the barrel.

The combination of these components has been found to be extremely effective for rapid, efficient, high quality plating of buoyant or near buoyant non-conductive parts. The particular configuration of this tube need not be cylindrical since other shapes such as triangular, square, hexagonal and so forth may be employed. A cylindrical spacer has been found to be the most economical and performs in excellent fashion.

In some instances, it may be desirable to transfer articles to a second barrel of similar construction after the parts have been completely covered with sufficient plate to give good electrical conductivity in the first barrel. The second barrel, for example, will have the contactor rods placed closer to or adjacent the plastic cylinder. In the second barrel, the rods build up with plate at a slower rate because they are more deeply covered with the mass of rolling parts, with more plate, therefore, being applied to the parts.

Extensive experimentation has shown the advisability of utilizing radial baffle plates or paddles when the cathodic contactor rods are placed close to the central spacer. This is especially helpful in larger diameter plating barrels. For example in a 16-inch diameter barrel, paddles **17** (FIGS. 3 and 13) extending the length of barrel and projecting radially inwardly to a width of 1 inch to 2½ inches exert a definite beneficial influence on the plating action. These baffles are of plastic material integral with or secured to the inner periphery of the barrel. Optimum location for the baffle is intermediate the edges of each flat peripheral polygonal segment, with the radially outwardly extending contactor rods being staggered therewith to project toward the apices of the polygonal sides (FIG. 13). These paddles cause generally sinuous movement of the objects, and further tend to hold the objects beneath the plating solution if the barrel is only partially submerged. They provide better agitation and mixing of both the parts and the solution during the plating operation. This results in more uniform plate distribution from part to part in the load, and faster plating rate due to the fact that the increased agitation allows the use of higher current densities without burning (formation of rough or treed deposits at high current density). The so-called paddles are especially advantageous when plating with large diameter barrels with the cathode contacts close to the plastic center to reduce the rate of build-up of the contacts.

It should be noted that the invention will work without these paddles. It has certain definite advantages under certain conditions. When the cathode contacts are placed closer to the periphery of the barrel, they provide agitation to both the solution and the parts. As explained before, as soon as parts have been electroplated with suffi-

cient copper or other electroplate in order to give them good conductivity, it is advisable to transfer them to a plating barrel with the contacts close to the plastic center in order to prevent the rapid build-up of the cathode contacts.

Operation

To prepare the plastic parts for plating, they must first be coated with a thin electrically conductive coating. This can be done by coating with a metal using one of several methods, including vacuum metallizing, cathode-sputtering, silvering reduction methods, metal spraying, metal cladding, or chemical reduction methods known as as electroless plating. The articles are of course deglazed by blasting, tumbling, or chemical etching. The article surfaces are cleaned. They are sensitized chemically as with stannous chloride, and then activated by a chemical reagent such as palladium chloride. A metal, such as copper or nickel, is then applied by a chemical reduction method. The coating is generally in the range of 0.00001 to .00005 inch thick before the electroplating occurs.

The coated parts are then placed in the novel barrel by removing one of the hexagonal sides, for example, which is secured in place by any suitable clamping means such as those conventionally used to hold this side to the periphery of the barrel. Since this forms no part of the invention, is conventional and well known, it is not specifically shown. The barrel is immersed in the plating solution. It is rotated at a rate of rotation of from 1 to 10 revolutions per minute, depending upon the type of plating, size of parts and so forth. Electrical current is applied through cables **54** and **56** to sleeves **60** and **62** hubs **64** and **66**. It therefore, is conducted out radial tube holders **90** to contactor rods **94**.

At first the parts will usually float to the top of the barrel, if they have a specific gravity less than the specific gravity of the plating solution. The contactor cathode rods, therefore, make contact mostly in the upper part of the submerged barrel. As the plate builds up to increase the specific gravity to an amount where the parts tend to sink, the contactors make optimum contact mostly in the bottom portions of the barrel. The barrel is normally filled about ⅔ full with the parts, but it cannot be loaded so completely that the parts cannot tumble. The rotation of the contactor rods with the barrel causes the parts to tumble even though they are lightweight and tend to float apart from each other and to remain in the top of the barrel. It will be understood that the main plating problem occurs initially when the parts are of substantially lighter specific gravity. These parts tumble over and around the elongated contactor rods and remain in intimate contact with one another as forced radially out to the vicinity of the rods by the central spacer tube. It has been found with extensive experimentation and use of the invention that the adjustable contactor rods and the center plastic spacing tube enable plastic parts to be plated with an excellent quality uniform plate with surprisingly few rejects.

Since the rods used as the contactor material are quite flexible and bendable, it has been found advisable in many instances to tie these together in some manner to prevent them from being deformed excessively during operation. Also, it has been found that if the means for tying these together is electrically conductive, the plating can often be improved further. Therefore, referring to FIG. 11, the elongated contactor rods **94** are tied together by wrapping around them a plurality of adjacent, binding, metallic holding elements **130**. These may be formed simply of a wire wrapped around the periphery at spaced axial locations. Alternatively, the elements may be of a heavier construction. The quality of products achieved with this apparatus in FIG. 11 is very similar to that of the apparatus in the first figures, but the contactor bars are more sturdy. Also, contact area and action are increased by the peripherally wrapped wires.

Modification

It has been found that some types of articles can be successfully plated utilizing the less preferred modified structure shown in FIGS. 8, 9 and 10. In this structure, the same central tube assembly **110** is employed in barrel assembly **14**, and the same end structures are employed, except that electrical conduction means extends clear through the barrel on its axis. The two separate cables **54** and **56** are sweated into the two ends of a continuous sleeve **60***a*. The surrounding hub support **64***a* also extends the length of the barrel over the sleeve. It includes a plurality of radially extending supports **90***a* over its length. Various type legs can be used with this type of hub. Specifically, instead of the U-shaped, axially elongated contact bars, a plurality of radially and peripheral extending contact elements, each in one transverse plane, are employed, such as those illustrated in FIGS. 9 and 10. These are mounted in the plurality of support sleeves **90***a*. The contactor elements include peripherally extending segments **150** generally arcuate in configuration (FIG. 10) and have radial leg segments which fit in sleeves **90***a*. The elements cooperatively form a circular portion in one plane normal to the axis of rotation. Alternatively, each singular element can form a continuous circular portion **152** (FIG. 9). Attached radial legs **154** inserted in sleeves **90***a* form electrical contact and physical mounting. These elements therefore, have a peripheral electrical contact area intermediate the central tube assembly **110**, and the periphery of the barrel. This combination does not achieve optimum tumbling action as the previous forms of the invention do in FIGS. 1 through 6 and 11. Consequently, for some types of articles, this form is satisfactory, but the first forms of the invention are greatly preferred. In a few instances, it is even possible to employ simple radial spokes without the peripheral segments, i.e., spokes **154** without ring **152**. However, the electrical contact as well as the physical tumbling characteristics are inferior. Consequently, this is employable in only select circumstances.

Modified hub assembly

In FIG. 12 is disclosed an improved end hub assembly. This was devised to lengthen the life of the rotating barrel assembly by overcoming the potential "galling" problem of the hub on the sleeve over the cable in the previous forms of the invention. The general peripheral barrel structure is similar, including a perforated shell **222** and a pair of end plates **220**. It is supported on a holding frame with suspension arms **224**, and driven by pulleys **234**.

The cable holder **230** is on the barrel axis, having a circular inner end **231** in opening **233** of the end plate **220**. Locking plates **244** are inserted between arm **224** and pulley **234** to secure the assembly.

The hub **266** is not basically a sleeve, however, but rather a solid metal rod having its inner end inside the plastic barrel and its outer end protruding into an annular, coaxial passage **245** in cable holder **230**. This passage has a narrow diameter neck slightly larger than the rod, and a larger diameter interior extending axially to plastic cap **252**. The power inlet cable **256** extends into the cable holder behind the cap and is integral with a cylindrical metal bearing cap **259** having an annular sleeve portion extending axially toward the barrel and around the outer end of the rod to make electrical contact therewith.

Plastic cap **252**, when attached, compresses conductive bearing cap **259** to cause its inner annular end to compress O-ring **298** against the shoulder of the constricted portion of passage **245**. This, preferably coupled with a rubber gasket **271** around rod **266** and against the inner axial face of cable holder **230**, effectively seals off the sliding bearing surfaces from the barrel interior. Preferably a silicone grease is packed between rod **266** and bearing cap **259**. Electrical conduction is therefore made from cable **256** to bearing cap **259**, to rod **266**, to radial sleeve

290, to cathode rods 294 for plating. The end discs 214 for spacer tube means 210 fit around hub rod 266. The inner ends of hub rods 266 as well as sleeves 290 are coated with an insulating jacket 267.

In these last forms of the invention, the elements may be positively driven to rotate with the barrel, or may be free to rotate, or remain stationary, while the barrel rotates.

It is conceivable that those skilled in this field will see other advantages than those specifically recited herein. Also, various minor structural modifications could conceivably be made in the particular preferred form of the invention and in the less preferred forms of the invention to suit a particular type of barrel, type of plating, size or configuration of articles, size of batch to be plated, buoyancy of articles or other such factors, yet without departing from the inventive concept taught. Therefore, this invention is not to be limited to the specific preferred forms of the invention illustrated, but only by the scope of the claims attached hereto.

I claim:

1. An electroplating barrel assembly for non-conductive lightweight buoyant and near buoyant articles, comprising: a non-conductive barrel having a perforated shell and a pair of end walls; a pair of hubs in said end walls for rotatably mounting said barrel on a central axis, including means for receiving electrical conductor means therein to make contact therefrom; a plurality of metallic contactor elements along the length of said barrel, electrically operably associated with said hubs, having the major active contact surface portions spaced radially intermediate said shell and said axis to create article tumbling electrical contact means; and an elongated, central, hollow, perforated, non-conductive spacer means between said ends, along said axis, spaced radially inwardly of said major active surface portions of said elements, and defining an open space therein, preventing articles from moving to the radial center of the shell.

2. An electroplating barrel assembly for non-conductive lightweight buoyant and near buoyant articles, comprising: a non-conductive barrel having a perforated shell and a pair of end walls; a pair of non-conductive supports in said end walls for rotatably mounting said barrel on a central axis and including means for receiving electrical conductor means therein to make contact therefrom; metallic spider hub means around said conductor means and including radial support fingers; a plurality of metallic contactor elements along the length of said barrel, supported by said fingers, and electrically associated with said spider hub means, and having the major active contact surface portions spaced radially intermediate said shell and said axis to create article tumbling and electrical contact means; said spider hub means and conductor means being protected from chemical attack and electrical exposure; said contactor means comprising a plurality of circumferentially spaced metal rods extending axially of said barrel; said rods being generally U-shaped and having parallel opposite legs extending radially and being removably attached to sleeves on said hubs; an elongated non-conductive spacer means between said end walls along said axis, spaced radially inwardly of said major active contact surface portions of said elements, preventing articles from moving to the radial center of the shell; said spacer means comprising a hollow perforated tube defining an open space therein.

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