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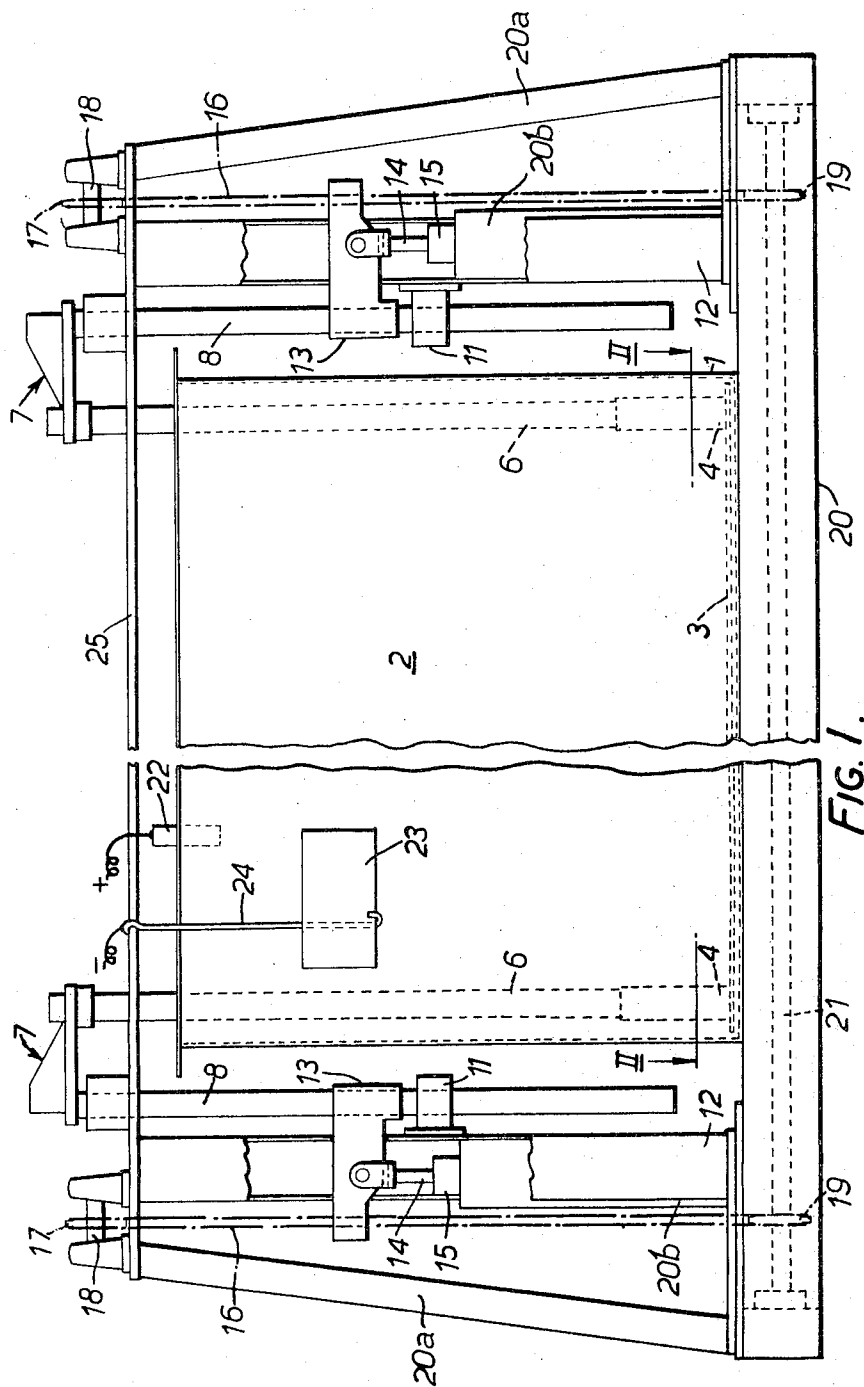
E. C. KEDWARD ET AL

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ELECTRODEPOSITION OF COMPOSITE COATINGS

Filed July 20, 1972

3 Sheets-Sheet 1



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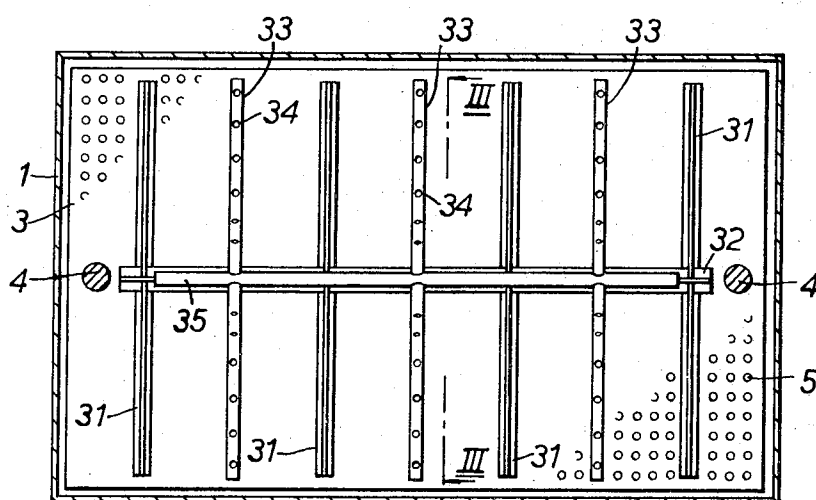


FIG. 3.

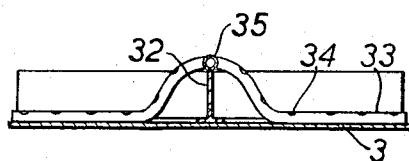


FIG. 4.

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ELECTRODEPOSITION OF COMPOSITE COATINGS

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Continuation-in-part of abandoned application Ser. No. 218,883, Jan. 19, 1972. This application July 20, 1972, Ser. No. 273,644

Int. Cl. C23b 5/00, 5/68

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5 Claims

ABSTRACT OF THE DISCLOSURE

A method and apparatus for the electrodeposition of composite coatings which comprise a metal matrix with ceramic cermet or laminar particle additions in which a horizontal agitator is reciprocated vertically in a region of the plating bath below that used for deposition.

This application is a continuation-in-part of Ser. No. 218,883, filed Jan. 19, 1972 and now abandoned.

This invention relates to apparatus and processes for the electrodeposition of composite coatings which consist of a metal matrix with particle additions, the metal and the particles being deposited from an electrolyte in which the particles are substantially insoluble. The particles may be, for example, ceramic, cermet, or laminar solids.

The invention is primarily concerned with the electrodeposition of coatings incorporating ceramic particles. Such coatings may be used for various purposes including wear and abrasion resistance, corrosion and oxidation resistance and improvement in the coefficient of friction (lubricity) and anti-fretting and anti-galling properties. In certain cases the coatings themselves may constitute the final product so that the process is one of electroforming.

The process comprises electroplating in a bath containing insoluble particles dispersed in the electrolyte, the particles being co-deposited with the metal. Difficulties have arisen with this process and it is believed that some of these difficulties arise from lack of homogeneity in the electroplating solution.

The invention is an improvement in or a modification of the invention (the main invention) described and claimed in our co-pending application Ser. No. 218,883. That application claims apparatus for the electrodeposition of composite coatings consisting of a metal matrix with particulate additions, the apparatus including a container for the electrolyte and the particles, a generally horizontal perforated agitator in the container, and means for reciprocating the agitator in a generally vertical direction in the part of the container below that used for deposition whereby the particles are homogeneously distributed throughout the part of the electrolyte in which electrodeposition takes place.

According to one aspect of the present invention apparatus for the electrodeposition of composite coatings includes a container for the electrolyte and the particles, a generally horizontal perforated agitator in the container, and means for reciprocating the agitator in a generally vertical direction in the part of the container below that used for deposition whereby the particles are distributed throughout the part of the electrolyte in which electrodeposition takes place.

According to a second aspect of the present invention in a method for the electrodeposition of composite coatings, electrodeposition takes place in a bath of electrolyte which contains insoluble particles, the electrolyte being agitated by movement generally up and down of a gen-

erally horizontal perforated agitator in the part of the bath below the part used for deposition whereby the particles are distributed throughout the part of the electrolyte in which electrodeposition takes place. Preferably the agitator is in the form of a plate which extends across substantially the whole cross-section of the bath but in certain cases it may be sufficient for the plate to occupy only a major part of the cross-section so that there is a considerable clearance between at least part of the edge of the plate and the walls of the bath. While it is preferred for the whole of the plate to move vertically through the same distance, i.e. for the plate to be reciprocated bodily, this may not always be necessary and in some circumstances it may be sufficient for the plate to be pivoted either along one edge or about an axis intermediate its width and for it to be oscillated about the axis of the pivot through a small angle preferably on either side of the horizontal.

The effect of moving a perforated plate up and down in the lower part of the bath is to force the electrolyte through the perforations both on the upward and the downward strokes so that a vigorous agitation of the solution is obtained and this maintains the particles in suspension.

The proportion of the part of the bath swept by the moving plate relative to the part above the plate which forms the useful part in which plating can be carried out will depend upon many factors including the size of the bath and the sizes of the particles to be maintained in suspension, the frequency of movement of the plate, the size and distribution of the holes in the plate, the size of the clearance between the plate and the walls of the bath and other factors but preferably the plate sweeps approximately the bottom third of the bath.

While reciprocation by a perforated plate will maintain the slurry of solution and particles in a sufficiently homogeneous condition for most plating situations, in some case, for example, when plating an article having an internal bore, the solution in the bore will become static. It has been found that if the apparatus includes means for admitting gas to the container in the region in which deposition takes place the particles are homogeneously distributed throughout the part of the electrolyte in which deposition takes place. The means for admitting gas may include means for distributing gas to a number of discharge openings carried by the agitator. Distribution means preferably comprises one or more perforated tubes attached to the agitator.

The invention may be carried into practice in various ways but one way of carrying out the invention will now be described by way of examples with reference to the accompanying drawings, of which:

FIG. 1 is a side elevation of an apparatus suitable for carrying out the process;

FIG. 2 is a fragmentary section on the line II—II of FIG. 1 showing the tank and agitator plate;

FIG. 3 is a plan view of a modified agitator plate, and FIG. 4 is a section on the line III—III in FIG. 3.

The apparatus shown in FIG. 1 comprises a rectangular tank 1 containing a bath of electrolyte 2 and particles which are to be codeposited. In the tank 1 there is a plate agitator 3 having perforations 5 (FIG. 2) through it. The perforations have bevelled edges which may form an angle of about 45° with the upper surface of the plate; the edges may be bevelled so that the hole in the upper surface of the plate is smaller than in the lower surface. At the central point 4 of each of two opposite sides the plate agitator is attached to one arm 6 of an inverted U-shaped member 7, one arm 6 of which is within the tank and the other arm 8 is outside the tank. The inverted U-shaped members 7 are arranged to reciprocate

in a vertical direction so as to reciprocate the perforated agitator plate 3 in the region adjacent the bottom of the container between the position shown in dotted lines in FIG. 1 and a position below the area in which deposition takes place. The distance moved by the agitator plate is conveniently about $\frac{1}{3}$ the depth of the bath. The U-shaped members 7 are guided in brackets 11 situated outside the tank and rigidly attached to a cylinder 12. Attached to the arm 8 of the U-shaped member 7 is a yoke 13 which is also attached to a piston rod 14 of a piston 15 which reciprocates within the cylinder 12. Reciprocation of the piston and piston rod, therefore, causes the U-shaped member and the agitator plate to reciprocate.

The movement of the piston is controlled by means which are not shown. The cylinder 12 is supported on a base plate 20 by a support member having three legs of which only two 20a and 20b, are shown.

It is important that both sides of the plates reciprocate in phase and for this purpose the yoke 13 is attached to an endless chain 16 which passes over an upper sprocket wheel 17 mounted on a shaft 18 situated at the top of the cylinder 12 and around a lower sprocket wheel 19 which is rigidly attached to a connecting member 21. Movement of the piston and piston rod will cause the chain to move the sprocket wheel 19 and rod 21. As the rod 21 carries the sprocket wheel 19 for both sides of the apparatus the movement of the pistons and therefore of the sides of the reciprocating agitator is kept in synchronism.

An anode 22 dips into the electrolyte 2 adjacent one side wall of the tank and a component 23 to be plated is suspended by hooks 24 from a bar 25 in the centre of the bath as the cathode. The anode and the cathode are connected to an electricity supply via control equipment of the kind normally employed for plating.

The process is carried out as follows. When plating is to take place, reciprocation of the plate 3 by the pistons is begun. Thus the plate sweeps approximately the bottom third of the bath which produces vigorous agitation of the electrolyte as it is forced through the perforations 5 and the narrow clearances between the edges of the plate and the walls of the bath. The particles are, therefore, taken into suspension. When the electrolyte has been agitated for a sufficient time for it to become homogeneous the components to be plated are loaded into the bath and the plating current is switched on and plating proceeds in the normal way. Reciprocation of the plate 3 is continued throughout the plating operation to maintain the particles in suspension.

A modified form of apparatus is shown in FIGS. 3 and 4. In this embodiment the plate 3 is provided with a number of strengthening bars 31 of T-section extending parallel with its two shorter sides. A similar strengthening bar 32 extends along the centre of the plate parallel with the longer sides of the plate. A stainless steel pipe 33 is situated between and parallel with each pair of bars 31. Each pipe has perforations 34 in its side wall arranged so that all the perforations face the top of the plating solution. The pipes 33 are connected to one another by a further pipe 35 which lies along the bar 32. One end of this pipe is connected by means of a flexible pipe which is not shown to an air supply outside the bath. The flexible pipe enables air to be pumped through the perforated pipes 33 while the plate is carrying out its reciprocating movement.

When plating is to take place using the modified apparatus air is forced out of the perforated pipes during reciprocation of the plate 3. The flow of air through the

perforations 34 assists the plate 3 in taking the particles into suspension. When the electrolyte has been agitated sufficiently the plating current is switched on and plating proceeds. Air is continually emitted through the perforations during the plating operation to maintain the electrolyte homogeneous.

The apparatus may be used for deposition of many different composite coatings examples of which include nickel, cobalt, copper, chromium and tungsten-cobalt alloy as the metal matrix and zirconium diboride and tungsten carbide as the insoluble particles. The composite coatings may incorporate a solid lubricant for cases where the coating is to act as a bearing using the term broadly to cover any relative movement between adjacent surfaces between which a load is transmitted. For example, graphite particles may be incorporated in the coating to provide a three-component coating of metal matrix, ceramic particles and graphite particles.

Plating may take place on any substrate which can be plated including, for example, steel, non-ferrous and light alloy components and plastics, glass and composite materials where such materials have been rendered conductive either by incorporation of appropriate material or by precoating with a conductive material.

What we claim as our invention and desire to secure by Letters Patent is:

1. A method for the electrodeposition, on an article, of a composite coating consisting of a metal matrix with particulate additions, the method comprising:

preparing a composite coating bath by mixing an electrolyte with insoluble particles;
placing said bath in a container;
suspending the article to be coated in an upper region of the bath;
agitating the bath by vertically reciprocating, in a zone adjacent the bottom of the bath, a generally horizontal perforated agitator which extends across substantially the entire horizontal cross section of the container, whereby the electrolyte and the insoluble particles are forced through the perforations of the agitator to suspend said particles in said electrolyte; and
passing an electric current through said article and said electrolyte.

2. The method of Claim 1 wherein gas is admitted to the container to produce a generally upward flow of gas in the region in which deposition takes place.

3. The method of Claim 2 wherein the outlet for the gas is arranged to move with the agitator.

4. The method of Claim 1 wherein the metal matrix is one of the group consisting of nickel, cobalt, copper, chromium, and tungsten-cobalt alloy.

5. The method of Claim 1 wherein the particles are one of the group consisting of zirconium diboride and tungsten carbide.

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