Jan. 23, 1968 W. T. FISHER ETAL 3,364,853

ELECTROSTATIC PRINTING WITH MEANS TO PREVENT FREE CHARGE FLOW

Filed Dec. 27, 1966 2 Sheets-Sheet 1

FIG. 1.

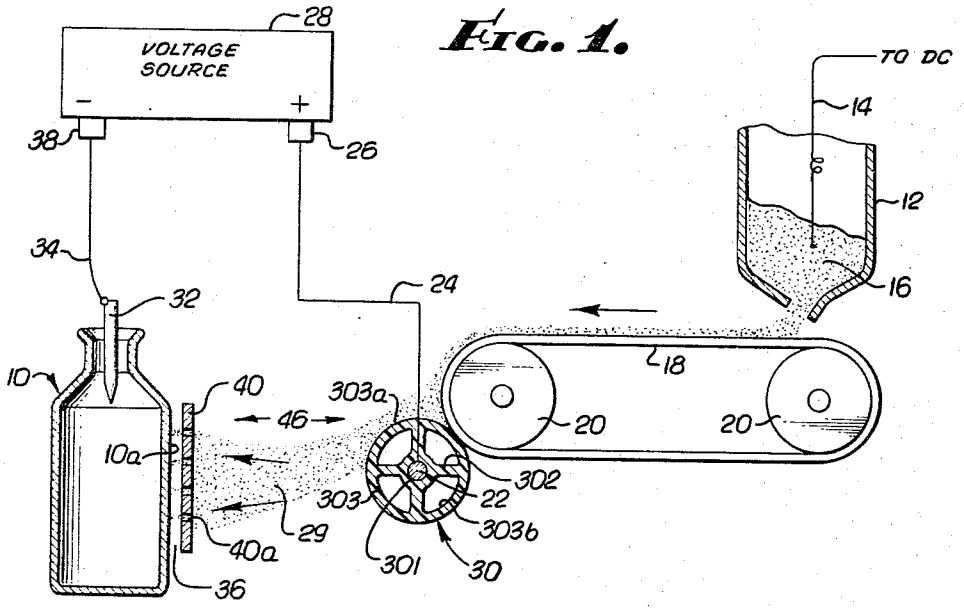


FIG. 2.

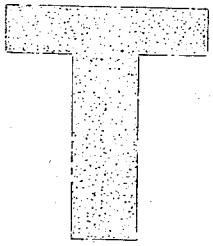
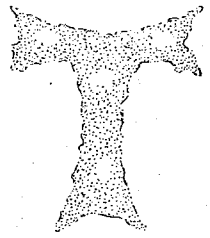


FIG. 3.



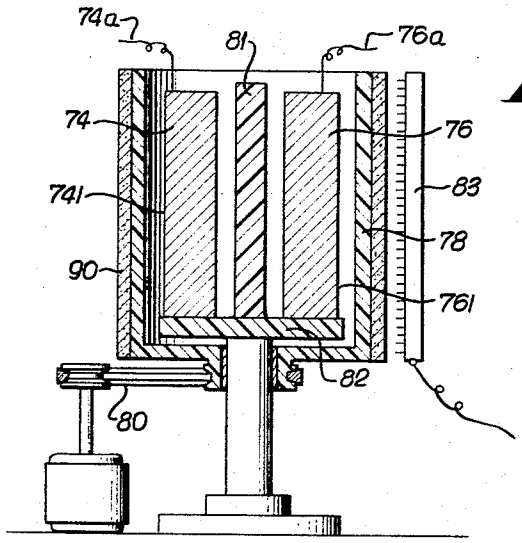


FIG. 8.

INVENTORS.
WILLIAM T. FISHER
ROBERT D. THOMPSON
CHARLES B. PATTERSON
STANLEY M. DAHL
BY White & Haefliger
ATTORNEYS.

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Fig. 4.

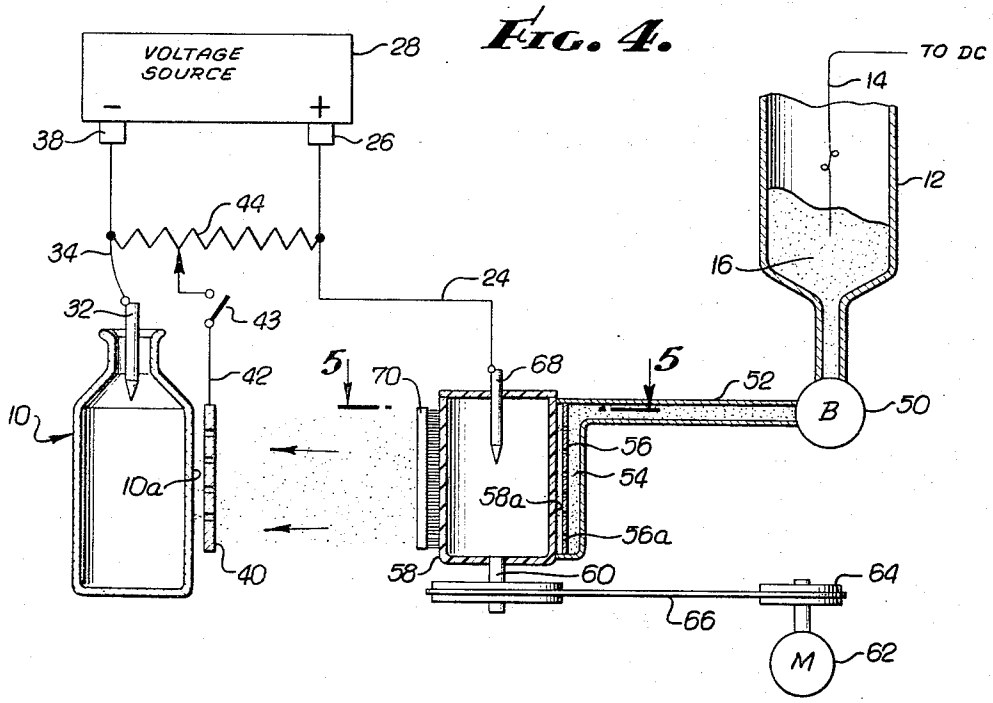


Fig. 5.

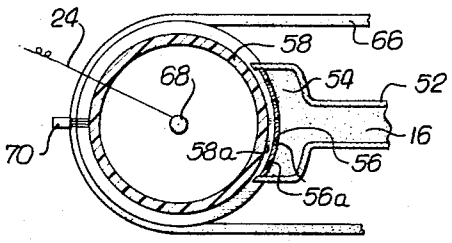


Fig. 6.

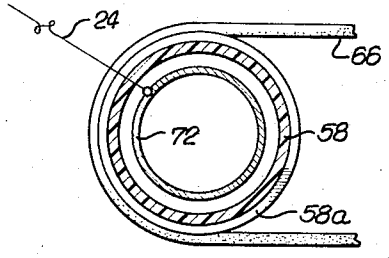
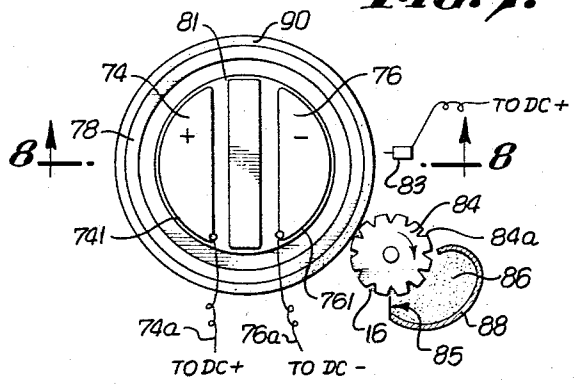


Fig. 7.



INVENTORS.
WILLIAM T. FISHER
ROBERT D. THOMPSON
CHARLES B. PATTERSON
STANLEY M. DAHL
By White & Haefliger
ATTORNEYS.

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3,364,853

ELECTROSTATIC PRINTING WITH MEANS TO PREVENT FREE CHARGE FLOW

William T. Fisher, Los Alamitos, Robert D. Thompson, San Jose, Charles B. Patterson, Lakewood, and Stanley M. Dahl, Whittier, Calif., assignors to Purex Corporation Ltd., Lakewood, Calif., a corporation of California

Continuation-in-part of application Ser. No. 479,461, Aug. 13, 1965. This application Dec. 27, 1966, Ser. No. 605,002

21 Claims. (Cl. 101—114)

ABSTRACT OF THE DISCLOSURE

In a printing method in which electrically charged particles are launched from an electrode and pass through a stencil and onto a target surface, free charge flow from the launching electrode to the image area and possibly to the stencil alters the image forming field and the resultant spurious field lines interfere with particle trajectories to the detriment of printed image fidelity to stencil aperture and sharpness of image boundaries and can cause pocking of images as well. The invention limits free charge flow in such printing methods by intercepting the free charge flow, illustratively with an essentially nonconductive body extending substantially across the field inducing particle movement, to enhance print fidelity, sharpen boundary definition and reduce pocking. The intercepting body is conveniently used to launch the printing particles which may be precharged for launching.

This application is a continuation-in-part of our copending application, Ser. No. 479,461, filed Aug. 13, 1965.

This invention relates to improved methods and apparatus for coating, printing, decorating or to like purposes depositing particles such as fine electroscopic pigment by electrostatic means on surfaces of planar or curvilinear configuration, and is applicable to the direct labeling or decoration of sheet or containers and other objects of irregular or intricate shape made from paper, plastic, glass, metal or combinations of these, or of other materials which have conductive or nonconductive surfaces. More particularly, the invention is concerned with achieving more faithful replication of characters, logos and like patterns of printed image by limiting the flow of free charges to the image areas tending to divert particles from the image areas thus to insure adequate particle deposition and good image boundary definition and to stabilize deposited images against pocking for heightened legibility of deposited image.

Electroscopic toner particles, either solid or liquid, may be printed on a target surface by passage of the massed particles through a stencil screen which is positioned opposite and in closely spaced relation to the target surface. An electrical field is maintained between the target and a spaced voltage source within which field the stencil is positioned so that electrically charged printing particles within the field are induced to move through stencil aperture areas corresponding to the pictorial or literal matter to be printed, and to project onto the target surface.

Creation of the required electrical field is effected by the application of a voltage differential between what may be termed a launching electrode and the object surface to be printed which is spaced therefrom with the stencil therebetween. Electrically charged particles, e.g. of pigment are launched into the field for passage to the target surface. Counter-electrode means are so associated with the target surface that the stencil-passing particles are caused to deposit on the surface. Such counter-electrode means may have any of various particular forms, such as the target surface itself where conductive, or a conductive backing for a nonconductive surface or a separate electrode, in effect backing the target surface. In container printing, a counter-electrode inserted in the container, or projected only partially thereinto, so as to ionize fluid within the container, creates an effective counter-electrode condition.

A continuing problem in electrostatic printing is the difficulty of achieving perfect replication of the stencil aperture. Often the lettering is "out of square," having attenuated corners and concave intermediate portions, with an unfortunate randomness that causes a picturesque illegibility in the final print, particularly where lettering is extensive and relatively small as, for example, use instructions on a package. In addition the lettering boundaries may be indistinct whether the letter is "square" with the stencil or not. Uniformity of printing particle density across and up and down the letter is sometimes a problem too, with cratering apparent randomly throughout the image areas. A further problem is insufficient printing particle flow to the image areas to cover the substrate with the opaque layer needed for good contrast and attractive printing.

We have discovered that all these problems are due at least in part to the presence in the image area of charges of like sign to the deposited particles. When the concentration of these charges is great enough, the field strength to the object surface is diminished, obviously, since there are significant quantities of like charges adjacent the supposedly opposing electrode condition. This reduces printing particle flow, which is dependent on field strength, and thus image intensity. The presence of these charges causes fuzziness of images because about-to-deposit particles are diverted by the electrically repelling charges in the image area. Similarly, already deposited particles will scatter within the image area with resultant pocking and cratering. Poor replication of stencil aperture outline is the result of these image areas charges forming spurious fields with the adjacent stencil, the field lines of which tend to bow the printing particles from their intended trajectory.

The present invention is predicated on the major concept, among others, of controlling charge accumulation in printing image areas, specifically by preventing free flow of charge to such areas during and between successive printing particle launchings. It has been found that at the high field strengths typically employed in electrostatic printing for rapid and voluminous particle movement, significant amounts of free charges, i.e. charges not associated with printing particles and only loosely bound to the launching electrode traverse the gap between electrode and image area and accumulate there to form a localized concentration of charge. These concentrations set up secondary, spurious fields between the stencil and object, emanating lines of force able to influence printing particle trajectory, to the dilution of the effectiveness of the primary electrical field in determining particle flight patterns and resulting in the caricature printing and other miscreations described above. Intercepting free charge flow tending to divert particles from the image area has been found to correct the foregoing difficulties insofar as they are caused by free charge accumulation in the image areas.

Thus the present invention provides a method of printing upon the surface of an object such as a polyethylene bottle that includes depositing electrically charge printing particles such as electroscopic pigment upon the surface to form a printed image area and in so doing generating a flow of free charges to the image area tending to divert particles from the image area and intercepting this

flow away from the image area. The particles traverse an electrical field maintained between the object and a spaced voltage source. Flow limitation is achieved generally by intercepting flow from the field forming voltage source, which typically has a charge sufficient to cause free charge flow to occur, by positioning an essentially nonconductive body in the path of the flow such as a dielectric plate, hemisphere, or semi-cylinder, e.g. of synthetic organic plastic material. Printing particles are selectively passed to the image areas of the object surface through an image area defining stencil maintained in the electrical field between the object and the nonconductive body. The stencil is maintained at some charge condition either biased, grounded or unconnected which is nondeflective of the trajectory of particles passing therethrough.

In certain embodiments of the invention use is made of the nonconductive, flow limiting body to convey the printing particles into the electrical field at a point opposite the stencil. For this purpose, the nonconductive body is constructed to be moveable entirely or portionwise out of the field for receiving printing particles, generally precharged to the same sign as the launching electrode, and returnable to the field for releasing the printing particles and introducing such particles into the field for travel to the stencil and beyond to the printable surface.

Further benefits accrue from practice of the method, particularly where the launching electrode is insulatively enclosed with nonconductive or dielectric material such as the free charge flow limiting body, in that operators are shielded from sparking discharge. In addition, free charge flow-occasioned cratering or image pocking is reduced as well.

In the printing of containers, to which the invention is well adapted, the container having a surface to be printed is positioned at a printing station, an electrical field is generated between the spaced voltage source and the container and electrically charged particles are passed through the stencil to the container at the printing station in the manner described above, while maintaining an essentially non-conductive body between the stencil and voltage source to intercept free charge flow from the voltage source.

Apparatus is provided for carrying out the above method of printing on the surface of an object that includes printing means for depositing electrically charged particles upon that surface in a manner generating a flow of free charges to the image area tending to divert particles from this area and means for intercepting such flow away from the image area such as an essentially nonconductive body. The printing means typically includes as the voltage supply means, a launching electrode spaced from the object for generating an electrical field therebetween; the nonconductive body is placed within the field to intercept free charge flow from the voltage supply means. Image and nonimage areas are defined by a stencil between the essentially nonconductive body and the object for selectively passing printing particles to the object surface. Conveniently, means for conveying particles into the field opposite the stencil is provided which may be associated with the nonconductive body such as a layer of mohair or other material capable of engaging the printing particles outside of the field and releasing them in the field. In a particular embodiment, the particle conveying means and non-conductive body are jointly movable entirely or portionwise out of the field. For example, the conveying means and body can be mounted to rotate about the launching electrode, first to receive, at a first position during revolution, printing particles, precharged or to be charged on the body and to convey said particles to between the launching electrode and the stencil; and second to release the particles, at a second position during revolution and opposite the stencil, as a stream toward the stencil and the object therebeyond; the launching electrode functioning as a means for electrically repelling with a launching force the particles from the combination insulative body and conveying means.

As applied to the printing of containers, means is additionally provided for positioning the container at a printing station within the electrical field and adjacent the stencil and a specific arrangement of parts is preferably employed including, as a nonconductive body to intercept free charge flow, a rotatably mounted cylinder of synthetic organic plastic material which encloses a relatively stationary, insulatively spaced pair of separated electrodes extending axially within the cylinder whereby on rotation alternate portions of the cylinder are subjected to field reversal successively in passing said electrodes.

The invention will be further described as to one illustrative embodiment thereof in conjunction with the attached drawings in which:

FIG. 1 is a view diagrammatically illustrating the invention as applied to improved printing on a container formed of dielectric material, such as polyethylene;

FIGS. 2 and 3 are views illustrating diagrammatically the variation in printed images, respectively with and without the use of the invention;

FIG. 4 is a view like FIG. 1 showing an alternate form of apparatus;

FIG. 5 is a view along line **5**—**5** in FIG. 4;

FIG. 6 is a view similar to FIG. 5 of an alternate form of particle launching and electrode apparatus;

FIG. 7 is a view similar to FIG. 5 of a further alternate form of particle charging, launching and electrode apparatus; and

FIG. 8 is a view taken along line **8**—**8** in FIG. 7.

Referring, now, to the drawings in detail there is shown in FIG. 1 a typical improved printing apparatus according to the present invention, particularly adapted to print or decorate an open-mouth container **10** having a printable surface **10***a*. Printing means for depositing electrically charged particles upon the container surface are shown including a printing particle supply comprising a hopper **12** having a charging wire **14** connected to, e.g. a positive D.C. source (not shown) for charging printing particles **16**, and conveyor belt **18**, suitably of rubber or cloth, which is driven continuously beneath the hopper outlet between sheaves **20**. Printing particles **16**, electrically charged within the hopper, fall by gravity onto the belt **18** and are carried to the launching area. There, launching electrode **22** is provided connected at **24** to, illustratively, the positive terminal **26** of a D.C. voltage supply **28** so that the particles **16** are repelled by the electrode **22** and thus launched as a stream **29**. An essentially nonconductive body is provided surrounding the electrode **22** to act as the actual launching surface, here shown in the form of cylinder **30** for purposes to be explained hereinafter. A counter-electrode means is provided to define an electrical field with electrode **22** including conductive probe **32** positioned within container **10** at the open mouth or neck thereof. The probe is connected at **34** to, illustratively, the negative terminal **38** of the D.C. voltage supply **28** to receive a charge to ionize the fluid medium inside the container so that the particles of stream **29** are attracted to the thereby created counter-electrode condition and surface **10***a*. Within the field thus defined there is placed a printing pattern defining stencil **40** of dielectric material or preferably, conductive material, generally of brass or beryllium-copper shim stock, which may be entirely unconnected, as shown, or grounded or biased to some value.

The stencil is provided with image defining apertures **40***a* which permit portions of printing particle stream **29** to pass the stencil and impinge on the container surface. The stencil apertures may be produced mechanically as by blanking out with a suitable die or in a punch press, or chemically or electrochemically, by etching away unmasked areas of the sheet stock, or by other suitable means.

In the typical arrangement shown in FIG. 1, the electrical field will generally have a quite high potential, e.g. on the order of 20,000 to 100,000 volts or more. This is provided by application of a voltage differential to the electrodes in a known manner and ordinarily by application of 40,000 to 60,000 volts to the launching electrode and 10,000 to 20,000 volts of opposite polarity to the probe of the counter-electrode.

For illustrative purposes herein, the launcher will be considered as positively charged and the probe therefore negatively charged. The particles will then be positively charged. It is to be noted that it is the relationship of the electrode polarities to one another and to the particles and not their sign that is of significance in printing. So while the illustrative apparatus is described herein with a positively charged launching electrode and a negatively charged counter-electrode and positively charged particles are employed, results would be identical if all signs were opposite.

Under the strong field conditions just described, a phenomenon occurs known as free charge flow from the launching electrode, as a result of charges loosely associated with the electrode material. Unless intercepted as provided for in the present invention, the excess charge flows to the image area and to the stencil even in the absence of electrical connection therebetween and independently of particle flow. Accumulation of positive charges in the image areas makes these areas positive charge rich, and field strengths between the launching electrode and the object surface are proportionately reduced, because the potential difference therebetween has been decreased. In addition, particles bearing positive charges launched toward the object are met in the image areas with like and therefore repelling charges to an increasing extent as the free charge flow from the launching electrode continues. Moreover, there is accumulation of positive charges on the stencil too, which alters the stencil charge condition unless grounded, particularly at the apertures perimeters and produces local charge concentrations which may significantly affect direction of particle movement beyond the stencil to the object. The net effect of these charge accumulations on the image area and stencil is diversion of the particles from the true path defined by the stencil and in particle dislocation following printing. In general, like charge accumulation in the image area tends to cause fuzziness in image outline as the particles are outwardly diverted from the charge rich image area slight and random distances. And deposited particles are repelled by the charge condition in the image area and tend to move to balance charges in that area. The result is appearance randomly of bare spaces or "pocking" where charge accumulation is great because there is at these locations charge, but not printing particles. These charge accumulations may set up spurious fields, e.g. between the stencil and the object surface whose lines of force will exercise directional effect on printing particles between the stencil and object and result in the "out-of-square" printing described above.

While it is contemplated that the stencil 40 during printing may have any desired closeness of approach to the container surface 10*a*, generally it is desirable to maintain at 36 sufficient spacing to preclude contact smearing of the deposited particles. The spacing at 46 between the launching electrode and stencil can range from zero spacing where stencil and electrode are integral to relatively wide spacing, typically in the range of 3 to 15 centimeters, which is desirable to promote and insure dispersion of particles constituting the stream 29 for free passage through the stencil openings.

Referring again to FIG. 1, the cylinder 30 is seen to be in the form of a wheel driven by means not shown and having hub 301 journaled on the electrode 22, with spokes 302 radiating from the hub to support cylinder wall 303 spaced a distance from the electrode. The surface 303*a* of the wall receives by gravity feed the charged particles 16 from the belt and conveys them angularly to opposite the stencil and thus into the electrical field between electrodes 22 and 32. Once in the field, the particles, which it will be remembered are charged to the same sign as the electrode 22 and are repelled therefore and assuming a launching level field as above described, the particles are lifted from the surface 303*a* and induced by electrical attraction to move toward the probe 32 of opposite charge. Free charge flow from the electrode 22 travels radially to impinge and collect upon the interior of cylinder 30, at inside wall surface 303*b*. In this manner flow to and accumulation at the image areas of surface 10*a* is restrained throughout printing.

It will be seen that what is required for successfully intercepting charge flow is a charge impermeable, e.g., essentially nonconductive material disposed radially around the electrode or at least across the field between the field defining electrodes.

As little as a thin coating of nonconductive material, such as a synthetic organic plastic, can form the wall surface 303*b* and provide effective interception, so that the entire cylinder 30 does not have to be fabricated of nonconductive material. Specific suitable materials to perform the intercepting functions include ceramics, especially naturally occurring oxides of polyvalent metals such as silicon, calcium and aluminum oxides, thermosetting synthetic organic polymers such as epoxies and phenolics, thermoplastic synthetic organic polymers such as olefin polymers, including specifically ethylene, propylene and butene polymers and copolymers, substituted ethylene polymers such as the polyhalogenated ethylene polymers, e.g., tetrafluoroethylene and chlorotrifluoroethylene polymers, aryl substituted polymers such as styrene and chlorostyrene polymers, as well as acyl polymers such as acrylic and methacrylic acid esters, polycarbonates and phenoxy polymers particularly those containing recurring units of polynuclear phenols such as the bisphenols combined with oxygen containing moieties derived, e.g., from epichlorohydrin or polysulfone or polyether materials, e.g., derived from condensation of bisphenols with appropriate materials, as well polyamide and polyimide materials and silicone polymers.

Referring now to FIGS. 4–8 in which like numerals are used for like parts and consistently with FIG. 1, there is shown in FIGS. 4 and 5 a variant apparatus for particle printing while inhibiting free charge flow from the launching electrode to stencil or image areas. As before, particles 16 are disposed in hopper 12 and are precharged by charging wire 14; but in this embodiment, they are conveyed as an air suspension by blower 50 along conduit 52 to plenum chamber 54 having perforated plate 56 as an outlet and abutting cylinder 58 of essentially nonconductive material rotated axially on shaft 60 driven by motor 62 through a speed reducer including sheaves 64 and belt 66. Supported within the central bore of the cylinder 58 is a launching electrode in the form of probe 68 connected at 24 with the positive terminal 26 of voltage supply source 28. The stencil 40 is connectable at 42 through switch 43 to potentiometer 44 for biasing to any desired voltage level. Or the stencil may be grounded. Particles passing through openings 56*a* in the perforate plate lodge against the exterior cylinder wall 58*a* and are carried around from plenum 54 to a point opposite to the stencil. There the dislodgement of the particles may be assisted by mechanical means such as stationary brush 70. The charge on the particles and probe 68 are such that absent the influence of the counter-electrode probe 32 the particles will remain on the cylinder surface 58*a* so that dislodgement occurs only within the field and opposite the stencil. Once launched the printing operation is effected in the aforedescribed manner.

The electrode configuration within a cylindrical free charge flow interceptor is widely variable, a central rod

running axially having been illustrated in FIG. 1 and a probe partly extending into the cylinder bore having been shown in FIGS. 4 and 5. In FIG. 6 still another form is shown, this a concentric cylinder of conductive material, sleeve **72** disposed within a cylinder **58** and connected at **24** to a voltage supply as in other embodiments. A brush electrode is also suitable.

In FIGS. 7 and 8 still another arrangement of electrodes is shown employing a pair of fixed electrodes **74** and **76** which are oppositely charged, as indicated, through connections **74***a* and **76***a* and which extend within cup-shaped nonconductive cylinder **78** which is rotatably driven by belt **80**. The electrodes are spaced apart and separated by insulating divider **81**, and supported on base **82**. The fixed electrodes extend axially through and arcuately within the cylinder interior to define a pair of positions: a first position defined radially of the curved face **761** of the electrode **76** and a similar, second position defined radially of the curved face **741** of the electrode **74**. A counter-electrode is provided at the first position to generate a field with electrode **76** in the form of a needle array **83** charged oppositely to electrode **76**, here positively. As any single point on the cylinder **78** moves angularly, it passes from the first to the second position and vice-versa and repeats. Since the electrodes defining these positions are connected to be at opposite potentials, the fields emanating therefrom are opposite and upon rotation of the cylinder alternate exterior portions thereof in passing the electrodes are subjected to successive field reversal. With such an arrangement, charged particles can be first electrostatically attracted to the cylinder, e.g., at the first position and then repelled to launched, e.g., at the second position. This is illustrated in FIG. 7 where particles **16** are mechanically conveyed to the surface of the cylinder **78** by spur gear surfaced roller **84** and in the longitudinal recesses **84***a* thereof from printing particle supply **86** disposed in semi-cylindrical shell **88** having a doctor blade edge **85** to control recess filling. These particles are given a positive charge as they pass needle array **83** and are carried angularly by the cylinder **78** to a point opposite the electrode **74**. This electrode is positively and thus like charged to the particles which therefore are repelled at the second position and fly from cylinder surface toward the target. As the cylinder rotates accumulated charge on the interior thereof is neutralized by the constantly changing field.

For added engagement of the particles, the cylinder surface is covered with a bristled or otherwise fibrous material **90** such as mohair which engages the particles. If material **90** is conductive like mohair discontinuities should be provided to prevent charge thereon from travelling around the cylinder exterior. Revolution of the cylinder conveys these particles to the second position. There, the particles are repelled by the like polarity field emanating from electrode **74** and are thus launched from the surface covering **90** toward the target surface (not shown), at which exists a particle attractive potential as hereinabove described.

The particle feed to the lauching surface such as **303***a*, **58***a* has been illustrated by gravity or air conveyor in FIGS. 1 and 4, respectively. Also suitable is mechanical transfer where the particles are carried to the launching surface by mechanical displacement. This has been snown in FIG. 7 where particles are transferred from recesses **84***a* on roller **84** to the surface, covered with a bristled material **90**, of the revolving cylinder.

Example

Electrostatic printing was effected on a polyethylene container with limitation of free charge flow by use of an apparatus similar to that shown in FIG. 8 using an electroscopic ink having a particle size of approximately eight microns. The launching electrode was a metal brush charged to 40,000 volts positive and the probe counter-electrode to 8,000 volts negative. The stencil was unconnected. The needle array was grounded and the particle charging electrode behind and insulated from the launching electrode was charged to −10,000 volts and both electrodes were encased, at diametrically opposite positions, in a polymethylmethacrylate cylinder, parallel to the cylinder center axis and in close proximity to the cylinder interior surface. Napped mohair strips two inches wide were secured to the cylinder exterior at one-half inch spacings. A uniform field was established across the container surface and literal information was sharply defined and undistorted as illustrated in FIG. 2. A duplicate experiment but without the cylinder in place was carried out. Results were as shown in FIG. 3. Border fuzziness, poor replication of stencil aperture and post-deposition pocking were encountered.

As the printing particle material, a uniformly fine powder is preferred. A suitable toner powder has a particle size of about 5 to 10 microns. A low temperature melting resinous powder may be used if it is desired to fix the toner particles by heat, but not so low that the powder sinters in storage. A satisfactory powder is essentially composed of a non-tacky, low melting and suitably colored natural or synthetic resinous material. The composition of the toner resin does not appear to be critical insofar as electroscopic launching ability and image formation are concerned. A number of electroscopically suitable resins are described in U.S. Patent No. 3,079,342. It is also possible in the instant invention, to use an electro-conductive powder consisting of flaked and polished aluminum powder having a particle size of less than about 40 microns in diameter. The aluminum powder readily produces an image under the same conditions as employed with resin-based pigment particles, the resulting image, however, must be subsequently fixed to the surface as by application of a clear coating material. A fine dispersion of a liquid toner can be used in lieu of the pigment powder. When reference is made to a pigment powder herein, it will be understood to include not only materials that may be pigments or dyes themselves, but also resins and other materials to which pigments or dyes are added or which are otherwise given color including white and black. Techniques for fixing or otherwise subsequently treating the printed images are well known in the art.

To summarize operation of the invention, printing particles **16** are electrically charged, are launched in a stream **29** by a like charged launching electrode, e.g. electrode **22** preferably from the surface of an essentially nonconductive body spaced adjacent the electrode and pass through stencil **40** and impinge on selected areas of a target such as container **10** behind which a counter-electrode condition is maintained as by a charge on probe **32**. The free charge flow normally incident to the highly charged condition of the launching electrode is intercepted before reaching the image areas on surface **10***a*, or stencil **40** by provision of the nonconductive body, typically a cylinder **30** of nonconductive material which surrounds the launching electrode and extends across the field existing between electrode and counter-electrode. With free charge flow thus contained, the free charge accumulation on image areas and stencil is prevented despite high charge concentrations on the launching electrode which, unless intercepted, would result in charge accumulations.

We claim:

1. The method of printing upon the surface of an object that includes depositing electrically charged printing particles upon said surface to form a printed image area said printing tending to generate a flow of free charges to said image area, which free charges tend to divert particles from the image area and positively preventing said flow of free charges from reaching the image area.

2. Method according to claim **1** including also maintaining an electrical field between said object and a

spaced voltage source and positioning an essentially nonconductive body within said field to intercept free charge flow from said voltage source.

3. Method according to claim 2 including also selectively passing said particles to said object surface through a stencil in said field between the object and the nonconductive body, said stencil being maintained at a charge condition which is nondeflective of the trajectory of particles passing therethrough.

4. Method according to claim 2 including also introducing the printing particles into said field at the object side of said nonconductive body.

5. Method according to claim 4 including also conveying said printing particles on said noncoductive body from outside of said field into said field for deposition on said object.

6. Method according to claim 5 including also precharging said printing particles prior to introduction into said field to the same sign as said voltage source.

7. Method according to claim 3 in which said object is a container and including positioning said container at a printing station and passing printing particles through said stencil onto the container surface at said station.

8. Method according to claim 7 including also conveying said printing particles on said nonconductive body from outside of said field into said field for deposition on said container.

9. Method according to claim 8 including also precharging said printing particles prior to introduction into said field to the same sign as said voltage source.

10. Apparatus for printing on the surface of an object that includes printing means including a conductive electrode for depositing electrically charged particles upon said surface to form a printed image area and free charge flow barrier means preventing a flow of free charges from said electrode to said image area which free charges would tend to divert particles from the image area.

11. Apparatus according to claim 10 in which said conductive electrode is spaced from said object for generating an electrical field therebetween.

12. Apparatus according to claim 11 including an essentially nonconductive body within said field between said conductive electrode and said object to intercept free charge flow from said conductive electrode.

13. Apparatus according to claim 12 including also a stencil between said body and said object for selectively passing said printing particles to said image areas.

14. Apparatus according to claim 13 including also means for introducing said printing particles into said field between said body and said stencil.

15. Apparatus according to claim 14 in which said particles are conveyed into said field on said body.

16. Apparatus according to claim 15 in which said body is alternately movable in and out of said field and is provided with means for picking up said particles outside of said field and conveying them into said field.

17. Apparatus according to claim 14 including means for precharging said particles prior to their introduction into said field.

18. Apparatus according to claim 17 including also means associated with said body movable in and out of said field for conveying particles into said field opposite said stencil.

19. Apparatus according to claim 18 in which said body and particle conveying means rotate and including also means for charging and depositing particles onto said conveying means at a first position thereof and means including said electrode for electrically repelling said particles from said conveying means with launching force at a second position thereof opposite said stencil.

20. Apparatus according to claim 19 in which said body is a rotatably mounted cylinder of synthetic organic plastic material and encloses a pair of relatively stationary, insulatively separated electrodes connected to be at opposite potentials and extending axially in said cylinder whereby on rotation alternate portions of the cylinder are subjected to field reversal successively in passing said electrodes.

21. Apparatus according to claim 17 including means defining a printing station adjacent said stencil and adapted to receive a container as the object to be printed.

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ROBERT E. PULFREY, *Primary Examiner.*

E. S. BURR, *Examiner.*