# United States Patent

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[54] **METHOD FOR COATING CONDUCTIVE ARTICLES**
**6 Claims, 1 Drawing Fig.**


[52] **U.S. Cl.** ..... **204/181**
[51] **Int. Cl.** ..... **B01k 5/00,** C23b 13/00
[50] **Field of Search** ..... 204/181; 148/6.2



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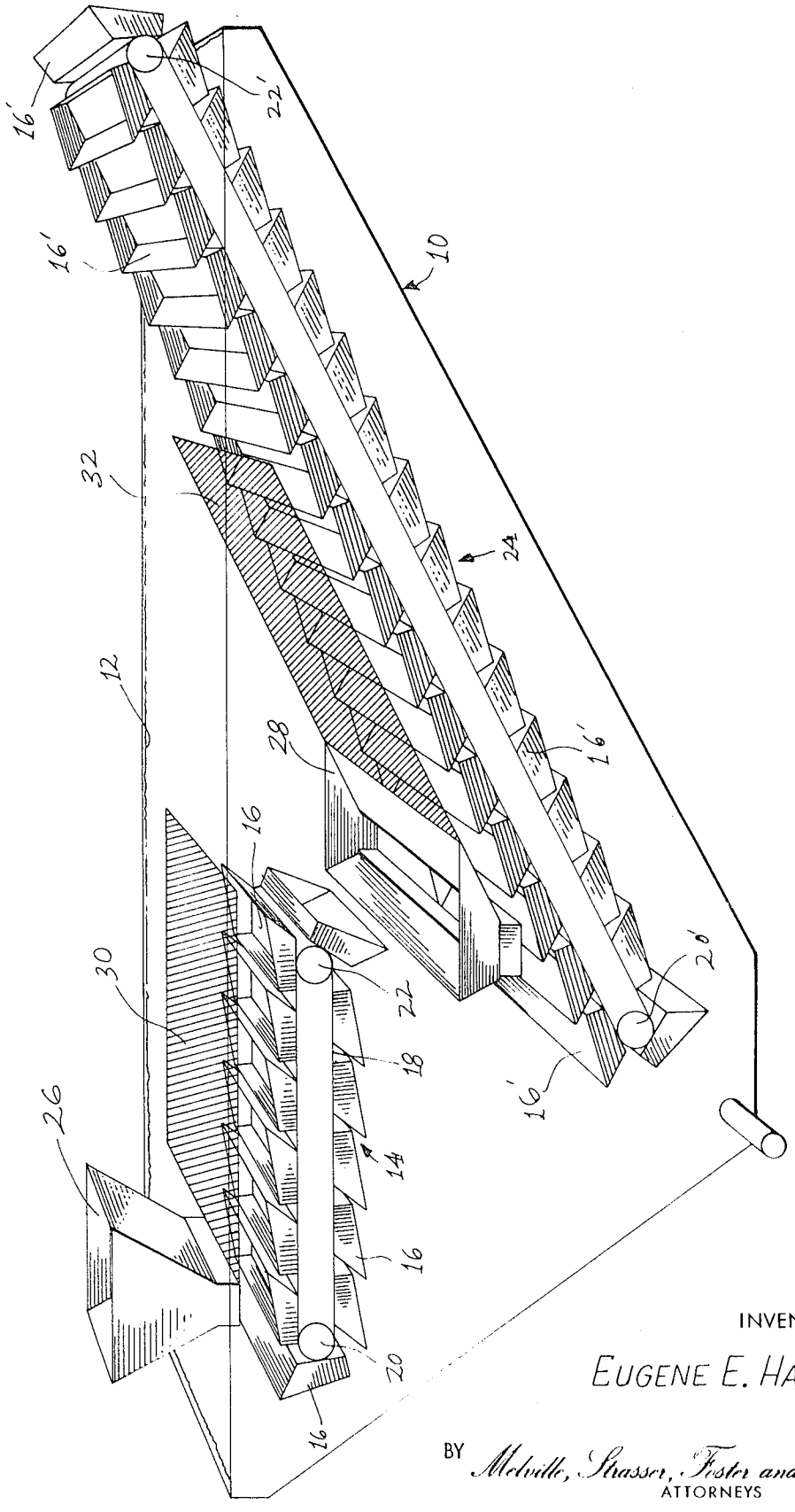


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**ABSTRACT:** Electrical deposition of organic film from an aqueous solution simultaneously on a plurality of conductive articles in a conductive container wherein the articles are thoroughly cleaned, a conversion coating is applied to the articles, the conversion coating is dried at an elevated temperature, the articles are immersed in the aqueous solution while in the conductive container, current is passed through the container and solution to irreversibly deposit the organic coating on the articles, and the articles having the coating are baked.

The apparatus includes means within a tank holding the aqueous solution for receiving a plurality of articles to be coated, and for shifting the position of the articles relative to each other at predetermined time intervals.




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# METHOD FOR COATING CONDUCTIVE ARTICLES

## BACKGROUND OF THE INVENTION

This application relates generally to a process for electrically depositing an organic coating on electrically conductive articles. Such systems have been variously called electrocoating, electrophoresis or electropainting. The electrically conductive articles or surfaces found applicable to the practice of the invention include the metals iron, steel, aluminum, zinc, brass, bronze, titanium, cadmium and columbium, although the method and apparatus may be used to coat any material having the ability to attract organic coatings ionized in an aqueous solution.

According to present techniques, the article to be coated is immersed in a specially formulated paint. These paints generally include a resin, a suitable pigment, and a solubilizing agent. While either anodic or cathodic electrocoating is possible, the anodic techniques are most highly developed. That is, the article to be coated is given a positive charge while the paint container or other electrode in the paint bath is given a negative charge. The resin and pigment components of the paint carry negative charges and will migrate toward the article itself, while the solubilizer carries a positive charge.

It is now known that these electrically deposited organic films have certain very unusual characteristics and advantages. In the first place, as indicated above, the particles of pigment and resin migrate toward the surface of the article being coated, where they are irreversibly deposited as a film. As this film builds up on the surface of the article being coated, that portion of the surface becomes less conductive. This of course tends to limit the charge on the article only to uncoated surfaces. Thus, the application of a paint film by this method provides an absolutely uniform thickness at all points on the article. This characteristic of the operation is often referred to as a "self-limiting" factor. That is, 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.

Thus, the uniform and accurately controllable film thickness is a great advantage to this process.

The instant invention will be described in its relationship to the electrocoating of fasteners, although it will be understood that it may be applied to the coating of any articles possessing sufficient electrical conductivity to hold the charge and thereby attract the paint particles.

The painting of small articles in large numbers has heretofore resulted in coatings which are unsatisfactory for many service applications because of the lack of uniformity of the coatings and their poor adherence. This is particularly true of coatings applied by the known dip and spray processes. While electrostatic techniques have improved the coatings, these too leave much to be desired. Prior coating techniques, including experimental studies of the electrophoretic process, have met with great difficulty in prior attempts to produce precoated articles which will be later subjected to mechanical forces and chemical attack.

It is believed that this difficulty is due primarily to two factors. First of all, considering for example the threaded fastener art, a threaded product by nature is extremely difficult to paint evenly due to surface tension of conventional coatings containing solvents. That is, screw threads, the head of a bolt or nut, or the slotted head of a typical screw present sharp angular surfaces, and conventional painting processes such as spraying or dipping do not result in uniform coverage.

Secondly, and perhaps more importantly, such fastener products as are used in industry are typically driven or installed by means of power equipment, such as pneumatic screwdrivers, nut runners, and the like. It is well known in the industry that such fastener-driving equipment will chip or scratch the paint from fasteners painted in any conventional manner.



In addition, such commercial fasteners are generally very small and utilized in large numbers, so that the painting operation must be set up to handle the job with a minimum of labor and individual part handling. That is, electropainting is generally considered impractical because, according to conventional practice, each article being coated is separately charged; this becomes economically impractical in terms of the quantity of products to be coated according to this application.

Keeping the foregoing discussion in mind, it is an object of this invention to provide a method for coating metallic objects with an organic paint film which is extremely adherent to the base article.

It is a further object of the invention to provide a method and apparatus for accomplishing such a coating with minimal manual or individual part handling.

Still a further object of this invention is to provide a method and apparatus which will, without individual handling, provide an accurate and controllable organic coating on a plurality of individual metallic articles.

## SUMMARY OF THE INVENTION

The method of this invention contemplates the thorough cleaning of the surface of the articles to be coated, applying a conversion coating to the surface of the cleaned articles, drying the articles by baking, passing the dry articles into a container within a suitably formulated paint bath, passing a current through the container and the bath, shifting the positions of the articles relative to each other at predetermined tim intervals after immersion, withdrawing the coated articles, and baking the coating.

Within the paint bath, the container referred to is comprised by two or more conveyors. The articles to be coated are first loaded into one of the conveyors which will transport them through a portion of the paint bath and discharge them into a second conveyor. The second conveyor or subsequent conveyors carry these articles through the remainder of the bath and discharge them for further processing.

## DESCRIPTION OF THE DRAWING

The drawing is a schematic view of the paint bath and one form of the conveying arrangement contemplated by this invention.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

The first step in any process of electrodeposition of paint usually involves a very thorough cleaning of the article to be coated. (In primer painting, for example, the cleaning step may be omitted.) It will of course be recognized that the selection of the best cleaning compounds will depend in part upon the nature of the contaminants on the article and other factors. As will be set forth in more detail hereinafter, alkali cleaning followed by a water rinse has proved highly satisfactory. Under certain conditions, such as when a heavy grease, drawing compound or oxide is on the product, it may be necessary to use a solvent-degreasing operation and/or an acid pickle.

Following the cleaning steps, a conversion coating is applied to the surface of the article to be coated. Two types of conversion coatings have been found satisfactory. On the one hand, particularly for articles which have been metallic coated as by galvanizing or the like, the article is passed through a phosphate bath (such as zinc phosphate), followed by a chromate seal.

A second conversion coating which in many instances is to be preferred calls for passing the article to be coated into a bath consisting of an organic fluoride containing chromic acid and zinc dust. While this material is more expensive in base form, it does not require a chromic acid rinse, and hence one of the stages of a conventional phosphating line can be eliminated. It may also be applied at room temperature.

Following the application of the conversion coating, the article is subjected to heat to make it completely dry prior to painting. The effect of this prebaking operation is not precisely known. Some have theorized that the paint will adhere better if the product enters the bath dry. While not intending to be bound by theory, applicant believes that this prebaking operation drives out occluded gases from a prior coating or even from the metal itself, and drives out the water of crystallization from the phosphate or chromate if these are previously applied. In any event, it has now been discovered that this prebaking step gives superior results in terms of corrosion resistance and strength of the bond between the paint film and the article itself.

This prebaking step should be carried out at a temperature and for a time generally equal to the time and temperature of the final paint-baking step described presently. Preferably, the maximum temperature attained by the articles in the prebaking step will be at least equal to the maximum temperature attained by the articles during the final baking. At the present time, and with presently known paint systems, prebaking times and temperatures will be on the order of at least four minutes at temperatures from 300° F. to 500° F.

The electropainting step is carried out in a bath containing a suitably formulated water base organic paint. The precise formulation of the paint utilized is beyond the scope of this invention. For present purposes, it is sufficient to say that many paint manufacturers have formulated paints for an electropainting operation. These include several different resin systems such as oleoresinous materials, acrylics, epoxies, and others.

Referring now to FIG. 1, the paint bath will be maintained in the tank indicated generally at 10. The normal level of paint in the tank is at 12.

Suitably mounted within the tank is the first totally immersed conveyor indicated generally at 14. This conveyor includes a plurality of containers 16, each of which is secured to the flexible drive means 18. The drive means 18 of course forms an endless conveyor about the drive pulleys 20 and 22. It will be understood that this conveyor is driven through any suitable drive train at the desired speed selected in the light of the paint system utilized.

Also within the tank 10 is the second or exit conveyor 24. As will be readily seen, the construction of this conveyor is substantially identical to the construction of the first conveyor, except that this conveyor is inclined upwardly so that a portion of it is disposed above the normal paint level 12 of the bath. (Corresponding parts of the conveyor 24 have been indicated in FIG. 1 by primed reference numerals.)

Adjacent one end of the first conveyor 14 is the loading hopper 26. This hopper is provided with doors or the like (not shown) for releasing, at predetermined intervals, the desired quantity of articles to be coated into the containers 16.

Disposed between the first and second conveyors is the interchange hopper indicated at 28. As the containers on the first conveyor reach the right hand limit of travel, they in effect dump their contents into the interchange hopper which effectively funnels the material into the containers 16' of the exit conveyor.

It will be apparent that the operation of the first and second conveyors described above the interchange hopper is effective to move the articles in the containers of the conveyor with respect to each other a predetermined time after immersion in the paint bath. It has been discovered that when a large quantity of items is randomly deposited in a container of this kind, it is possible to trap air bubbles or to have contact points between adjacent articles which prevent full and effective coating of the entire article. By the provision described above, this invention insures uniformity of the coating even though a relatively large number of articles is being treated simultaneously in a container.

Maintained within the bath are the two cathode grids 30 and 32. The anode or positive connection from the source of electric current (not shown) is effected by a brush-type contact to the first and second conveyors 14 and 24 described earlier.

After emergence from the paint bath, the articles are preferably subjected to a water rinse and then baked in accordance with the requirements of the paint being used. The term "baking" as used herein shall be understood to include other methods of completing the polymerization of the organic coating such as air curing at ambient temperature or radiation curing.

To facilitate a full understanding of this invention, the following specific example of a commercial run is given. Two hundred pieces of ¼–14 ×¾, hex head self-tapping electrogalvanized steel screws were cleaned in a mild alkaline cleaner commercially available under the designation PARKER 346 as sold by the Parker Division, Hooker Chemical Corporation. This cleaner was diluted in the proportion of 6 ounces per gallon of water, and the bath was maintained at a temperature of 170° F. The articles were maintained in this bath at this temperature for a period of 5 minutes.

Following a water rinse after the alkaline cleaner, the articles were immersed in a zinc phosphate bath available from the Parker Division, Hooker Chemical Corporation under the trade designation BONDERITE 378 S. Total acid of the solution equaled 15 points. The bath maintained at a temperature of 160° F., and the articles were immersed in this bath for a period of 5 minutes.

Following the phosphate bath, the articles were subjected to a chromic acid rinse one-tenth percent by weight) at 150° F. for 30 seconds.

This in turn was followed by a double water rinse. The first rinse was with ordinary tapwater, while the second was with deionized water in order to prevent contamination of the paint during the subsequent steps.

The product was then subjected to a preliminary baking at 400°F. for a period of 5 minutes.

The particular paint used in this example was available under the designation JD169 available from Jones-Dabney Division of Celanese Coatings Company. As supplied by the manufacturer, this paint contained 40 percent nonvolatiles. Before use, the paint was diluted with deionized water at the rate of one part paint to three parts water.

When finally ready for use, the paint contained 10 percent nonvolatiles and was slightly alkaline (pH 8.0 ).

The paint bath was maintained at a temperature of 75° F. and the electrical charge was maintained at 120 volts. The dwell time for the articles in the bath was 1 minute.

The final baking of the coated articles was at a temperature of 400° F. for 30 minutes.

The resulting products from the foregoing run yielded a paint coating 0.7 mils thick. These products were tested for corrosion resistance and for ability to hold paint under mechanical driving. The articles passed these tests with no failures.

It is believed that the foregoing constitutes a full and complete disclosure of this invention. Since many modifiacations can be made within the scope and spirit of this invention, no limitations are expressed or implied except as 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. A method for electrodeposition of an organic film simultaneously on a plurality of conductive articles comprising the steps of:

a. applying an aqueous coating to said articles;
b. prebaking said articles so as to dry said conversion coating;
c. immersing said articles in a paint solution;
d. passing a current through said articles and said paint solution to electrically deposit said organic film on said articles; and
e. baking said painted articles.

2. The method claimed in claim 1 wherein said conversion coating is applied by immersing said articles in a phosphate bath, and thereafter rinsing said articles with a solution having free chromate ions to form a chromate seal.

3. The method claimed in claim 1 wherein said prebaking of said articles is effective to heat said articles to a temperature at least equal to the maximum temperature attained by said articles in said baking of said painted articles.

4. The method claimed in claim 1 wherein said prebaking of said articles is accomplished at a temperature in the range of 300° to 500° F. for a time period of at least 4 minutes.

5. The method claimed in claim 1 wherein, while immersed in said paint solution and while having said current passed therethrough, said articles are caused to move with respect to each other at least once.



6. In a method for electrodeposition of an organic film simultaneously on a plurality of conductive articles including the steps of cleaning the surface of said articles, applying an aqueous conversion coating to said articles, immersing said articles in a paint solution, passing a current through said articles and said paint solution, the additional step of causing said articles to move with respect to each other at least once while immersed in said paint solution and while having said current passed therethrough.

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# UNITED STATES PATENT OFFICE
# CERTIFICATE OF CORRECTION

Patent No. 3,616,392 Dated October 26, 1971

Inventor(s) Eugene E. Haney

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

Column 4, line 22, the phrase "BONDERITE 378 S" should read -- BONDERITE 37 S --.

Column 4, line 27, following the word "rinse" insert -- ( --.

Column 4, line 64, following the word "aqueous" insert -- conversion --.

Signed and sealed this 9th day of May 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents