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Brody et al.

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[54] **METHOD AND APPARATUS FOR ELECTROSTATICALLY COATING AN OBJECT**

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[58] **Field of Search** 117/17, 33; 118/624, 625, 118/638, 640

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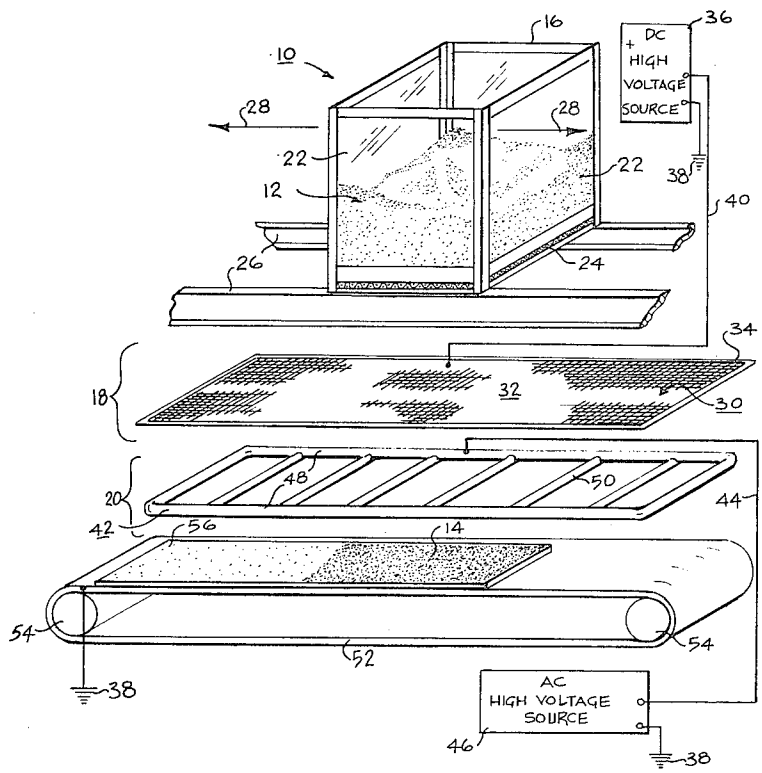
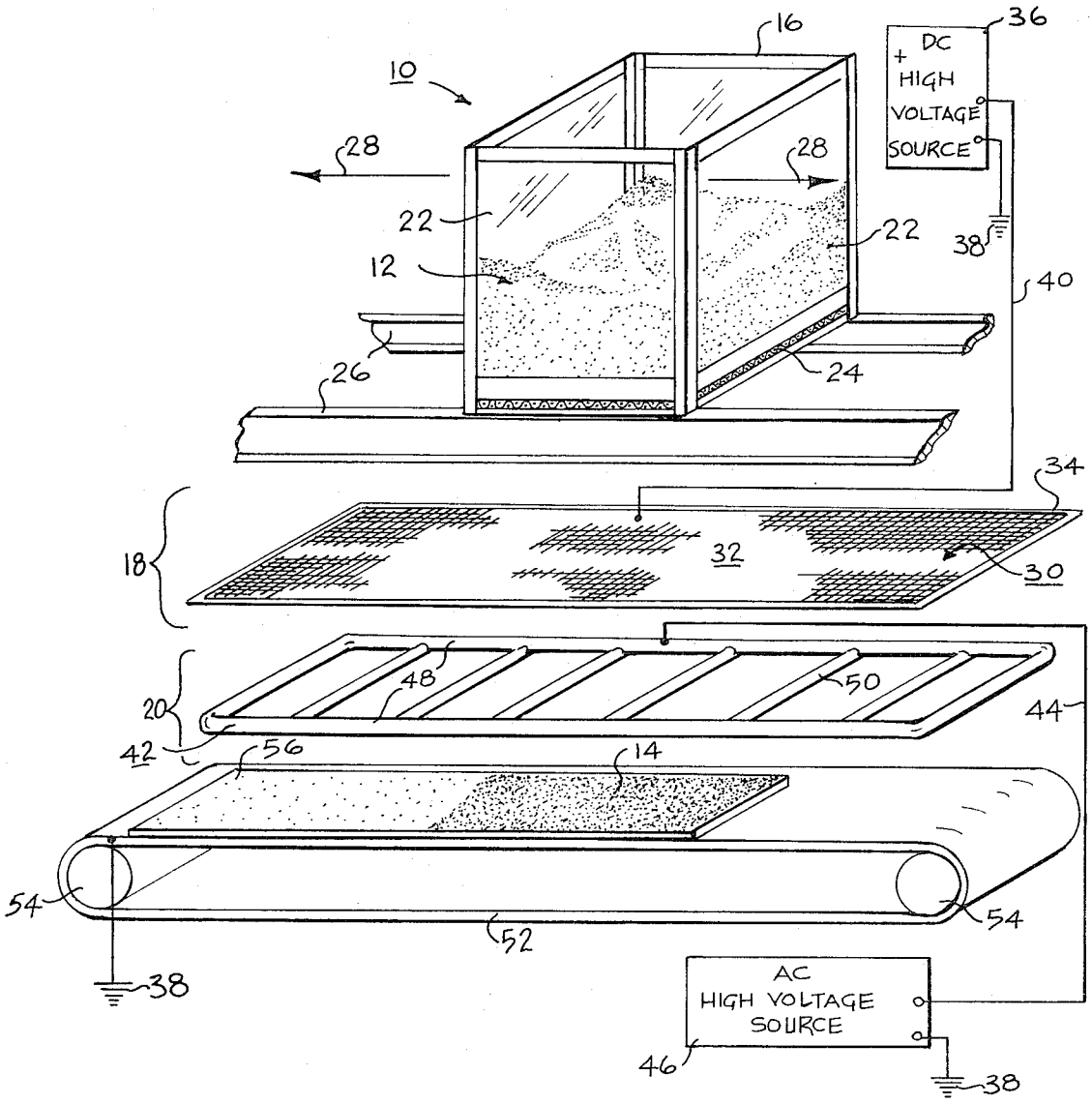
[57] **ABSTRACT**

An apparatus and method for electrostatically applying a plurality of particles such as flock to an object. The particles are placed into a hopper at an uppermost portion of the apparatus and are propelled downwardly through a metallic screen to which an unchanging electrical charge is applied. The particles are given a predetermined orientation and continue their downward passage through a metallic grid to which a changing electrical charge is applied. In another embodiment, the flock is propelled in an upward direction through changing and unchanging electrically charged zones. The particles attach themselves to the object in a uniformly dense manner and substantially align themselves in accordance with the electrostatic lines of force.

10 Claims, 1 Drawing Figure





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METHOD AND APPARATUS FOR ELECTROSTATICALLY COATING AN OBJECT

BACKGROUND OF THE INVENTION

A. Field of the Invention

The invention relates to the application of comminuted materials to an object. In particular, this invention pertains to the propulsion of flock-type material primarily through a plurality of electrically charged zones onto an adhesively covered surface.

B. Prior Art

Prior methods and apparatus are known which apply particles to a wide variey of objects wherein the particles impinging on the object are propelled in the direction of the force of gravity. However, in some of these apparatus no electrostatic force fields are introduced into the particle path. This conventional type of apparatus relies primarily on the force of gravity for propulsion of the particles and results in a non-uniform density as well as a substantially random orientation of the particles with respect to the object surfaces being coated.

In some apparatus of the gravitational-assist type the particles may be blown onto the receiving object wherein a combination of gravity and pressure propulsion is used. However, in this apparatus the particles take on a random directional orientation as well as a non-uniformly dense adhesion to the object.

In some prior systems, an alternating current charge is applied to a zone through which the particles fall before impingement on the object. However, such apparatus causes non-uniform distribution of the particles across the surface of the object and gives it an irregular texture. Additionally, the use of only one alternating current zone does not permit operator control of the flux density of the downwardly-directed particles. Further, in such apparatus, the particles impinge on the object surfaces at substantially non-uniform angles.

SUMMARY OF THE INVENTION

Apparatus and method for applying a plurality of particles to an object by propelling the particles through a plurality of electrically charged zones. The particle path passes through at least one zone containing a changing electrical field and at least one other zone which has an unchanging electrical field applied thereto.

BRIEF DESCRIPTION OF THE DRAWINGS

The sole FIGURE is a perspective view of the coating apparatus according to the present invention.

DETAILED DESCRIPTION OF THE DRAWINGS

Referring now to the FIGURE, there is shown flocking or coating apparatus **10** for applying a plurality of particles or flocking material **12** onto appropriate surfaces of the object **14**. The method and apparatus invention as herein described provides for the propulsion of particles **12** within the hopper **16** onto the object **14** through passage through a pair of electrically charged zones **18** and **20**. The flock **12** in its substantially linear translation between the hopper **16** and the object **14**, passes sequentially through a first zone **18** which has applied to it an unchanging electrical charge, and secondly through a changing electrical field zone **20**. The application of predetermined voltage to change the respective electric fields within these zones permits the operator to control the flux density of the flock **12** being captured by the object **14**. In addition, these controlled voltage fields, as hereinafter described, provide a uniform density of the flocking material **12** on the object surfaces and promote a predetermined non-random orientation of the flock **12** on the object **14**. The object **14** is adhesively coated with a glue **56** or otherwise treated, as will be described, to assure secured capture of the particles **12** after their passage through electric zones **18** and **20**.

The invention as herein defined pertains to a wide variety of comminuted materials which have the capability of accepting electrostatic charges. One such material used in the invention is commonly and commercially referred to as "D.C. electrostatically finished" flock. This type of flock may be made of cotton, rayon, synthetic fiber polyester or similar material. One company producing such material is Precision Fibers, Inc. of Chadds Ford, Pennsylvania. The comminuted material **12**, as used in the instant invention generally takes the form of elongated members having for an example, a length in the range between 50 and 250 mm, and a fineness between 6.0 and 19.0 denier. Although the flock having these lengths and weights is commercially available, the subject invention is operative through a wider range of dimensions dependent on the environmental conditions such as temperature, humidity, pressure, and other physical parameters of like nature. These physical parameters combined with the flock characteristics determine the electrical parameters to be applied in order to achieve the desired coating characteristics on the object **14**.

The particles **12** are permanently secured to the object surface through application of a glue layer **56** covering the surface to be covered. The glue **56** may be one of a number sold on the market such as water-based adhesives. Although glue **56** has been commonly used for the adhesion of the particles to the object, the object surface could be treated so as to permanently capture the particles **12** in a number of alternate ways. One method of treatment applicable to thermoplastic object surfaces is to heat the object **14** until its surface becomes relatively soft and accepts at least parts of particles **12**. It is even conceivable that the object's surface could be heated and that the ends of thermoplastic flock would be rendered tacky thereby and thus stick thereto.

The flocking material **12** is placed within the hopper **16** either manually or through some conventional automatic filling means not important to the inventive concept. The hopper **16** comprises two pairs of opposing sidewalls **22** having a screen floor **24** which permits passage of the comminuted material **12** in a downward direction. The sidewalls **22** may be opaque or transparent and made of glass, plastic or some like material to permit visual observation of the flock **12** within the hopper **16** during subsequent operations.

Opposing tracks **26** as shown in the FIGURE can be used to support the hopper **16** over the electrically charged zones **18** and **20**. If desired, the hopper **16** may be adapted to oscillate longitudinally on the tracks **26** to permit agitation of the flock **12** and facilitate the discharge of the material **12** through the screen **24**. Also, if desired, in order to break up clumps of flocking material that may form in the hopper **16**, there may be included some moveable blade members or other agita-

tion devices within hopper **16** which may also operate to force more particles through the screen mesh.

The material **12** falls from the hopper **16** into the zone **18** whose charge is produced and maintained constant by the application of a DC voltage applied to screen-member **30.** The screen-member **30** comprises a frame **34** and an attached screen **32** whose mesh is considerably larger than the mesh of floor **24** since it is not intended to retain a body of particles but only to produce an electrostatic field influencing the particles passing through the mesh. The frame **32** is mounted by insulating members, for example, to sidewalls (not shown) or to other structural components which are not important to the invention. The screen **32** is constructed of a highly conductive material such as stainless steel and is electrically connected through conductor **40** to a positive terminal of a high voltage D.C. source **36** whose other terminal is grounded. The application of the D.C. voltage to screen **32** produces an unchanging positive electrical field throughout zone **18.** In combination with gravity assist, the positive field attracts the flock **12** from the hopper **16** downward. The voltage source **36** may be adjusted between for example, 10,000–60,000 volts D.C., although the voltage, being dependent on environmental and other factors such as distance of the hopper to the object, etc., may be outside this range. The choice of voltage can also be used to modify the particle flow, e.g., to control the particle flux density.

The material **12** passing through the screen **30** is attracted into changing charge zone **20** which is produced by a changing voltage applied to the grid **42.** As shown, the grid **42** comprises opposing tracks **48** passing in the longitudinal direction **28** which are joined by transverse rails **50.** The grid **42** is made of an electrically conductive material such as stainless steel or some like material. A high voltage alternating current source **46** is connected to the ground **38** and also to the grid **42** via electrical conductor **44.** In operation, the AC high voltage source **46** and D.C. high voltage source **36** produce a pair of electrically charged zones **18** and **20,** one being a constant charge zone of one sign and the other being a changing charge zone of alternately varying signs. The flocking material **12** is further propelled onto the object **14.**

The object **14** is maintained on an upper surface of the endless belt **52** which moves by contact with rollers **54** that are driven by motors or the like in direction **28.** The belt **52** is connected to ground conditions **38** so as to ground the object **14.** As shown, the object **14** is transported in the direction **28** under the falling flocking material **12** which then adheres to the object surfaces.

In the manner described, the apparatus **10** provides for the particles **12** to be propelled sequentially through a first or unchanging charge zone **18** and then through a second or changing charge zone **20.** The particles after passage through the zones **18** and **20** impinge on and stick to the adhesively covered or otherwise treated surfaces of the object **14.** The particles **12** align themselves substantially in the direction of the electric field lines and therefore maintain a predetermined non-random orientation with respect to the object surface.

It should be understood that the positions of the electrical zones **18** and **20** as shown in the FIGURE may in some instances be reversed such that the particles **12** initially enter the changing charge zone **20** and then pass to the unchanging charge zone **18.** Furthermore, the particles **12** contained within the hopper **16** are shown to be aided by gravity during propulsion to the object surfaces, but the particles may be propelled in a gravitationally opposed direction toward the object through the DC and AC fields as taught herein.

In such an embodiment, the hopper **16** would be located below the belt (or object) and above the hopper there would be electrostatic zone **18** and electric zone **20** and finally the object **14.** In this case, the object **14** would have to be mounted or somehow fixedly secured to an upper panel member over the upwardly-directed material **12.**

Another embodiment of the method and apparatus invention concept may be found through the use of more than two charged zones. In this embodiment, the particles **12** may be propelled through three or more zones in an alternative sequence of changing, unchanging, changing, etc., charge characteristics. The flux density of the object impinging flock material **12** may thus be varied by controlling the D.C. voltage applied to the electrodes of one or more of the unchanging charge zones as is done in the embodiment shown in the sole FIGURE.

While different and desirable embodiments of the present invention have been shown, it is to be understood that this disclosure is for the purpose of illustration only and that various changes and modifications may be made without departing from the spirit and scope of the invention as set forth in the appended claims.

What is claimed is:

1. An apparatus for applying a plurality of flock particles to an object comprising means for supporting an object to which particles are to be applied, means for supplying particles which are to be applied to the object, first means for generating an unchanging electrical field, said first means being disposed between said supply means and said supporting means; second means for generating a changing electrical field, and said first means being disposed between said supply means and said second means.

2. An apparatus as defined in claim **1** wherein said object supporting means is below said supply means.

3. An apparatus as defined in claim **1** wherein said first and second means comprise electrically conductive members with openings therein, and said openings are large enough to permit substantially unimpeded passage of said particles therethrough, said first means being coupled to a source of direct current and said second means being coupled to a source of alternating current.

4. An apparatus as defined in claim **1** wherein said object supporting means is above said supply means.

5. An apparatus as defined in claim **4** wherein said first and second means comprise electrically conductive members with openings therein, and said openings are large enough to permit substantially unimpeded passage of said particles therethrough, said first means being coupled to a source of alternating current and said second means being coupled to a source of direct current.

6. A method for applying a plurality of flock particles to an object comprising the steps of providing a supply of flock particles and an object to which said flock particles are to be applied, applying a changing electric

field to said flock particles between said supply and said object, and applying an unchanging electric field to said flock particles between said changing electric field and said supply so that some of said flock particles are repelled by said unchanging electric field and the remainder of said flock particles are driven by said changing electric field to said object.

7. A method as defined in claim **6** wherein said unchanging electric field is achieved by applying a direct current thereto and said changing electric field is achieved by applying an alternating current thereto.

8. A method as defined in claim **6** including the step of positioning said supply and said object so that said particles are transported primarily in the direction of the force of gravity.

9. A method as defined in claim **6** including the step of positioning said supply and said object so that said particles are transported primarily in a direction against the force of gravity.

10. A method as defined in claim **6** including the step of varying the density of said flock particles in said changing electric field by regulating the strength of said unchanging electrical field.

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