Aug. 13, 1968 F. M. GILBERT 3,397,126

PLATING OF SMALL PARTS

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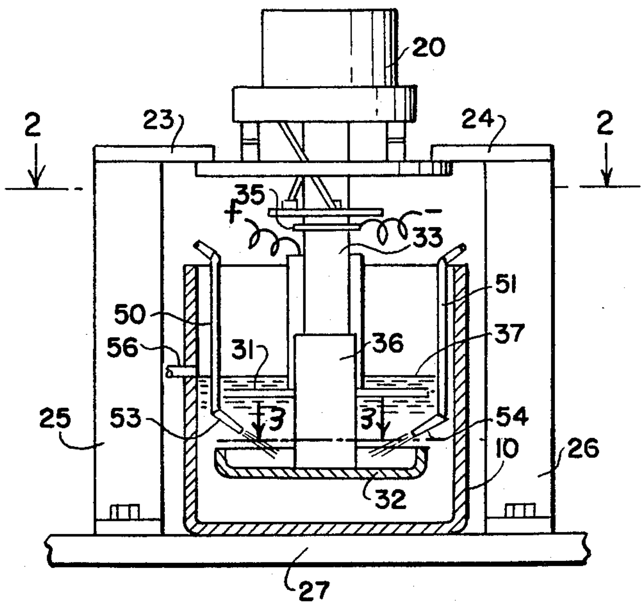
FIG. 1



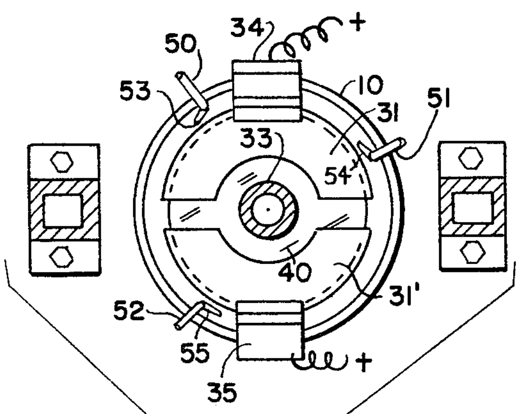


FIG. 2

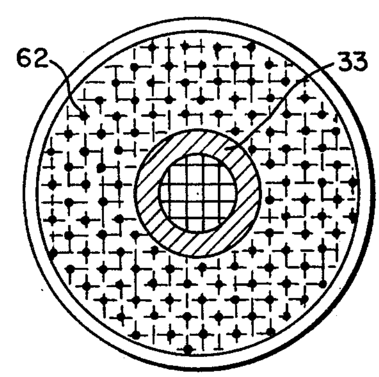


FIG. 3

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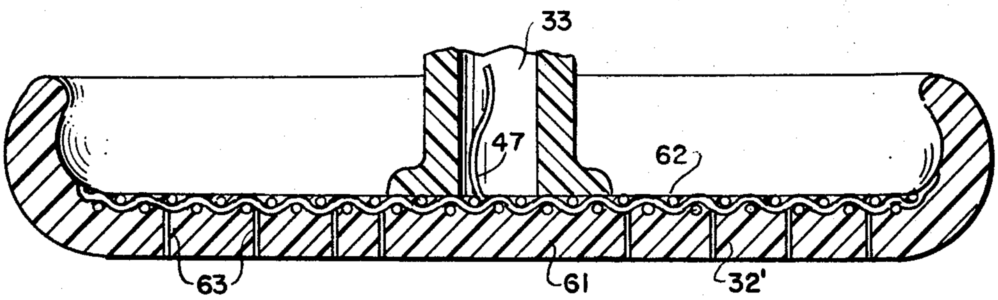
FIG. 4



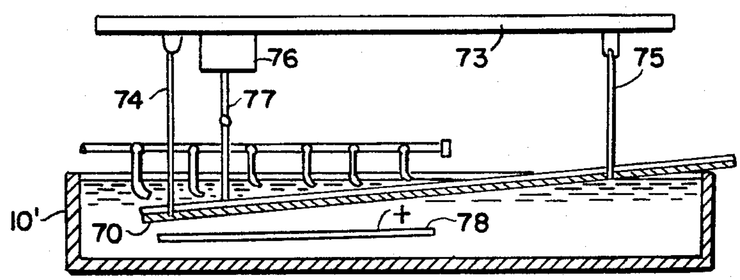


FIG. 5

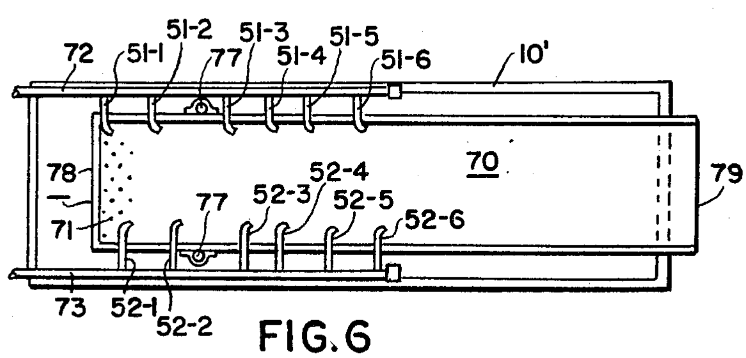


FIG. 6

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PLATING OF SMALL PARTS

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6 Claims. (Cl. 204—23)

This application relates to a process and apparatus for electroplating parts, especially small parts which may be readily distorted or injured by bending.

Normally, the best method for electroplating of small parts is by barrel plating. In such processes the parts are fed to a rotatable barrel or similar container which can be dipped into an electroplating bath which includes an anode, a cathode connection is provided to the interior of the barrel, and the barrel is rotated to continuously move the parts and agitate the solution during the electroplating operation. The barrel plating eliminates the necessity of establishing a separate cathode connection for each part, continuously moves the parts to provide agitation and renewal of the cathode film, etc. Where such parts contain readily bendable strip or wire projections and/or frangible glass or ceramic insulating portions, barrel plating is not feasible because the thin wire and strip portions are bent or curled and the glass or ceramic parts get cracked or broken during rotation of the barrel. Also where such parts are to be plated in one or more smaller localized areas, constant contact with the electrode areas of the barrel cannot be maintained so that all areas are not plated to an equal thickness. Since there is a trend toward miniaturization, this has become a real problem and in some cases it has been necessary to individually rack such small parts on a conveyor means and plate by that process. In the plating by racking, a higher speed of plating can be obtained than by the barrel process but the handling problem is great.

Among the objects of the present invention is to provide a process and apparatus for plating parts without injuring them and without requiring the racking and cathodically connecting of each part individually.

Among other objects of the invention is to provide a process and apparatus for rapidly and uniformly plating miniaturized parts to any predetermined thickness of plating without individually racking each part.

Recently it has been proposed to plate small parts by distributing said parts on a substantially horizontal plate-like holder held in an electrolytic bath, providing electrode means for contacting the parts, and continuously vibrating the holder to continuously change the position of the parts with respect to the holder and with respect to each other while electrolytically treating the same. While this process operates satisfactorily with some small parts, it has been found on the other hand that there is often a tendency for certain parts to be plated to pile up on each other as a result of their failure to be moved with respect to the holder by the vibrations of the latter.

It has been further found that some parts to be plated, while being moved progressively along a vibrator conveyer when surrounded by air or gas vapors are too small to be moved by the same vibrator-conveyer when surrounded by liquids. Some such parts even tend to float away from the electrode contacts embedded in the holder of the vibrator-conveyer. My observations in connection with this phenomenon indicate that there is a thin disturbed layer of liquid created adjacent the interfacial surface of the liquid and the holder. This disturbed layer of liquid prevents certain small parts from contacting the surface of the holder and from being progressively and uniformly moved by the conveyer.

According to the present invention the parts are distributed on a substantially horizontal vibratable holder

containing a multiplicity of small exposed electrode contacts and disposed in an electrolytic bath. The holder is continuously vibrated at a relatively slow speed in one direction to tend to carry the parts therewith and at a relatively fast speed in the opposite direction so as to move the holder relatively to the parts by reason of the inertia of the parts, the movement of the parts with respect to the vibrator holder is promoted by directing fluid in the forward and downward direction with respect to the desired movement of the parts, and the parts are electrolytically treated as they move along their predetermined path on said vibrator holder.

The holder may be dish shaped in which case the vibration will be torsional or it may be rectangular in which case the vibration will be a back and forth or rocking one.

When it is stated that the vibratable holder is substantially horizontal, this does not exclude the possibility that the holder be purposely tilted by an amount insufficient to prevent the parts from moving to all parts of the surface of the holder. In some cases a slight tilt from the true horizontal may be desirable to feed the parts into or out of the bath or to prevent parts from accumulating at the rim of a dish-type holder.

The device of the invention may be employed with any type of electrolytic solution. Since it is in connection with the electroplating of such small parts with precious metals that the problem most often occurs, the invention will be described in detail with respect to electroplating processes in which the work parts are made cathodic. However, it will readily be recognized that the process and apparatus are advantageous for electropolishing, and similar processes in which the work is connected to the anode, except where non-conducting anodic films are formed which will stop current flow to the parts.

In many cases the entire plate-like holder may have sufficient conductivity and be cathodically connected to a source of electroplating current. In such a holder, portions of the surface area may be coated, by a layer of oxide of the metal of the holder, by an insulating enamel paint, lacquer, etc., or by insulating tape, etc., to prevent deposition of the plating metal on such parts. Numerous but relatively small cathode contact areas are required to provide connection to the parts being plated. In other cases the plate-like holder may be made of insulating material and with a metal mesh or a multiplicity of other contact buttons, strips, etc., set into the surface of the insulator to convey current to the parts.

Other objects and advantages of the invention will be apparent from the following detailed description of several forms of the invention when read in connection with the accompanying drawings, in which:

FIG. 1 is a side view partly in cross section of one device for carrying out the invention.

FIG. 2 is a cross sectional view taken on line **2—2** of FIG. 1.

FIG. 3 is a cross sectional view taken on line **3—3** of FIG. 1.

FIG. 4 is a detail cross sectional view of the holding device of FIGS. 1–3.

FIG. 5 is a side cross sectional view of a modified form of apparatus for carrying out the invention.

FIG. 6 is a top plan view of the device of FIG. 5.

In the form of the apparatus shown in FIGS. 1–2 the tank **10** rests on base **27** and the work holding pan **32** is held and vibrated by vibrator **20** through shaft **33**. As shown in FIG. 2, the anodes **31, 31'** are supported from brackets **34, 35** attached to the sides of tank **10**. The entire shaft **33** and pan **32** may be made of conductive metal with the cathode connection **35** at the upper portion thereof. The lower portion of the shaft **33** may be covered with tape **36** to prevent deposition thereon. The tank **10** is filled to a level above the anodes **31** as shown at **37** of FIG. 1.

Any form of vibrator **20** may be employed with the apparatus. The vibrators shown are those familiarily used in conveyor devices which are available commercially.

Suitably positioned along the sides of the tank **10** so as to be out of contact with the electrodes **31, 31'** are the pipes **50, 51, 52** which extend into the tank to a region between the electrodes **31, 31'** and the holder **32.** Pipes **50, 51, 52** end in spargers or nozzles **53, 54, 55,** respectively which are positioned to direct a fluid spray downward and in the direction of movement of the parts (which is counter clockwise as shown in FIG. 2). Nozzles **53, 54** and **55** are preferably adjustable to direct the fluid thereof at various angles with respect to the holder **32.** Obviously the pressure of fluid in the spargers may also be varied. Tank **10** is provided with an overflow pipe **56** to maintain the level **37** of the bath substantially constant. The vessel to which pipe **56** leads may be connected to the pump supplying pipes **50, 51** and **52** so as to provide for circulation of the electroplating liquid.

Where the parts to be plated are small and/or contain a substantial proportion of non-conductive areas which are not to be plated it is not safe to rely on indirect contact of the parts with the electrode and consequently a multiplicity of direct electrode contacts must be supplied in the holder itself. FIGS. 3 and 4 illustrate a device having a multiplicity of contacts. These contacts are provided by embedding a conductive wire mesh **62** into a molded resinous bottom **61** of the vibratable holder **32'.** After the wire mesh **62** is molded into bottom **61** to a very shallow depth, the interior surface is ground off to expose the upper surface of the hills of the wire mesh, or about one half of the total cross points of the wire mesh. Contact of the wire mesh to make it anodic or cathodic is made by wire **47** in the center of shaft **33.** In this way by choosing a coarser or finer screen, almost any number of equally-spaced contacts may be provided.

It is sometimes desirable to feed a large number of parts to be plated to the holder **32'** and such parts may be at least two deep in some parts of the holder. When this happens some parts may be more heavily plated than other parts even though exposed for the same length of time because they are nearer to the anodes **31, 31',** for example. This tendency can be overcome by placing additional anodes below the holder **32** and perforating the holder as shown at **63, 63.** The perforations **63** must obviously be smaller than the parts to be plated.

To operate the device of FIGS. 1–4, the tank **10** is filled to level **37** with electroplating solution, pipes **50, 51** and **52** are connected to a source of fluid under pressure, preferably the same electrolyte as in tank **10.** The holder **32** is connected to a cathodic source of current and plates **31, 31'** are connected to provide the anode. Vibrator **20** is put in operation and the parts to be plated are supplied to the holder **32.** After a certain predetermined time, the parts are removed and will be found to be uniformly plated over the conducting areas thereof. After plating, the holder and its vibrator can be transferred to other tanks **10** containing rinsing, polishing, and additional plating solution, etc. It has been found possible to provide small parts with a uniform alloy coating for example, by plating a predetermined thickness of a first metal, then plating a predetermined thickness of a second metal thereon, and heat treating the parts to cause the two layers to alloy. This requires high plating precision for obtaining the desired ratio of the two metals on all the parts in order for the same alloy to be obtained on all of the parts.

Since the process and apparatus plates the small parts without rolling the parts upon each other or without pressing them against a highly curved surface, the parts are plated without injury while at the same time, the advantages of barrel plating processes such as uniform plating of all surfaces, replenishment of the cathode film to permit high current densities, ready connection to a cathodic (or anodic) current, etc. are obtained.

The parts need not travel in a closed circuit as shown in FIGS. 1–4 but may also be fed onto a straight through pan means as illustrated in FIGS. 5 and 6. Thus, parts may be fed to the lower end of vibrator pan **70** which is partially submerged in the rectangular tank **10'.** Pan **70** is also provided with a plurality of exposed electrode contacts **71** which may be exposed portions of an embedded wire mesh similar to that shown in FIG. 4. Sparger supply pipes **72** and **73** are provided along the sides of pan **71** and the spargers **51–1** to **51–6** and **52–1** to **52–6** are provided along the sides of the pan **70.**

The pan **70** is vibratably supported from the fixed beam **73** by the links **74** and **75** and an eccentric or other vibrator means **76** vibrates the pan **70** through a yoke device **77.** An electrode **78** (anode in FIG. 5), is provided below the pan **70.** In the device shown, the parts to be plated are fed in at the lower end of pan **70** and out at the upper end **79.** However, the parts could be fed in the opposite direction and if desired the pan **70** can be substantially parallel to the bottom of tank **10'.** It can be seen that a vertical series of such tanks can be provided to continuously feed the parts through an entire sequence of operations.

An advantage of this method of plating is the fact that the constant vibration of the part prevents the adherence of gas (some hydrogen is normally released at the cathode when plating work pieces) to the parts. In barrel plating this adds to the resistance of the system and contributes to the need to use relatively low plating current densities that is lower than the current densities available for still plating. Using vibratory means this does not occur and the current densities possible are of the order normally used in still plating solutions. The plating time is therefore shortened. Furthermore, the electrodeposit is denser and of higher quality.

It has been found quite possible to plate small, fragile parts with an acid 24 karat gold at 5–10 a.s.f. Still tank plating with this bath is generally done at 5–15 a.s.f.

Parts have been plated satisfactorily with chromium and nickel at current densities about the same as normally used in still plating.

For electropolishing and similar operations wherein the anode may be dissolved anodically, carbon or similarly inert anode strips, rods, buttons, etc., are preferred.

The features and principles underlying the invention described above in connection with specific exemplifications will suggest to those skilled in the art many other modifications thereof. It is accordingly desired that the appended claims shall not be limited to any specific feature or details thereof.

I claim:

1. In the process for the electrolytic treatment of parts particularly those having portions which are easily distorted or cracked, the improvement comprising:

depositing a plurality of such parts on a horizontal surface containing a multiplicity of conducting portions exposed on said surface,

connecting the conducting portions of said horizontal surface to one of the cathode and anode of a source of direct current,

continuously vibrating said surface to provide a driving force tending to move the parts over said surface,

providing an electrolytic bath surrounding said surface and the parts thereon, establishing the other of said cathode and anode connections in said bath, and

additionally supplying a fluid impelling force to drive said parts over said surface in the desired direction.

2. The process as claimed in claim **1** wherein said surface is vibrated so as to move said parts in a closed path.

3. The process as claimed in claim **1** wherein said surface is vibrated along one dimension so as to move said parts from one end to the other thereof.

4. An apparatus for electroplating small parts comprising:

a pan means for holding a multiplicity of small parts,
means for supporting said pan means so that it can be vibrated in a substantially horizontal position,
vibrator means connected to said means for supporting the pan means adapted to vibrate said pan means so as to move the contents in a predetermined path along the surface thereof,
an electrode connection extending to a multiplicity of spaced portions of the upper surface of said pan means whereby to make contact with parts placed in said pan means,
means adapted to form a container for electrolyte surrounding said pan means,
a second electrode means positioned to contact the electrolyte of said container means, and
means to supply fluid downward and forward with respect to the direction of motion of said contents of said pan means to overcome the resistance toward motion of the parts supplied by said electrolyte.

5. An apparatus as claimed in claim 4 wherein said pan means is circular and wherein said vibrator means supplies a torsional vibrating force.

6. An apparatus as claimed in claim 4 wherein said pan means is rectangular and said vibrator means rocks said pan means back and forth parallel to one dimension thereof.

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