Sept. 17, 1968 D. M. FREDRICKSON 3,401,628

METHOD OF ELECTROSTATICALLY COATING RECESSED SURFACES

Filed July 2, 1964

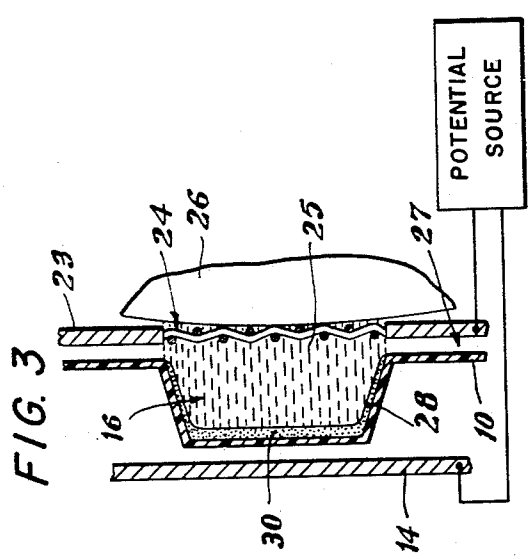

FIG. 3

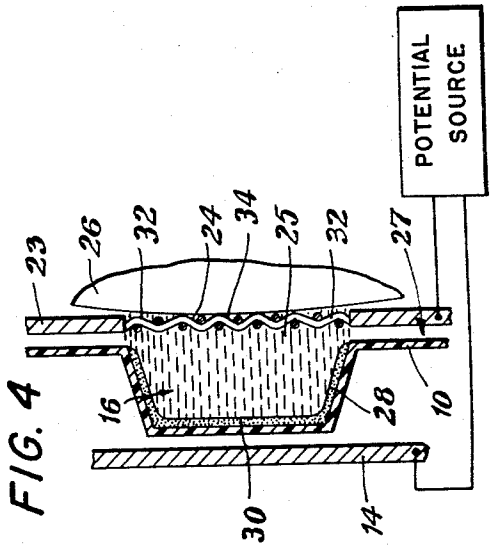

FIG. 4

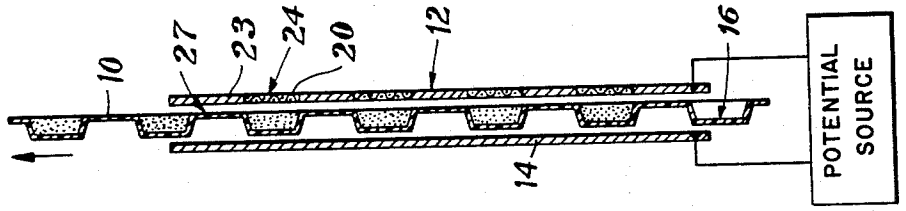

FIG. 2

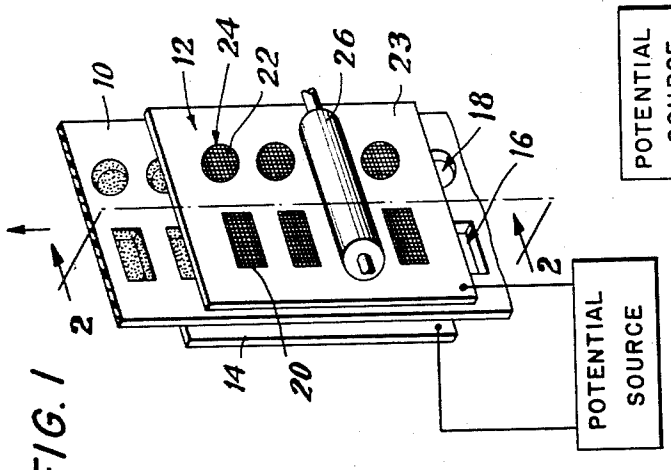

FIG. 1

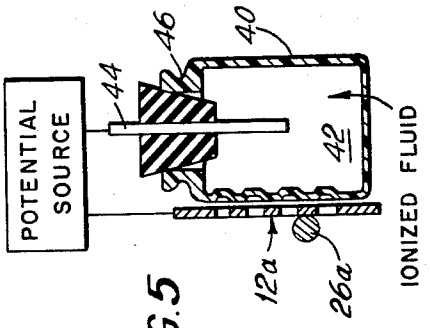

FIG. 5

INVENTOR.
DONALD MARVIN FREDRICKSON
BY Leonard K. Kohan
ATTORNEY

United States Patent Office 3,401,628 Patented Sept. 17, 1968

3,401,628

METHOD OF ELECTROSTATICALLY COATING RECESSED SURFACES

Donald Marvin Fredrickson, Trenton, N.J., assignor to American Can Company, New York, N.Y., a corporation of New Jersey

Filed July 2, 1964, Ser. No. 379,970
4 Claims. (Cl. 101—129)

ABSTRACT OF THE DISCLOSURE

A method for uniformly electrostatically coating recesses upon the surface of a substrate material by utilizing a stencil-like screen through which coating particles pass. The screen has varied sized apertures such that the larger apertures are aligned with those portions of the recesses lying most normal to the screen and the smaller apertures are aligned with those portions of the recesses lying most parallel to the screen.

This invention relates to a method for coating the recesses on the surface of a material, and more particularly to a method of utilizing an electrostatic printing technique to coat the desired depressions on an irregular surface without depositing coating upon other areas of the surface.

It is a familiar technique to decorate surfaces having depressions therein by coating these recesses and leaving the generally planar outer surface uncoated. The usual method for doing this is to coat the entire surface of the article, including both the recesses and the non-recessed areas of the material. Thereafter the excess coating material that has been deposited on those areas not recessed is generally removed by wiping. The remaining paint within the recesses delineates the design that is desired to be emphasized and is not generally subject to excessive abrasion through handling.

It is quite obvious that this method of decorating is both expensive and wasteful. More material must be utilized than is needed for the decorating operation and in addition the procedure of removing this excess material is both time consuming and costly.

It is therefore an object of the present invention to provide a method for coating recesses on the surface of an irregular material without coating the non-recessed areas of the material.

It is another object of the present invention to provide a method of coating recesses upon the surface of an irregular material without directly contacting the surface of the material.

Still a further object of the present invention is to provide a method of coating the desired recessed portions of a generally planar surface without also depositing the coating on the surface of other areas of the material.

Yet another object of the present invention is to provide an inexpensive and simple method of decorating an article having an irregular surface.

A still further object is to uniformly coat the recesses within the surface of a non-planar material.

Numerous other objects and advantages of the invention will be apparent as it is better understood from the accompanying description, which, taken in connection with the accompanying drawings, discloses a preferred embodiment thereof.

The above objects are accomplished by positioning a material which is to be decorated between an electrically conductive screen having a plurality of apertures therein and spaced therefrom and an electrically conductive substance. The apertures are aligned with recesses within said material that are to be coated and the screen is spaced from the material. The screen and the electrically conductive substance are connected in an electrical circuit and

an electrical potential difference is established between the screen and the substance. Finely divided pigment particles are brought to the outer surface of the screen. These pigment particles are of a size less than the size of the screen apertures and are thus able to pass through these apertures. The particles are then passed through the apertures and into an electrostatic field created between the conductive screen and the conductive substance when the electrical potential difference is established. Upon entering this electrostatic field the particles will be forced towards the material and will be deposited within the recesses that are in alignment with the screen apertures. Thereafter the deposited particles are coalesced to form a continuous coating within the recesses.

Referring to the drawings:

FIGURE 1 is a perspective view of an electrostatic coating apparatus for carrying out this invention;

FIG. 2 is a sectional view taken substantially along the line 2—2 in FIG. 1;

FIG. 3 is an enlarged partial sectional view illustrating the method of coating a recess in an embossed sheet;

FIG. 4 is an enlarged partial sectional view showing a modified form of coating a recess within an embossed sheet;

FIG. 5 is a sectional view showing the apparatus for coating recesses within the outer surface of a container.

As a preferred or exemplary embodiment of the instant invention, FIGS. 1 and 2 illustrate an embossed sheet **10** positioned between a conductive screen or stencil **12** and a conductive substance **14**. As shown in the drawings the conductive substance **14** is a metallic plate.

Although in the instant embodiment, the embossed sheet **10** is made of a plastic material, it is to be understood that this sheet may be made of either conductive or non-conductive materials such as fiber, metal, etc. If the sheet **10** is made of a conductive material, it may be used as both the conductive substance and as the material to be decorated. A series of recesses **16** and **18** are embossed in this sheet by means well known to those skilled in the art. Although the recesses are shown to be rectangular and circular in shape, it is readily apparent that the shape may be of any type desired.

Within the stencil **12** are a plurality of open screen areas **20**, **22** which conform in shape to the recesses **16** and **18** respectively. The remainder of the stencil is covered by a suitable masking material or, if desired, a separate masking plate or template **23** could be utilized to define the screened areas through which electrostatic printing will take place. Although the apertures **24** in the screen **12** may vary in size as desired, the usual procedure is to use a screen of from 100 to 300 mesh.

One pole of a direct current potential source is connected to the conductive stencil **12** while the other pole of the potential source is connected to the conductive plate **14**. When current is induced into the circuit an electric field is established in the space between the stencil **12** and the plate **14** due to the potential difference therebetween.

Finely divided pigment particles **25** are brought into contact with the outer surface of the stencil **12** by suitable means, such as the illustrated roller **26** onto which has been placed a quantity of particles. Although the roller means is shown as the method of feeding the particles to the stencil **12**, it is readily apparent that other mechanical means such as brushes, or air jets may be utilized. In addition, the particles may be transported to the screen **12** by means of electrical charges.

In carrying out this invention, the sheet **10** is placed between the stencil **12** and the plate **14** so that sheet **10** is spaced from the stencil **12**, leaving an air gap **27** therebetween. Although the plate **14** is shown to be also spaced from the back portion of the sheet **10**, this is

not a requirement but may be done for convenience. If desired, the plate **14** may abut the back of the sheet **10**. The conductive stencil **12** and the conductive plate **14** are then connected to a suitable potential source.

When the screen areas **20**, **22** are aligned with their corresponding recesses **16**, **18** in the sheet **10** the coating operation is then ready to begin (FIG. 3). The roller **26** has previously been covered with a suitable quantity of coating material, in the form of fine powder particles **25**. As the roller **26** is moved across the outer surface of the stencil **12**, the particles **25** adhering to the roller are formed through the apertures **24** in the screens **20**, **22**.

The powder particles **25** assume the charge of the conductive stencil screen **12** by contact. In addition, the particles **25** become triboelectrically charged through contact with the feed roller or brush. As there is a potential difference between the stencil **12** and the plate **14**, the particles **25** passing through the apertures **24** move through the electrostatic field in the air gap **27** toward the plate **14**. However, since the sheet **10** lies between the stencil **12** and the plate **14**, the particles **25** are deposited upon the sheet **10** in a pattern conforming to the screen areas **20**, **22** within the stencil **12**. As the recesses **16**, **18** are aligned with these screen areas **20**, **22**, respectively, the particles **25** are thereby deposited only within the recesses and not upon the generally planar surface areas of the remainder of the sheet. Thus a coating **28** will be formed within the recesses **16**, **18** and will continue to build-up as long as particles are passed through the respective screen areas aligned with the recesses and the potential difference is maintained.

Since the apertures **24** are of substantially uniform size, the thickness of the coating **28** upon the surface **30** of the recesses will vary depending upon the angle the surface **30** maintains with the plane of the screen area. Those areas of the surface **30** which are substantially parallel to the plane of the screen area will have a thickness somewhat different from those areas of the recess which are more normal to the plane of the screen area. This is due to the path the particles **25** travel between the screen **12** and the sheet **10** and the surface areas to be coated, the path being essentially normal to the plane of the screen areas **20**, **22**.

In a modified form of the invention, as shown in FIG. 4, the size of the apertures **24** will be varied somewhat in order to produce a more uniform thickness of the coating **28** on the surface **30** of a recess. In this form of the invention, the electrostatic coating technique will be essentially the same as that described hereinbefore. However, since the size of the apertures **24** near the edges **32** of the screen areas **20**, **22** will be somewhat larger than those towards the center **34**, more pigment particles **25** will be permitted to pass through the apertures **24** at the edges **32** of the screen areas **20**, **22**, than will pass through the center portions of the screen areas **20**, **22**. This will result in a tendency for a more uniform thickness of the coating **28** to be formed upon the surface **30** of the recesses aligned with their respective screen areas.

After the coating **28** has been deposited within the recesses **16**, **18** it is necessary for this coating to be coalesced in order to securely adhere it to the surfaces of the recesses. It is readily apparent that the procedure for coalescing will vary according to the type of particle used for the coating. Two methods which are apparent to those skilled in the art are heat fusing or solvent solution.

Since there are many variables present in the process, such as distance between sheet **10** and the stencil **12**; the size of the powder particles; the magnitude of the D.C. potential; etc., these conditions may be varied in carrying out this invention without in any way departing from it.

Although the air gap **27** between the conductive screen **12** and the sheet **10** is preferably as narrow as possible,

in order to reduce the magnitude of the voltage necessary to effect transfer of the particles **25**, it has been found that this gap may be as great as 0.50 inch. It is apparent that the greater the magnitude of the gap **27** the greater will be the magnitude of the potential difference between the screen **12** and the conductive substance **14**.

Particle size will, of course, vary with the size of the screen apertures. Certain powders have been found to be more responsive to certain polarities than others and will, therefore, produce better results for a given polarity of the conductive screen. However, any suitable pigment powder may be utilized in carrying out this invention, so long as the particle size will not be so great as to prevent its passage to the screen apertures.

The magnitude of the potential difference between the stencil **12** and the plate **14** will be such as to provide a satisfactory movement of the particles **25** toward the screen **10** without resulting in an electrical short between the stencil **12** and the plate **14**. Voltages between 500 and 10,000 volts D.C. are generally adequate for carrying out this process.

Although the invention has been described with the use of generally planar sheets of recessed material, it is readily apparent that other shapes having recesses therein may also be coated using the process of this invention. For instance, ordinary glass or thermoplastic bottles having depressions in their outer surfaces may be coated using the process hereinbefore described.

If an article, such as a bottle **40** is to be coated (see FIG. 5), another type of conductive substance rather than the plate **14**, hereinbefore described, may be used. A fluid substance such as a conductive liquid or an ionizable gas **42** may be placed within the bottle **40**, an electrode **44** may then be placed within the neck **46** of the bottle and a suitable voltage impressed thereon to charge the liquid or ionize the air or other gas within the bottle **40** thereby providing a conductive fluid substance to which a conductive screen **12***a* may be electrically connected. Thus the electrostatic field for carrying out the transfer of the particles from a source, such as the roller **26***a*, through the conductive screen to the object to be coated is created.

The term "conductive substance," as used herein, is intended to mean a substance that will cooperate with an electrode when an electrical potential is applied thereto, to establish an electric field therebetween which can transfer charged particles as described herein.

In some modifications of this concept it is possible that the image bearing screen may not itself be charged, but will serve only to define an image area for particles delivered from a charged plane above it. For instance, the roller or brush applicator may be the charged plane.

It is thought that the invention and many of its attendant advantages will be understood from the foregoing description and it will be apparent that various changes may be made in the steps of the methods described and their order of accomplishment without departing from the spirit and scope of the invention or sacrificing all of its material advantages, the form hereinbefore described being merely a preferred embodiment thereof.

I claim:

1. A method of substantially uniformly coating recesses upon the surface of container wherein portions of said recesses are substantially parallel to an electrically conductive screen and portions of said recesses are substantially normal to said screen, comprising the steps of:

positioning said container adjacent to, but spaced from, an electrically conductive screen having a plurailty of varied-sized, relatively large apertures to be placed in alignment with said substantially normal recessed portions and relatively smaller apertures to be placed in alignment with said substantially parallel recessed portions therein, said container having therein an electrically conductive ionizable fluid, said

screen and said fluid being connected in an electrical circuit;

aligning said screen apertures with said recesses and spacing said screen from said material so that the larger apertures are aligned with those portions of said recesses being most normal to said screen and the smaller apertures aligned with those portions of said recesses being most parallel to said screen;

establishing an electrical potential difference between said conductive screen and said conductive fluid to ionize said fluid and establish an electrostatic field between said screen and said ionized fluid;

bringing finely divided pigment particles to the outside surface of said screen, said particles having a size less than the size of the smallest of said screen apertures and able to pass through said apertures;

passing said particles through said apertures and into said electrostatic field between said conductive screen and said ionized fluid, whereby said particles will be forced toward said container and will be deposited in a substantially uniform coating upon the surfaces

within said recesses in alignment with said screen apertures;

and coalescing said deposited particles to form a continuous coating within said recesses.

2. The method of claim 1 wherein said finely divided pigment particles are triboelectrically charged.

3. The method of claim 1 wherein in the step of establishing an electrical potential difference, said electrical potential difference is between 500 and 10,000 volts D.C.

4. The method of claim 1 wherein said deposited pigment particles are coalesced by heating.

References Cited

UNITED STATES PATENTS

2,024,087	12/1935	Ballard	101—127
2,341,827	2/1944	Sukumlyn	118—301 XR
3,191,574	6/1965	Robertson	118—308 XR

ROBERT E. PULFREY, *Primary Examiner.*

E. S. BURR, *Examiner.*