CONVEYOR FOR ELECTROPAINTING

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References Cited

UNITED STATES PATENTS
3,420,766 1/1969 Michelson 204/201
3,336,903 8/1967 Point 118/624
3,097,958 7/1963 Morris 118/303

ABSTRACT

Apparatus for electrophoretically depositing a coating from an electrophoretic solution simultaneously on a plurality of articles including a vibratory conveyor having a helical track and arranged to contain a supply of said solution. An electrode is positioned within the vibratory conveyor concentrically with respect to the track, and spaced inwardly therefrom. A supply of electric current is arranged to oppositely charge the electrode and the vibratory conveyor so that a coating is electrically deposited upon the plurality of articles carried by the track of the vibratory conveyor.

19 Claims, 6 Drawing Figures
CONVEYOR FOR ELECTROPAINTING

BACKGROUND OF THE INVENTION

This invention relates generally to an apparatus for depositing a coating simultaneously on a plurality of electrically conductive articles. Such systems are variously called in the art of electrocoating, electrophoresis, or electropainting.

These processes all contemplate that the article to be coated is placed in a solution, preferably a specially formulated paint bath, and given an electric charge of one polarity. An electrode, also immersed in the same bath, is given the opposite charge. The resin and pigment components of the paint will, under the influence of these opposite charges, migrate toward the article itself and are deposited on the surface as a dense coating of uniformly distributed individual particles. A film is formed when heat is applied. When organic particles are involved, polymerization may take place; when inorganic particles are involved, fusion may take place.

The art has long recognized the inherent advantages of these processes. First of all, these processes provide a uniform coating thickness at all points on the article. It is generally known that as the deposited coating builds up upon the surface of the article being coated, that portion of the surface becomes less electrically conductive. This tends to limit the charge on the article only to uncoated surfaces. In other words, for a given set of conditions, a predetermined quantity of paint will be deposited on all portions of the article, and when that level has been reached, substantially no further accumulation will occur.

In addition, empirical investigations have established that an electrically deposited thermally treated film is much more tightly adherent to the surface of the article than conventionally applied paint coatings.

These advantages are of particular importance in the painting of threaded fasteners. That is, conventional paint coatings cannot be applied evenly at sharp edges due to the high surface tension of these conventional paint coatings containing solvent. This lack of uniformity, or accumulation of excess coatings in areas such as the threads, or slotted head of a fastener is conducive to chipping of the coating during handling or use.

Furthermore, particularly in commercial applications, a very tightly adherent paint coating is necessary in order to prevent scratching or chipping of the coating when the fasteners are driven or installed by means of power equipment.

While these advantages are widely known, the art has found it extremely difficult to develop an apparatus which will successfully carry out the process with respect to large numbers of small articles, such as, for example, threaded fasteners and the like. Conventional techniques wherein each article to be coated is separately charged are totally impractical. The only known method and apparatus is disclosed in U.S. application Ser. No. 781,049 filed on Dec. 4, 1968 in the name of Eugene E. Haney. The apparatus disclosed in this application is particularly adapted to carry out the coating portion of the process set forth in detail in that application.

By way of general review, the electropainting process contemplates first of all a very thorough cleaning of the surface of the article to be coated. Exemplary cleaning steps would include alkali cleaning followed by a water rinse; a solvent degreasing operation and/or an acid pickle; or a continual agitation of the parts to be coated in a container having alumina pellets.

Following these cleaning steps, a conversion coating of a type well known in the art is applied to the surface of the article. This conversion coating is then subjected to a baking operation to completely dry the conversion coating.

The articles to be painted, having a prebaked conversion coating, are then introduced into a bath containing a suitably formulated paint. The formulation of the
paint for utilization in this process is not a part of this invention. There are many existing paint formulations including different resin systems such as oleoresinous materials, acrylacs, epoxies, and there are other electrophoretic solutions for the deposition of inorganic materials such as aluminum oxide. The remainder of this specification will be directed specifically at an electrophoretic paint process utilizing an organic resin. While in the paint bath, the article to be coated is given an electric charge of one polarity, while an electrode of the opposite charge is immersed in the bath. In theory, either anodic or cathodic electrocoating is possible. At the present time, the anodic techniques are the most highly developed. Under these procedures, the article to be coated is given a positive charge, while the other electrode in the paint bath is given a negative charge. Under these circumstances, the resin and pigment components of the paint bath carry the negative charge and will migrate toward the article itself, and be deposited on the surface thereof as a coating.

Turning now to FIG. 1, the preferred apparatus of this invention is indicated generally as conveyor 9 which includes a container 10 which is cylindrical in configuration, and is provided with the domed bottom 12. Secured to the inner surface of the walls of the container 10 is the helical track 14 which extends upwardly from the bottom, and includes an exit portion 16 extending over the top edge of the container 10.

The entire container structure just described is vibrated at high frequency by means of the base structure indicated schematically at 18.

The high speed vibration of the container 10 is effective to cause a plurality of small articles placed on the bottom 12 of the conveyor to move outwardly toward the periphery of the container, and then to walk up the helical track 14. In accordance with the teachings of application Ser. No. 781,049, the vibratory "walking" action of the articles on the track 14 is effective to cause the articles to move with respect to each other at least once during the period of immersion in the paint bath. Thus, the unit just described is effective to continuously convey convey plurality of small articles introduced into the container upwardly on the helical track 14 and outwardly over the track portion 16 for further processing.

The necessary electric charge is given to the articles to be coated through the container 10 itself. To this end, the container 10 will be connected in a conventional manner to a source of direct current. The charge will be transmitted through the container 10 and/or track 14 to the articles carried thereon.

An electric current of the opposite charge is introduced into the paint bath by means of the electrode 20. It will be observed that the electrode 20 is in the form of a cylinder having an intumet lower edge. This cylinder may be suspended within the container 10 in any suitable manner.

Empirical investigations have established that the relationship between the charged area of the electrode 20 and the charged area of the container 10 is very important. Specifically, in the anodic coating, the area of the cathode 20 must be equal to or larger than the charged area of the anode or container 10.

It will be apparent in the embodiment shown that the total area of the cathode 20 is substantially smaller than the total area of the inside of the container 10. In order to limit the charged area of the anode, it is necessary to apply an insulative coating 22 to a portion of the inner surface of the container to sufficiently reduce the charged area to a level equal to or less than the area of the cathode 20. Investigations have established that the entire bottom 12 of the container may be insulated, the entire side wall area of the container may be insulated, and the uppermost portion of the helical track 14 may be insulated. Suitable insulation may be provided in a variety of forms, such as the provision of a nonconductive resin coating or the like.

It is believed that operation of the foregoing embodiment should be clear. The articles to be coated may be introduced in any convenient manner to the bottom of the conveyor 9. The vibration of the container 10, as previously indicated, advances the articles from the bottom of the container helically upward. Once conductive articles encounter the lower portion of the track 14, the electric charge of the track will be transferred to the articles, and hence the electrical deposition process begins. The charged length of track 14 must be sufficient to permit the deposition of the required organic coating thickness.

It will also be apparent that when the articles being coated move to the upper portion of the track 14, it no longer receives any charge by virtue of the insulation 22. When the articles being coated emerge above the surface of the paint which is indicated in FIG. 1 at 24, they will continue to move along the exit portion 16 of the track 14. In the case of relatively heavy articles, the vibratory energy which is effective to move the articles along the track, may also be effective to mechanically remove some portion of the previously deposited coating. To this extent, it is desirable to provide some form of lubrication for the fasteners moving on this portion of the track. Suitable lubrication, in the sense in which that term is utilized herein, may be provided by a spray of the organic paint on this portion of the track through the nozzle 26.

The container 10 is provided with an overflow drain 28 positioned so as to maintain the normal level of paint above the top of the electrode 20. The container may also be provided with a drain 30 at the bottom so that it may be completely drained for cleaning, changing solutions, and so on.

When the articles being coated reach the end of the track portion 16, they may be processed according to the teachings of the application referred to earlier. For example, they may be subjected to a water rinse, and then baked in accordance with the requirements of the paint being utilized.

FIGS. 4 through 6 illustrate a second embodiment of the invention. Generally considered, this embodiment differs from the one heretofore described in that the helical path of travel is continually expanding. The helical path, rather than lying on the surface of a cylinder, lies generally on the surface of an inverted cone. Reference numerals used in connection with this embodiment are similar to those used with the foregoing embodiment with the addition of the letter "a." Specifically, the conveyor, indicated generally at 9a, includes the container 10a, the bottom 12a, and the helical track 14a. The upper portion of the track 16a again extends above the upper edge of the container 10a. The
The preferred electrode configuration is indicated at 20a. The outer surface of the electrode is generally frusto-conical. In this particular embodiment, in order to increase the effective area of the cathode, it may be desirable to provide the electrode with a partial top 21a with an opening 25a through which the articles are fed. Again, the relationship set forth earlier holds true. That is, the charged area of the electrode 20a must be equal to or greater than the effective charged area of the container 10.

The charged area of the container 10a is again limited by virtue of the insulative coating 22a applied to the bottom, side walls, and upper portion of the track 14a.

It is believed that the foregoing constitutes a full and complete disclosure of this invention, and no limitations are to be inferred or implied unless specifically set forth in the claims which follow.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. Apparatus for electrophoretically depositing a coating from an electrophoretic solution simultaneously on a plurality of articles comprising:
   a. container means having a bottom and side walls and adapted to hold a supply of said solution;
   b. electrically conductive means rigidly secured to said container means and defining a helically upward path of travel from said bottom of said container means;
   c. means for vibrating said container means;
   d. an electrode positioned within said container means and spaced from said electrically conductive path defining means;
   e. means for supplying electric current of one polarity to at least a portion of said path defining means; and
   f. means for supplying electric current of the opposite polarity to said electrode.

2. The apparatus claimed in claim 1 wherein said bottom wall of said container means is domed.

3. The apparatus claimed in claim 1 wherein said path defining means is secured to said side wall of said container means.

4. The apparatus claimed in claim 1 wherein said side wall of said container means is electrically insulated.

5. The apparatus claimed in claim 1 wherein said means for vibrating said container means is external thereto.

6. The apparatus claimed in claim 1 wherein said electrode is negatively charged and said path defining means is positively charged.

7. The apparatus claimed in claim 6 wherein the surface area of said electrode is at least as great as the surface area of the charged portion of said path defining means.

8. The apparatus claimed in claim 1 wherein said electrode is generally circular in horizontal cross section.

9. The apparatus claimed in claim 1 wherein said helically upward path of travel lies on the surface of a cylinder.

10. The apparatus claimed in claim 9 wherein said electrode is cylindrical and concentric with said helically upward path of travel.

11. The apparatus claimed in claim 1 wherein the radius of said helically upward path of travel is constant.

12. The apparatus claimed in claim 1 wherein the radius of said helically upward path of travel continually increases.

13. That apparatus claimed in claim 1 wherein said helically upward path of travel lies on the surface of an inverted cone.

14. The apparatus claimed in claim 13, wherein said electrode includes a frusto-conical portion, the included angle of said frusto-conical portion being substantially equal to the included angle of said conical path of travel.

15. The apparatus claimed in claim 1 wherein said solution is an electrophoretic paint containing organic resins.

16. A vibratory conveyor for electrophoretically depositing a coating from an electrophoretic solution simultaneously on a plurality of articles comprising:
   a. a container holding said solution and having a track extending helically upward from the bottom thereof;
   b. means for electrically charging said container;
   c. an electrode disposed in said container concentrically with said track;
   d. means for electrically charging said electrode, said last mentioned means being effective to charge said electrode oppositely from the charge of said container;
   e. means insulating at least a portion of the inner surface of said container whereby the effective charged area of said container is not greater than the area of said electrode.

17. The apparatus claimed in claim 16 wherein said track extends above the normal level of said solution in said container, and including means for lubricating said portion of said track.

18. The apparatus claimed in claim 17 wherein said means for lubricating said portion of said track comprises a supply of said solution.

19. The apparatus claimed in claim 16 wherein said solution is an electrophoretic paint containing organic resins.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,682,136        Dated August 8, 1972

Inventor(s) Eugene E. Haney and Karl T. Bagdal

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

All of the 19 claims of Patent No. 3,682,136 should be canceled and replaced with the following 4 claims:

1. A vibratory conveyor for electrophoretically depositing a coating from an electrophoretic solution simultaneously on a plurality of articles comprising:
   (a) a container holding said solution and having a track extending helically upward from the bottom thereof, said track extending above the normal level of said solution in said container;
   (b) means for electrically charging said container;
   (c) an electrode disposed in said container concentrically with said track;
   (d) means for electrically charging said electrode, said last mentioned means being effective to charge said electrode oppositely from the charge of said container; On the cover sheet, in
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CERTIFICATE OF CORRECTION

Patent No. 3,682,136 Dated August 8, 1972

Inventor(s) Eugene E. Haney and Karl T. Bagdal

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

(e) means insulating at least a portion of the inner surface of said container whereby the effective charged area of said container is not greater than the area of said electrode; and

(f) means for lubricating said portion of said track above the normal level of said solution in said container.

2. The apparatus claimed in claim 1 wherein said bottom wall of said container means is domed.

3. The apparatus claimed in claim 1 wherein said means for lubricating said portion of said track comprises a supply of said solution.

4. The apparatus claimed in claim 1 wherein said solution is an electrophoretic paint containing organic resins.

On the cover sheet, "19 Claims" should read -- 4 Claims --.

Signed and sealed this 8th day of May 1973.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

ROBERT GOTTSCALK
Commissioner of Patents
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1. A vibratory conveyor for electrophoretically depositing a coating from an electrophoretic solution simultaneously on a plurality of articles comprising:

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   (b) means for electrically charging said container;

   (c) an electrode disposed in said container concentrically with said track;

   (d) means for electrically charging said electrode, said last mentioned means being effective to charge said electrode oppositely from the charge of said container;
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3. The apparatus claimed in claim 1 wherein said means for lubricating said portion of said track comprises a supply of said solution.

4. The apparatus claimed in claim 1 wherein said solution is an electrophoretic paint containing organic resins.

On the cover sheet "19 Claims" should read -- 4 Claims --.

This certificate supersedes the Certificate of Correction issued the 8th day of May 1973.

Signed and sealed this 26th day of March 1974.

(SEAL)
Attest:

EDWARD M. FLETCHER C. MARSHALL DANN
Attesting Officer Commissioner of Patents