

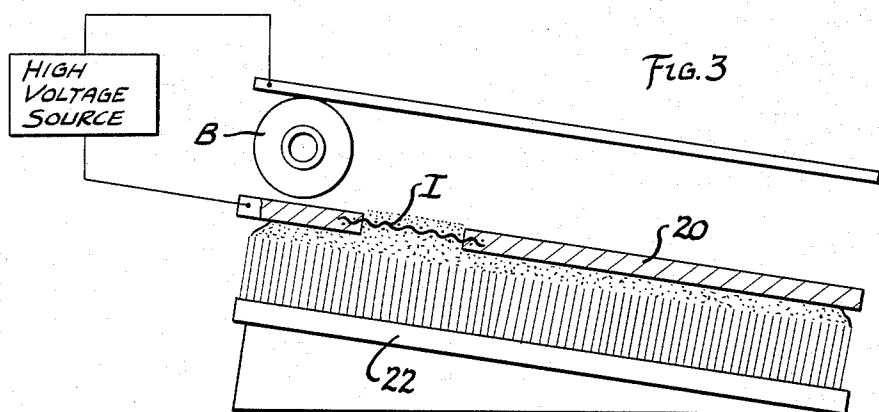
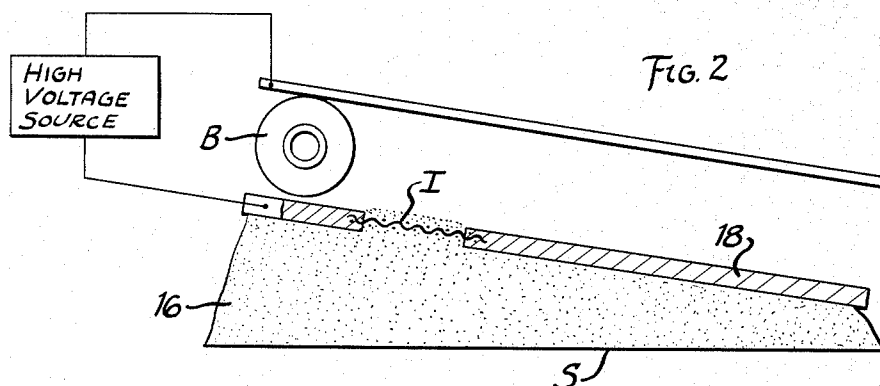
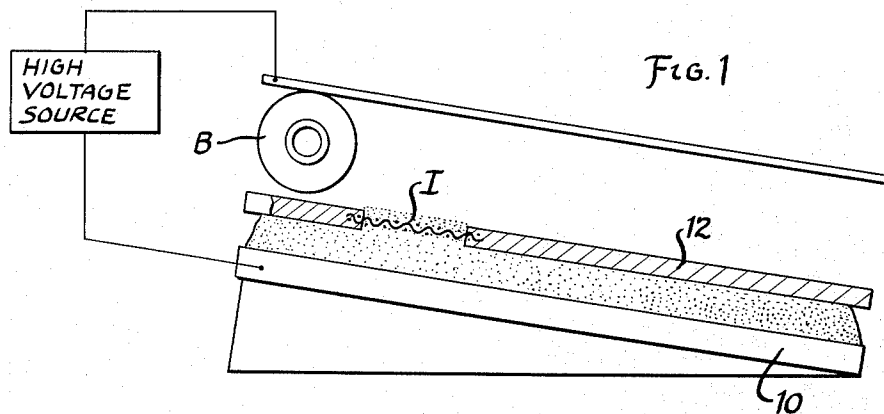
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METHOD OF ELECTROSTATIC SCREEN PRINTING

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3,241,483

METHOD OF ELECTROSTATIC SCREEN PRINTING

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4 Claims. (Cl. 101—129)

This invention relates to methods of electrostatically applying to a hot glass article a decorative or protective coating, and more particularly to methods for handling and locating the coating material for electrostatically induced transfer to the article surface.

In United States patent application of Kenneth G. Lusher, Serial No. 242,229, filed December 4, 1962, now U.S. Patent No. 3,150,547, and William H. Wood, Serial No. 242,230, filed December 4, 1962, both applications being assigned to the assignee of the present application, various methods and apparatus for electrostatic coating or printing of heated glass objects are disclosed. In general, the processes disclosed in the two above applications involve the steps of locating upon a carrier plate or screen a layer of printing powder shaped in the form of the image to be applied to the glass surface, and then bringing the surface to be printed into close adjacency with the powder while forming an electric field which electrostatically attracts the particles to the surface. The high temperature of the bottle surface thermally fuses the particles to the surface.

As disclosed in the two applications referred to above, the formation of the powder into the image configuration prior to transfer to the glass surface is generally accomplished in one of three ways. In one method, a stencil, usually in the form of a coated fine mesh screen, is provided with an image aperture by removing the screen coating from the image area to form a restricted opening through which the powder or particles can pass. The stencil is located closely above a smooth surfaced carrier plate, a supply of powder is placed upon the stencil and the upper surface of the stencil is brushed to pass powder through the image aperture onto the surface of the carrier plate. The stencil is removed, the article to be printed is brought into adjacent relationship or contact with the powder on the plate and an electric potential is applied between the plate and article to electrostatically transfer the powder from the plate to the article.

As is apparent from the foregoing description, this particular method requires that the stencil be carried to the plate for the powder transfer from the stencil to the plate and the stencil then must be removed before the article can be moved into printing relationship with the plate. Further, it is desirable to clean the plate of untransferred powder between successive printings. Still further, some difficulty is encountered in achieving sharp resolution around the image periphery because of the tendency of the powder particles to scatter somewhat as they are brushed through the stencil.

In a second method, the printing powder or particles are transferred directly through the image screen to the article surface. In this method, the heated article is brought into registry in close adjacency beneath an electrically conductive stencil with the image formed in a fine wire mesh. A printing powder is disposed on top of the screen and electric potential is applied between the screen and article, and while the potential is applied, the particles upon the screen are brushed to express them through the fine mesh image apertures.

While this method eliminates the intermediate step of transferring the printing powder to a carrier plate as in the previously described method, the scattering of particles is still present to some extent. Further, because the

article to be printed must be brought into registry beneath the screen before the printing powder is electrostatically transferred to the article surface, the screen mesh must be relatively fine with respect to the physical size of the powder particles so that the particles pass through the screen only under the application of a force other than gravity, as by the application of the electric field combined with the mechanical brushing. Because of the fineness of the mesh, some problems are encountered with bridging or clogging of the mesh.

As a third method, a carrier plate may be employed in which pockets or recesses in the plate surface are filled with powder, this particular method being closely related to the method first described above. Problems encountered with this third method reside generally in freeing the unrecessed surface of the plate from particles. As in the method first described above, this third method also requires the filling of the recesses with powder particles between each printing operation and, in those cases where relatively large area recesses are included in the image, brushing of the plate to clean the unrecessed surface of the plate after the depositing of powder within the recesses may partially scour powder from some of the larger recesses.

It is one object of the invention to provide a method for forming an electrostatic printing powder into an unconfined image layer of uniform thickness and density having sharply defined edges.

It is another object of the invention to provide a method in accordance with the foregoing object wherein the printing powder passes directly from a supply to the surface of the article being printed.

It is another object of the invention to provide a method wherein electrostatic printing powder is transferred from a supply to the surface to be printed in a manner such that the requirement of cleaning the implements employed in the transfer of the powder between the printing of successive articles is eliminated.

It is another object of the invention to provide an electrostatic printing method wherein printing powder is formed into an image layer in which the powder particles are at rest at the time of application of the electrostatic field.

Other objects and features of the invention will become apparent by reference to the following specification and to the drawings.

In the drawings:

FIGURE 1 is a schematic diagram illustrating one form of the invention;

FIGURE 2 is a schematic diagram illustrating another form of the invention; and

FIGURE 3 is a schematic diagram showing still another form of the invention.

In the drawings, three different methods directed toward the achievement of the above objects are disclosed as being applied to the printing of an image on the surface of a cylindrical glass bottle. In this exemplary application of methods of the present invention, the bottle to be printed is formed by conventional glass-forming techniques and discharged closely following the formation step onto an inclined plane on which the bottle rolls under the influence of gravity. As the bottle rolls down the inclined surface, it is cooled to a temperature at which it possesses structural integrity, but is still at a relatively high temperature—i.e. 500° to 1,000° F. Within this latter temperature range, the glass possesses two characteristics desirable in the electrostatic printing operation. Within this temperature range, the electrical conductivity characteristics of the glass are within a practical range for the application of the desired electrostatic charge.

Examples of specific glass compositions and electrical

conductivity variation with temperature are set forth in the above-identified Wood application Serial No. 242,230 which also describes in detail exemplary printing powder compositions. The above-identified Lusher application Serial No. 242,229 discloses one form of an inclined plane structure with which the present invention may be employed, and since these details do not, per se, constitute the novel portion of the present invention, these details will not be repeated herein.

Referring now to FIGURE 1, in this embodiment a layer of printing powder is deposited upon the surface of a carrier plate 10 of a suitable electrically conductive material. The powder is formed into a layer of a selected thickness by any suitable means, such as a doctor blade and is spread over the plate surface to cover an area greater than the area of the image to be printed.

Plate 10 is then mounted upon the inclined plane assembly, not shown, down which the bottle B to be printed is to be rolled with the upper surface of the plate extending parallel to and accurately located at a fixed distance below the path of movement of the bottle. The plate is electrically insulated from those parts of the inclined plane assembly which are in electrical contact with the bottle.

A stencil 12 having an image aperture I is then placed upon the upper surface of the layer of powder upon plate 10. In the embodiment of FIGURE 1, the material from which the stencil is cut does not necessarily have to be electrically conductive and may take the form of a relatively stiff cardboard or paper stencil or may be in the form of a coated woven mesh with the coating removed at selected areas to define the image aperture. In the usual case, some means will be provided for aligning the stencil with the path of movement of the bottle.

The stencil is then pressed downwardly and held against the upper surface of the layer of powder on plate 10 to mechanically express some of the powder upwardly through the image aperture of the stencil. The powder is deposited on the plate initially in a loose pile and at the conclusion of the doctoring operation is of substantially uniform density. By regulating the thickness of the powder layer and the pressure at which the stencil is pressed against the powder, the amount of powder expressed through the image aperture is regulated and the expressed powder is formed into an image shaped layer of substantially uniform thickness above the stencil.

A heated bottle B from the forming machine is then placed upon the inclined plane structure and rolls down the inclined plane, the peripheral surface of the bottle passing above the expressed powder layer. A high voltage source is electrically connected to the bottle and to plate 10 to establish an electric field having one potential surface on the bottle and its other potential surface on plate 10 so that a predetermined electric potential difference exists between the bottle and plate as the bottle rolls down past image aperture I. The electric field so established electrostatically attracts the powder expressed through image apertures I to the hot bottle surface and the powder, upon reaching the bottle surface, becomes thermally adhered to the surface. Preferably, the bottle rolls along a path spaced slightly above stencil 12 and does not contact the stencil directly. The spacing or gap permissible depends on the magnitude of the electric potential and characteristics of the powder, glass, temperature, etc., but is generally of the order of one-tenth of an inch or less.

Referring now to FIGURE 2, a modified arrangement is disclosed in which the printing powder is formed into a relatively large pile 16 upon any suitable support designated generally S. The upper surface of the pile of printing powder is smoothed into an incline matching that of the inclined plane by any suitable means, such as a doctor blade. In the embodiment of FIGURE 2, the stencil 18 is constructed from a coated woven mesh of metallic or other electrically conductive material and

is electrically connected to the high voltage supply to form one pole or plate of the electric field. After the pile has been smoothed, the stencil and pile are forced vertically against each other to express printing powder upwardly through the image openings I formed in the mesh coating to form an image-shaped layer of powder of substantially uniform thickness as in the previous case. The bottle is then rolled down the inclined plane while the electric potential is applied between the hot bottle and stencil to electrostatically transfer the expressed powder layer to the bottle surface. In the embodiment of FIGURE 2, the stencil preferably is located in fixed relationship to the bottle path and the powder may be expressed through the image apertures by elevating the pile support S and holding the support at its elevated position during the printing. Alternatively, the pile may be provided with side plates which guide the doctor blade in smoothing the top of the pile so that the top of the pile is spaced a known distance from the bottle path and the metal stencil may then be pressed downwardly and held against the pile of printing powder.

In the embodiment of FIGURE 3, a metal or electrically conductive stencil 20 of the type employed in the FIGURE 2 embodiment is fixedly mounted relative to the bottle path. A brush 22 loaded with printing powder is pressed upwardly against the stencil and oscillated back and forth to express powder particles from the brush upwardly through the stencil openings. After brushing in this manner for a predetermined number of oscillations, the brush is held stationary beneath the image openings as the hot bottle is rolled down the inclined plane, the electric potential being applied between the bottle and stencil as in the FIGURE 2 embodiment to accomplish the electrostatic transfer of the particles expressed through the screen.

The exemplary embodiments described above possess several common advantages over those referred to in the initial portion of the specification. A layer of powder of uniform thickness and density is expressed through the image aperture of the stencil so that a uniform density of printing is achieved over the entire image area on the bottle. The powder particles within the layer are at rest when the electric field is applied and thus have their motion during transit to the article surface entirely and solely under the control of the electric field. Cleaning of the stencil between successive printing operations is unnecessary because the upper surfaces of the stencil, apart from the screen within the boundaries of the image opening, are not exposed to printing powder.

In those embodiments where an electrically conductive stencil is employed, especially those having fine mesh screen, the close proximity of the metal of the stencil to the hot bottle may cause thermal expansion of the screen. In the methods disclosed above, the screen is maintained taut and true at all times because of the upward pressure exerted against the screen by the printing powder beneath it.

The methods disclosed above are especially well adapted for printing on bottles having concavely curved—i.e. narrow-waisted—body portions because the shape of the brush or upper surface of the pile may be easily conformed to the desired curvature while still achieving the tautness of the screen upon exposure to the high bottle surface temperatures.

While various exemplary methods have been described in detail above, it is believed that it will be apparent to those skilled in the art that the methods described may be varied or modified. Therefore, the foregoing description is to be considered exemplary rather than limiting, and the true scope of the invention is that defined in the following claims.

I claim:

1. The method of electrostatically printing a heated glass surface comprising the steps of locating a supply of printing powder beneath an electrically conductive

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stencil having openings therein defining the image to be printed, mechanically pressing the supply and lower side of the stencil against each other to express a predetermined amount of powder upwardly through said openings to form an image-shaped layer of powder of substantially uniform thickness projecting above the upper side of said stencil, applying an electric potential between a heated article to be printed and said stencil, and bringing the heated and electrically charged article surface to be printed into spaced vertical registry above the expressed layer of powder while maintaining the stencil pressed against the powder supply.

2. The method of electrostatically printing comprising the steps of forming a layer of printing powder of substantially uniform thickness upon the surface of an electrically conductive plate, locating a stencil having openings therein defining the image to be printed above said layer of powder, mechanically forcing the stencil and the plate against each other to express powder from said layer upwardly through the openings in said stencil to form an image-shaped layer of powder of substantially uniform thickness above said stencil, bringing an article to be printed into spaced vertical registry above the layer of powder and applying an electric potential between the article and the plate to electrostatically attract the expressed powder to the article surface.

3. The method of electrostatically printing a heated glass surface comprising the steps of supporting a layer of printing powder of uniform thickness upon an electrically conductive carrying plate, pressing a stencil having openings therein defining the image to be printed downwardly upon the layer of powder supported on the plate to mechanically express a predetermined amount of powder upwardly through the stencil openings to form an image-shaped layer of powder of substantially uniform thickness at the upper side of said stencil, applying an electric potential between a heated article and said carrier

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plate, and bringing the heated and electrically charged article surface to be printed into adjacent vertical registry above the expressed layer of powder while maintaining the stencil pressed downwardly against the layer of powder supported upon the carrier plate.

4. The method of electrostatically printing a heated glass surface comprising the steps of forming a bed of printing powder having a flat upper surface upon a support, locating an electrically conductive stencil having openings therein defining the image to be printed above the flat upper surface of said bed, mechanically pressing the upper surface of the powder bed and the lower surface of the stencil against each other to express a predetermined amount of powder upwardly through the stencil openings to form an image-shaped layer of powder of substantially uniform thickness above upper side of said stencil, applying an electric potential between a heated article and said stencil, and bringing the heated and electrically charged article surface to be printed into adjacent vertical registry with the expressed layer of powder while maintaining the stencil pressed against the powder supply.

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ROBERT E. PULFREY, *Primary Examiner*.

DAVID KLEIN, *Examiner*.

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,241,483

March 22, 1966

Richard Dwight Duff

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 1, lines 15 and 16, for "now U.S. Patent No. 3,150,547" read -- now abandoned --.

Signed and sealed this 18th day of October 1966.

(SEAL)

Attest:

ERNEST W. SWIDER

Attesting Officer

EDWARD J. BRENNER

Commissioner of Patents