

[54] **ELECTROSTATIC COATING METHOD**
[75] Inventor: **William C. Goodridge**, Branford, Conn.
[73] Assignee: **Electrostatic Equipment Corporation**, New Haven, Conn.
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[52] U.S. Cl. **427/33**
[51] Int. Cl. **B05b 5/02**
[58] Field of Search 117/DIG. 6, 93.4 R, 17, 117/93.44, 21; 118/301, 406, 634, DIG. 5

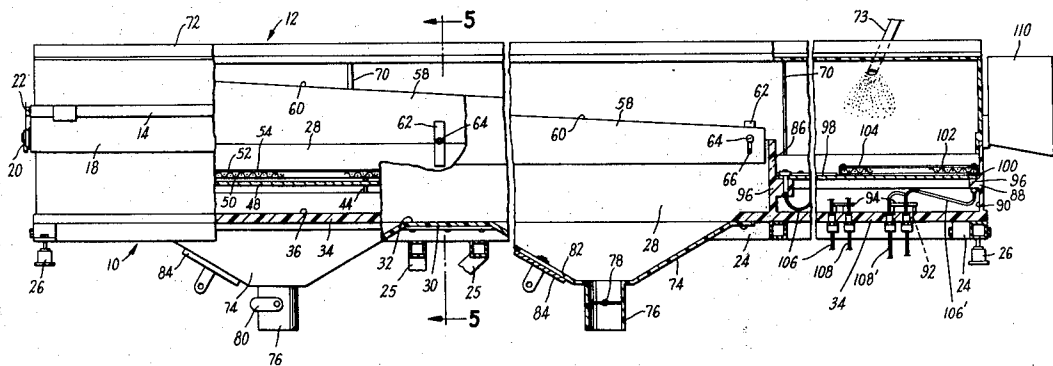
[56] **References Cited**
UNITED STATES PATENTS
2,505,063 4/1950 Palermo 91/12
2,632,716 3/1953 Starkey 117/93.44
3,061,943 11/1962 Bennett et al. 34/95
3,167,454 11/1965 Tompson 118/425

3,248,253 4/1966 Barford et al. 117/17
3,377,183 4/1968 Hurt et al. 117/17
3,382,845 5/1968 Jester 118/610
3,695,909 10/1972 Fabre et al. 117/17.5
3,713,862 1/1973 Winkless 117/17.5
3,828,729 8/1974 Goodridge 118/634

Primary Examiner—Michael Sofocleous

[57] **ABSTRACT**
Objects are coated by passing them along a travel path adjacent a baffle, on the opposite side of which a cloud of electrostatically charged particles is generated, and across an elongated edge portion of which the charged particles may readily pass. Generally, at the beginning of the travel path the lower portions of the objects will be masked by the baffle so as to promote deposition of the particles upon the upper surfaces initially. As it proceeds along the travel path, progressive exposure of the lower portions of the object will permit the complete and uniform coating thereof.

10 Claims, 8 Drawing Figures



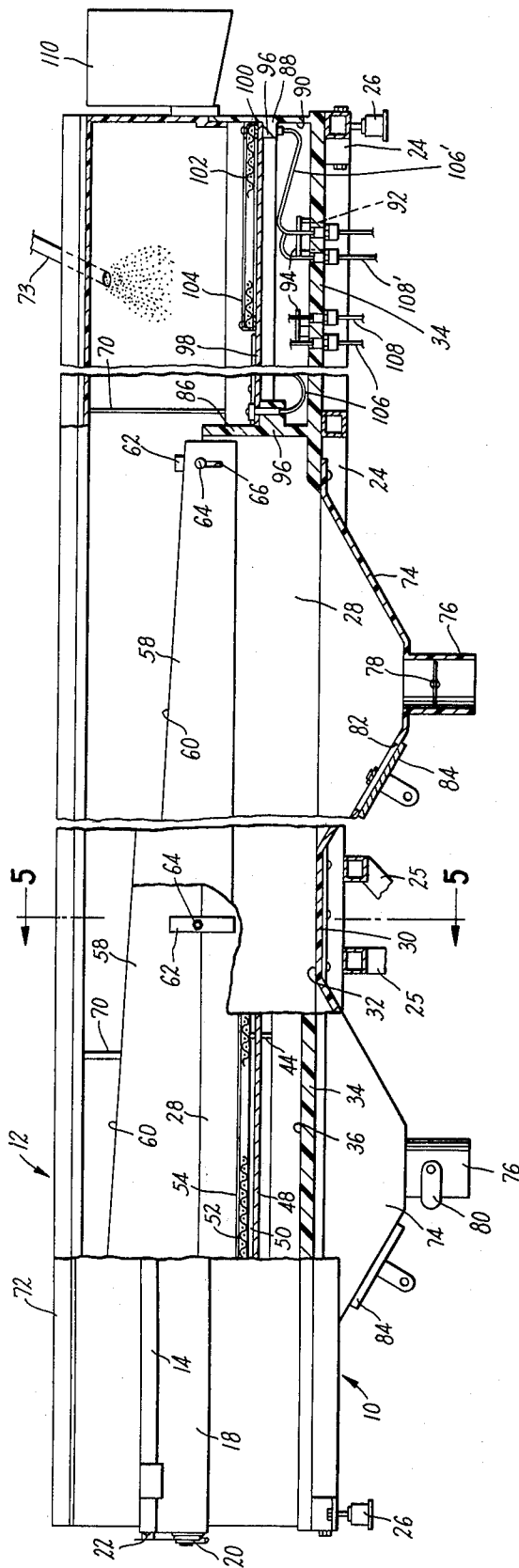


FIG. 1

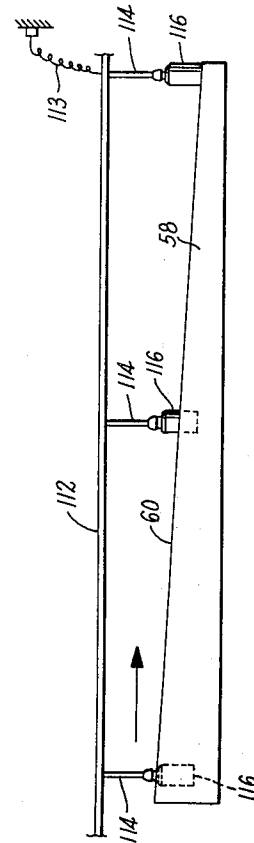


FIG. 2

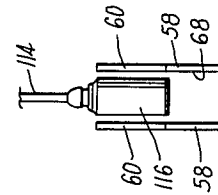


FIG. 3

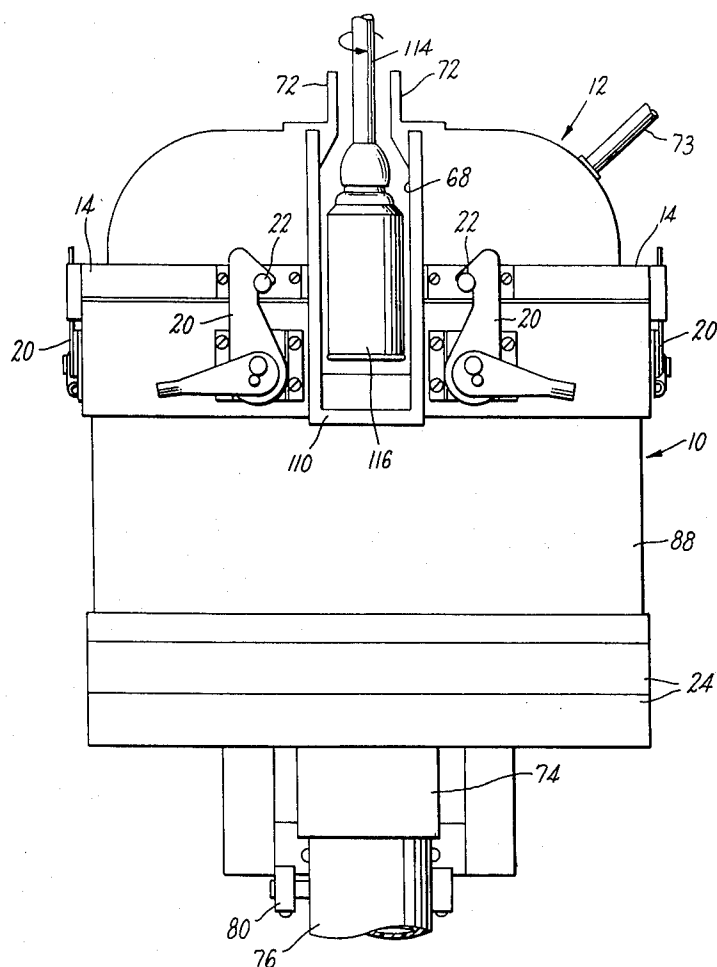


FIG. 4

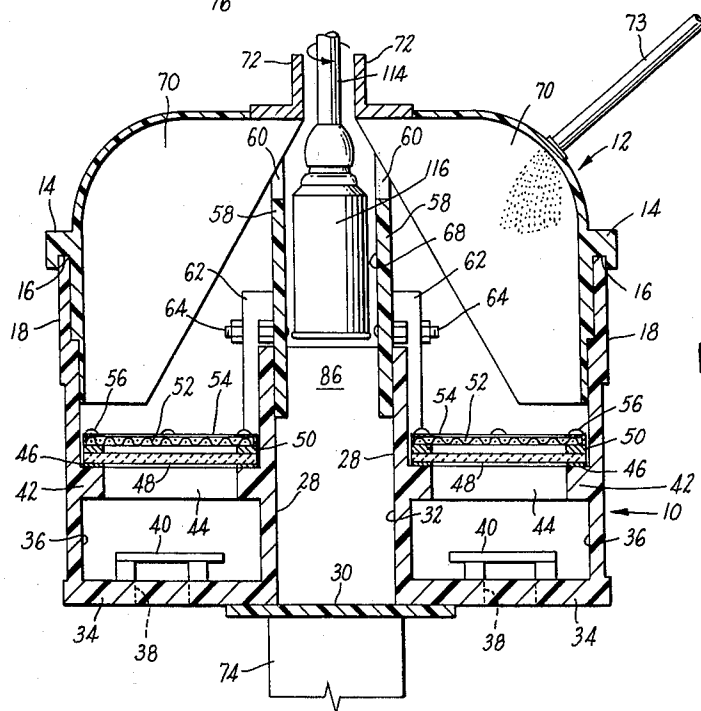


FIG. 5

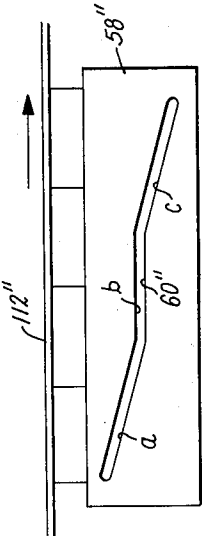


FIG. 7

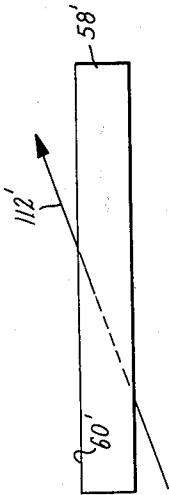


FIG. 8

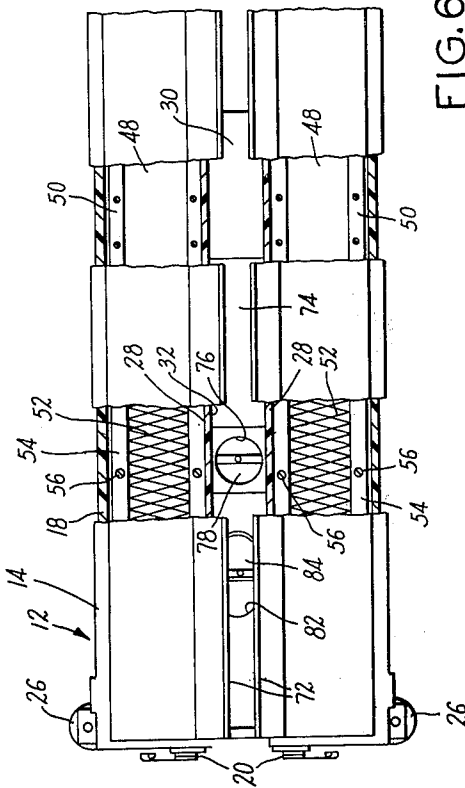
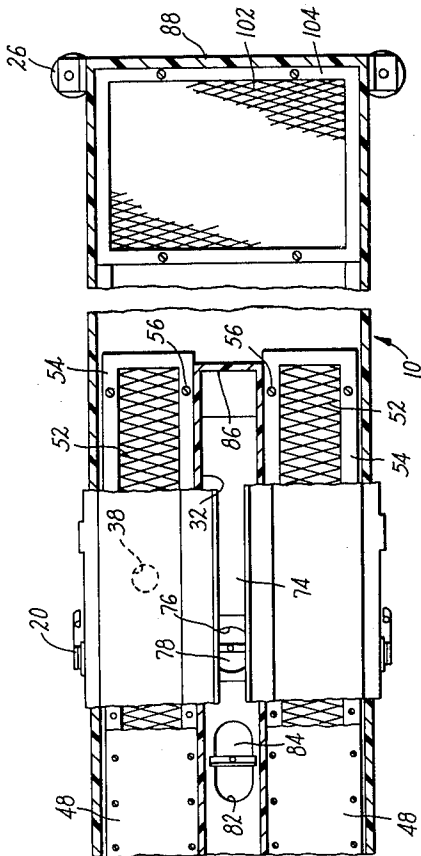


FIG. 6

ELECTROSTATIC COATING METHOD RELATED APPLICATION

This application is a division of copending application for U.S. Letters Patent Ser. No. 254,472, filed on May 18, 1972, and now issued as U.S. Pat. No. 3,828,729.

BACKGROUND OF THE INVENTION

Apparatus and techniques have been disclosed in the prior art by which a variety of objects can be coated by the electrostatic deposition of particles thereon. One highly effective and convenient type of apparatus that is used for such coating consists fundamentally of a particle bed fluidizing device equipped with an electrode for producing an electrostatic charge on the particles. Exposure of the object to be coated to the cloud of charged particles so produced, while the former is maintained at an effectively opposite potential (normally grounded), will cause electrostatic attraction and adherence of the particles thereto. The object may then be heated or otherwise treated so as to fuse the particles into a unified surface coating, depending of course upon the nature of the particles and other factors.

Although such apparatus is used with a high degree of satisfaction for the coating of many different types of objects (such as continuous lengths of wire, tubing, and the like as well as individual objects which may be passed into or adjacent the cloud of particles), it is not fully satisfactory for the production of uniform coatings upon objects having an axial length which is greater than a certain value. This is due largely to the characteristic of such charged particles of seeking the shortest and most direct route to a surface for deposition. In other words, the charged particles will deposit upon the most accessible area of effectively opposite charge, and consequently objects which have surfaces at substantially different distances above the bed will acquire heavy deposits upon their lower portions while developing progressively thinner coatings on the upper surfaces. In addition, the absolute height to which any particle rises will have a finite value, which will depend upon the physical characteristics of the particle and the potential difference existing between it and the attracting body. The voltages necessary to charge particles sufficiently to cause them to rise to surfaces which are more than a given distance above the bed become prohibitive, from the standpoints of both safety and also satisfactory operation, as a result of which miscoating of the upper portions of many objects would frequently occur under practical operating conditions.

Accordingly, it is the principle object of the present invention to provide a novel method by which articles of significant axial length may be uniformly coated with charged particles from a cloud thereof.

It is also an object of the invention to provide such method which is highly efficient, safe, simple and convenient to perform.

A more specific object is to provide a novel method for the coating of an object of significant axial length with charged particles produced in an electrostatic fluidized bed.

SUMMARY OF THE INVENTION

It has now been found that the foregoing and related objects of the invention can be readily attained in a method for electrostatically coating an object, which

comprises the steps of generating a cloud of electrostatically charged particles adjacent one side of an upstanding baffle, and passing the object to be coated along a predetermined travel path adjacent the other side thereof. The upstanding baffle is adapted to block at least an axial portion of the object. It has an edge portion which is adapted to permit passage thereacross of charged particles from the cloud, and which is configured to progressively expose the axial portion of the object for contact by the particles during its passage thereby.

In practicing the method of the invention a multiplicity of objects may be sequentially passed along the travel path for coating; they may be suspended in an appropriate manner during such passage, and they may be rotated about a vertical axis if so desired. Depending upon whether the edge portion of the baffle slopes downwardly (in the forward direction of the travel path) or is substantially horizontal, the object may be passed thereadjacent along a travel path that is, respectively, either substantially horizontal or disposed at an angle to the edge portion. Most desirably, the travel path extends between two of such baffles, with a cloud of electrostatically charged particles being generated adjacent the outer side of each one thereof to simultaneously contact opposite sides of the object during passage therealong. The method may include the step of generating at least a second cloud of particles possessing an electrostatic charge of substantially different magnitude than that of the particles of the first-mentioned cloud. It may also include the step of heating the object subsequently to the deposition of particles thereon, in which instance the particles will be of a heat-fusible material with the heating step thereby producing a fused coating thereof upon the object. In the most preferred embodiment, the cloud of charged particles is generated by passing a stream of gas upwardly through a bed of particles to cause fluidization thereof, and electrostatically charging the particles.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a fragmentary side elevational view in partial section of apparatus suitable for use in practicing the method of the present invention;

FIG. 2 is a diagrammatical side elevational view of the conveyor and the exposed one of the pair of baffles employed in the apparatus of FIG. 1, drawn to a reduced scale and showing a number of cans being transported for electrostatic coating;

FIG. 3 is a right end view of the parts of the apparatus illustrated in FIG. 2 and drawn to a scale slightly enlarged therefrom;

FIG. 4 is a right end elevational view of the apparatus of FIG. 1 drawn to an enlarged scale;

FIG. 5 is a section view along line 5—5 in FIG. 1, drawn to the scale of FIG. 4;

FIG. 6 is a fragmentary plan view in partial section of the apparatus of FIG. 1;

FIG. 7 is a side elevational diagrammatical view of a different baffle and conveyor arrangement suitable for use in the practice of the method of the invention; and

FIG. 8 is a view similar to FIG. 7 showing another type of baffle suitable for use therein.

DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

Turning now in detail to FIGS. 1 - 6 of the appended

drawings, therein illustrated is apparatus which includes an electrostatic fluidized bed unit comprised of a fluidized bed base and a cover therefor, generally designated by the numerals 10, 12 respectively. The cover 12 has a peripheral flange 14 with a downwardly opening channel 16 in which is received the upper edge of the sidewall 18 of the base 10. A number of hook locks 20 are spaced about the opening of the base 10, and cooperate with corresponding studs 22 on the flange 14 to lock the cover 12 thereto. The tubular elements 24, which provide a frame bed for the base 10, rest upon substructure elements 25; the fluidized bed unit is connected to the chassis by anti-vibration members 26, and means (not shown) is provided to vibrate the unit, with the members 26 serving to prevent transmission of motion therefrom to the substructure.

As may best be seen in FIG. 5, the base 10 includes a pair of parallel upstanding interior walls 28 which cooperate with a base plate 30 to define a central trough 32 running along most of the length of the unit. The walls 28 also cooperate with the bottom walls 34 to define two elongated lateral plenum chambers 36, which are coextensive with the trough 32 and lie on opposite sides thereof. Air inlet ports 38 extend through the bottom walls 34 and have diffusion plates 40 positioned thereover, the latter serving to promote distribution along the length of the chambers 36 of air injected through the ports 38.

A peripheral flange 42 extends about each of the chambers 36 to provide support for a chamber-spanning porous plate 48 which is spaced thereon above the bottom wall 34. Interposed between the flanges 42 and the plates 48 are thin layers 46 of gasket material, and strut elements 44 extend across the flanges 42 to strengthen the base 10 and to provide additional support for the plates 48. The rectangular frames 50 secure (such as by flat-headed screws) the porous plates 48, and also support the grid-type electrodes 52, which are substantially equal in area to the plates 48. The electrodes 52 are maintained in place by appropriate frames 54, which may be welded or otherwise secured thereto, the frames 54 being fastened to the flanges 42 by round-headed screws 56.

An elongated baffle 58 is secured to each of the interior walls 28 by cooperating clamps 62, which are tightened thereagainst by the nut and bolt fasteners 64 which pass through the walls 28 and through the elongated slots 66 in the baffles 58. As will be appreciated, the slots 66 enable adjustment of the height as well as the angular attitude of the baffles 58 with respect to the interior walls 28. Each of the baffles 58 has an upper edge 60 which slopes downwardly toward the outlet end of the unit, i.e., in a downstream direction; the edges are in substantial horizontal alignment, and the baffles 58 are parallel, to thereby define a passageway 68 of uniform width along the full length of the baffles 58.

The cover 12 has a number of spaced reinforcing webs 70 and upstanding flanges 72 which extend along its entire length on either side of the passageway 68. The flanges 72 cooperate with an enclosure or cowling (not illustrated) which substantially surrounds the unit and has marginal edges abutting against the flanges 72 to prevent the entry of powder or debris thereinto. A feed conduit 73 is attached to the cover 12 to provide means for furnishing powder to the unit from a reservoir or supply thereof (not shown), and means (also

not shown) may be present within the unit for detecting the quantity of powder therein to automatically control the feed operation on a continuous basis. The bottom of the unit is furnished with two hoppers 74 which communicate with the central trough 32 and have conduits 76 extending downwardly therefrom. The conduits 76 are hooked into a vacuum system (not shown) to enable the withdrawal of excess powder which would otherwise tend to accumulate in the trough 32, and the butterfly disk 78 and operating mechanism 80 therefor, which are provided on each conduit 76, control the vacuum effect. Each hopper 74 has a cleanout opening 82 that is normally closed by a cover assembly 84, the principal purpose of which is to permit the ready removal of the articles, which may fall into the trough 32 from time to time during the coating operation.

As is most readily seen in FIGS. 1 and 6, a narrow end wall 86 lies transversely between the interior walls 28 adjacent the outer ends thereof and defines, in cooperation with the outer end wall 88 of the unit, a plenum chamber 90 extending across the width thereof. As in the case of the elongated plenum chambers 36, the plenum chamber 90 is provided with inlet ports 92 and diffusion plates 94 for the injection and distribution of air, and the peripheral flange 96, which projects inwardly from about the chamber 90, supports a porous plate 96, a peripheral frame 100, a grid 102, and a grid frame 104. Mounted through the bottom wall 36 beneath the plate 98 are cables for appropriate electrical interconnection, the cables 106, 106' providing high voltage to the grids 52 and 102, respectively (the grids 52 normally being maintained at a higher voltage than grid 102), and the cables 108, 108' being connected respectively (by means not shown) to the frame bed 24 and the flanges 72 to maintain them at ground potential.

Adjacent the outlet end of the unit and in communication with the passageway 68 is a channel extension 110, which serves to enable the controlled release of powder that may become trapped between adjacent articles, vacuum means being attached to the extension 110 for that purpose if so desired. As suggested in FIGS. 2 and 3, a conveyor 112, which is electrically grounded at 113, is disposed above the unit and has a multiplicity of mounting hangers 114 depending therefrom, each supporting a can 116 thereon for coating. The conveyor may be of any conventional design, and the hangers may desirably be electrically conductive and have magnetic coupling elements on the ends thereof to support the cans and maintain them at ground potential; of course, when different articles are to be coated in the unit other support means may be more suitable. As the arrow in FIG. 2 indicates, the conveyor 112 transports the cans 116 from left to right along a horizontal path through the passageway 68. Initially, the cans 116 are substantially entirely blocked or masked by the baffles 58; however, due to the slope of the upper edges 60, as the cans 116 proceed downstream progressively lower surface portions become horizontally aligned with the edges 60 and thereby exposed for powder contact behind the baffles 58.

Since, as has previously been pointed out, the lower portions of the cans 116 or other depending objects most readily attract the charged particles, considerably lower voltages are necessary to generate a cloud capable of producing a deposit thereon. The plenum chamber 90 and the porous plate 98 and electrode 102 asso-

ciated therewith (which constitute a substantially independent cloud chamber or charged particle-generating effect) may therefore be used for this purpose, with the electrode 102 being charged to a substantially lower voltage to afford concomitant power economy and convenience of operation. As will be apparent, the cans 116 proceed on the conveyor 112 downstream through the passageway 68 between the baffles 58, over the electrode 102, and outwardly from the unit through the extension 110. They may then pass through sequential excess powder removal, heating and cooling stages, and preheating effects ahead of the fluidized bed unit may also be provided.

Although the foregoing apparatus may be preferred, it will be evident that many variations are possible; one alternative is depicted in FIG. 7, showing a simple modification of the arrangement of the conveyor and baffles employed. Thus, the baffle 58' is substantially the same as baffle 58 of the preceding figures, but has a free upper edge 60' which is substantially horizontally disposed. The conveyor 112' is comparable to the previously-described conveyor 112 but, rather than extending horizontally, it is slightly inclined. As a result, objects depending from the conveyor 112' are progressively exposed behind the baffle 58' with virtually the same coating effect as is produced by the apparatus of the previous figures.

However, the apparatus of FIG. 7 affords the advantage of enabling the coating of objects of increased axial length in a direction generally perpendicular to the fluidized bed (extended dimensions parallel to the bed of course presenting little difficulty). Because the edge 60' is a uniform distance above the electrodes (not illustrated, but horizontally disposed therebelow), and the objects pass from a position lower than the electrode location, the axial length that can be coated is not limited by the height to which the charged particles are capable of rising. As will be noted, this is not true of the apparatus of FIGS. 1-6 due to the parallel disposition of the travel path of the cans 116 and the electrodes 52; in such apparatus, it will not generally be feasible to coat objects having portions that are more than about 6-8 inches above the electrodes.

A second modification of the apparatus is shown in FIG. 8 wherein, rather than utilizing a free upper edge of the baffle to provide the edge portion across which the charged particles must pass, the baffle 58'' has a complex slot 60'' consisting of three rectilinear elements *a*, *b*, *c*, extending therein in the general direction of the travel path. The baffle 58'' cooperates with the conveyor 112'' to progressively expose lower portions of objects depending therefrom as they travel in the direction indicated by the arrow. It will be noted that the central element *b* of the slot 60'' is substantially horizontal, as a result of which no fresh surfaces of the objects will be exposed during passage thereby. An exposure of extended duration will thereby be afforded, as may be desirable in coating an object having a central portion which is somewhat inaccessible or on which a heavier coating is desired. From this simple illustration it will be appreciated that many variations in the configuration of the edge portion are possible to achieve a wide variety of coating effects, and it should be clear that, although continuous rectilinear edge portions have been illustrated, in some instances it may be desirable to utilize discontinuous edges or curvilinear portions to achieve the deposits desired.

Other variations in the apparatus are of course possible, and include the provision of different arrangements and greater or lesser numbers of electrodes, plenum chambers, etc., to generate different cloud chamber effects and to expose the objects to different conditions during passage along the travel path. Although not specifically discussed heretofore, it will be appreciated that a single-effect fluidized bed may be employed with the objects passing behind only one baffle interposed therebetween.

The materials of construction will be equally obvious to those skilled in the art, and need not be discussed in detail. However, perhaps it should be mentioned that the construction of the fluidized bed is desirably largely of a plastic or other dielectric material, so as to prevent interference by the elements thereof with the efficient deposition of powder upon the objects. It might also be important to note that, although it is most desirable to maintain the objects at ground potential during deposition, they may be at other potentials, as long as adequate attractive and adhesive forces are produced; moreover, electrical connections to the objects may be dispensed with entirely in some instances.

Virtually any powder that is conventionally used for electrostatic powder coating may be employed to provide the charged particles in accordance with the present invention. For example, resins such as polyvinyl chloride, polypropylene, polyethylene, epoxides, acrylics, polyesters, etc. may all be used successfully in accordance herewith. Among the myriad uses for the type of apparatus illustrated, the coating of aerosol and food and liquid packaging cans, tanks for fire extinguishers and gas storage, transformer housings, and boxes of various types and configurations might be mentioned as exemplary.

Thus, it can be seen that the present invention provides a novel method by which articles of significant axial length may be uniformly coated with charged particles from a cloud thereof, and more specifically with particles produced in an electrostatic fluidized bed. The method is, in addition, highly efficient, safe, simple and convenient to perform.

What is claimed is:

1. In a method for electrostatically coating an object, the steps comprising: generating a cloud of electrostatically charged particles adjacent one side of a generally upstanding baffle having an elongated edge portion permitting ready passage thereacross of said charged particles from said cloud, and passing at least an axial portion of an object to be coated laterally adjacent the other side of said baffle along a predetermined travel path which traverses the imaginary, laterally-extending projection surface of said edge portion at a nonperpendicular angle thereto, said baffle initially blocking from contact by said particles at least said axial portion of the object, and causing exposure of progressively lower vertical portions thereof for contact by said particles during passage of the object along said travel path thereby, so as to develop a coating on said axial portion along an axis that is angularly displaced from the axis of said travel path.

2. The method of claim 1 wherein a multiplicity of objects are sequentially passed along said travel path for coating.

3. The method of claim 1 wherein said travel path extends between two of said baffles, and wherein a cloud of electrostatically charged particles is generated adja-

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cent the outer side of each of the baffles to simultaneously effect particle contact upon opposite sides of the object during passage therealong.

4. The method of claim 1 wherein at least a second cloud of electrostatically charged particles is generated at a location spaced along said travel path from the location of said first-mentioned cloud, the particles of said second cloud having a charge of substantially different magnitude than the particles of said first-mentioned cloud.

5. The method of claim 1 including the additional step of heating the object subsequent to deposition of particles thereon, said particles being of a heat-fusible material and said heating step thereby producing a fused coating thereof upon the object.

6. The method of claim 2 wherein the objects are suspended during passage along said travel path.

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7. The method of claim 1 wherein said edge portion slopes downwardly in the forward direction of said travel path and wherein said object is passed thereadjacent along a travel path that is substantially horizontal.

8. The method of claim 1 wherein said edge portion is substantially horizontal and wherein said object is passed thereadjacent along a travel path that is disposed at an angle to said edge portion.

9. The method of claim 1 wherein said object is rotated about a vertical axis during passage along said travel path.

10. The method of claim 1 wherein said step of generating a cloud of electrostatically charged particles comprises passing a stream of gas upwardly through a bed of particles to cause fluidization thereof, and electrostatically charging said particles.

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