

March 24, 1953

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2,632,716

METHOD OF COATING ARTICLES

Filed Sept. 29, 1945

2 SHEETS—SHEET 1

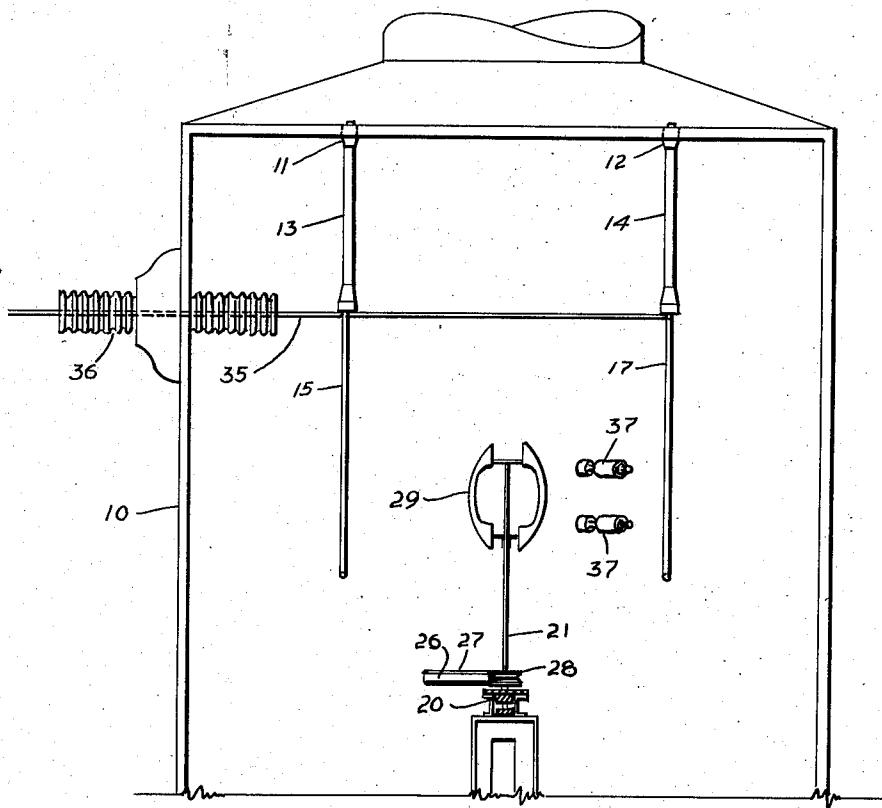


FIG. 1

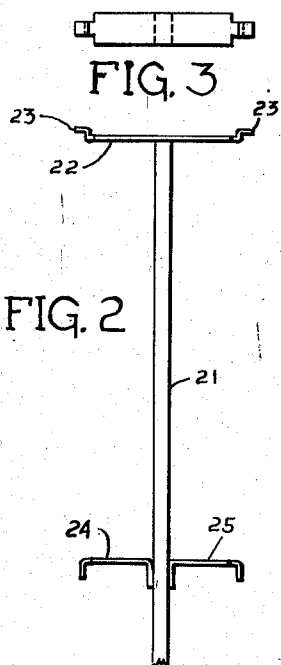


FIG. 3



FIG. 4



FIG. 5

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2 SHEETS—SHEET 2

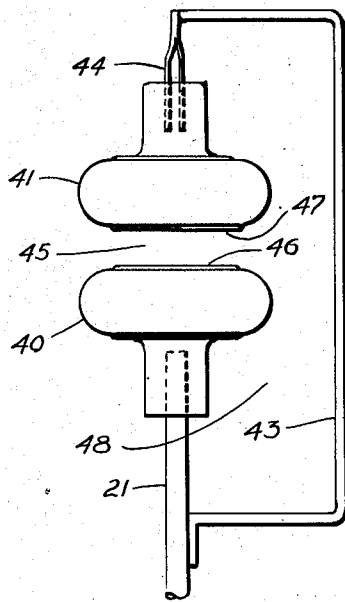


FIG. 6

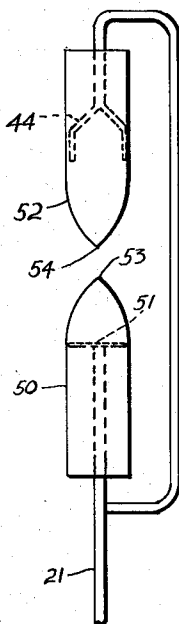


FIG. 7

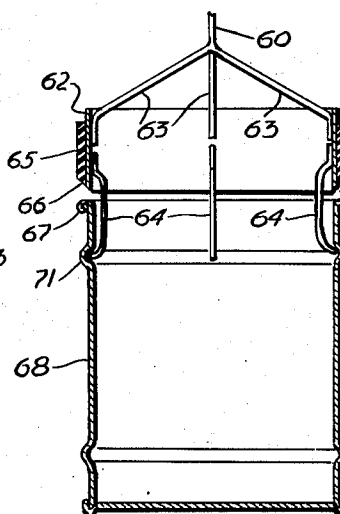


FIG. 8

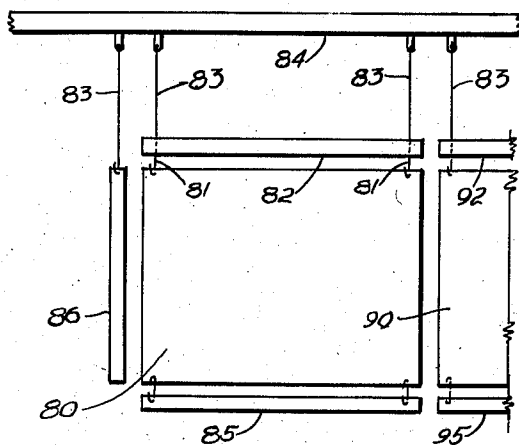


FIG. 9

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2,632,716

METHOD OF COATING ARTICLES

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Application September 29, 1945, Serial No. 619,371

10 Claims. (Cl. 117—93)

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The present invention relates to the coating of objects or articles in an electrostatic field by finely divided particles, and relates in particular to an improved method of controlling the deposition on certain areas of such articles or objects.

Heretofore it has been proposed to coat articles with finely divided particles by setting up an electrostatic field between spaced, ionizing discharge electrodes and articles which act as collecting electrodes when moved in the path defined between the discharge electrodes, the particled coating material being introduced for deposition under the influence of the field action upon the articles to be coated. When a group of such articles are introduced between the discharge electrodes as by means of a conveyor or the like, it is seen that each article forms a component of one continuous collecting electrode and that the effective field becomes established upon the foremost article entering into proximity to the discharge electrode and remains established until the last article of the group passes beyond the influence thereof. In the practice of such method, the finely divided particles are deposited upon the surfaces extending parallel to the discharge electrode, and upon those surfaces disposed at an angle thereto, and in some instances, upon the opposite surface from that to which the spray is directed, this latter deposition being technically termed "wrap around." However, in many cases the method of coating just described results in a distribution of coating material different from that which is desired. Thus, such method is prone to produce a relatively light coating, or in extreme cases no coating at all, on sharply pointed or sharply rounded marginal edge portions of the article. Less sharply curved edges or projections frequently receive an excess quantity of coating. Where uniformity of coating thickness is desired, projections, edges, marginal contours or the like therefore frequently present a problem. In other cases, the simple method above described may produce a coating of uniform character when a non-uniform coating is desired.

In accordance with the present invention I have found that the distribution of coating over the article surfaces varies to a great extent in accordance with and because of the varying degrees of affinity of diverse surface contours of the articles as influenced by the action of the field and can be controlled by locating in the electrostatic field adjacent the article to be coated another body whose presence in the electrostatic field appropriately modifies the field to the end of producing the desired distribution of coating.

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In many instances the added body may be another of the articles to be coated; and the two articles are so positioned relative to each other and to the discharge electrodes that the electrostatic field is modified in a manner which further the distribution of coating in the desired manner over both articles as they pass through the coating zone.

Where the article to be coated terminates in a point or edge sufficiently sharp to create a reionizing zone and consequent repulsion of coating material particles, the positioning of the terminal point of a similar article oppositely thereto and at the properly spaced relation therefrom results in the elimination of the reionizing effect and repulsion of coating material particles. Where the article possesses a projection or edge not sharp enough to produce ionization, such projection or edge is likely to receive a heavier coating than other portions of the article. However, by positioning another body adjacent thereto, which may be a similar article placed so that one of its edge surfaces lies in spaced, oppositely disposed relation to the corresponding surface of the first, the tendency of coating material to be deposited too thickly on the projection or edge is eliminated. Where it is desired to produce an abnormally thin coating on an area of the article, another body may be positioned to produce a localized reduction in the coating precipitating effect of the field. For this purpose two articles also may be employed for mutual effect on each other, the surface portions to be lightly coated being placed face to face in spaced relation and both articles passed simultaneously as a unit through the coating zone with or without rotation. In some cases it may be advantageous to group two or more articles about a common support with surfaces to be lightly coated directed inwardly of the group, whereby the joint effect of the articles will tend to inhibit the electrostatic deposition of coating upon both the inwardly directed surfaces and the support.

Although, in general, it is preferred to employ a like article to be coated placed so that one of its higher or lower affinity surface contours lies in spaced, opposed relation to the corresponding contour of its companion article, in some instances I may use a specially shaped second body so disposed with respect to the primary body as to obtain the desired localized field intensity modifying effect. Thus, for example, in coating a hollow cup or cylindrical body, the coating of the open end can be controlled by locating a cylindrical or cup-shaped sleeve substantially co-

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axially adjacent thereto having its open rim adjacent that of the cup or cylindrical body which in effect presents another object in oppositely disposed relation while omitting the non-effective portion of such other object, namely the closed end. The edges of the sleeve may be flat, round, or tapered as desired to produce the desired control of deposition on the cylindrical body. To minimize coating of the sleeve it may be covered with a layer of material, such as hard rubber or "Bakelite," which will accumulate and retain a surface charge of like polarity to that of the approaching coating material particles. The method employing an object of such dielectric properties that a surface charge is accumulated thereon to control the deposition of particles in an electrostatic field, forms a part of the present invention.

In coating flat plates the plates may be located in such edge to edge proximity with each other or with added field-modifying elements as to control deposition on the edges and prevent or allow "wrap around" as desired.

The invention will be described in greater detail in connection with the accompanying drawings in which are illustrated preferred embodiments of the invention by way of example, and wherein:

Figure 1 is a partly diagrammatic end view of a paint spray booth, illustrating the location of the spray guns, electrodes, and objects to be coated.

Figure 2 is a side elevation of a detail.

Figure 3 is a plan view of a detail of Figure 2.

Figure 4 is an end view of a handle to be coated shown in Figure 1.

Figure 5 is a side view of Figure 4.

Figure 6 is a side view illustrating another embodiment of the invention.

Figures 7 to 9 illustrate further embodiments of the invention.

Referring to Figure 1 of the drawing, an open ended spray booth designated generally by the numeral 10 may be constructed of any suitable material such as insulation board. Located on the roof of the spray booth in any suitable manner are brackets 11 and 12 from which extend insulator rods 13 and 14. Electrode frames 15 and 17, which are shown as constructed of rods of suitable size welded together to form a rectangle, are suitably secured to the insulator rods 13 and 14, and ionizing electrodes, preferably in the form of fine wires, are strung vertically between the horizontal rods of the electrode frames to form an electrode grille. The electrode frames are arranged one on each side of the path of movement of the articles to be sprayed to provide an electrostatic field which extends along such path for example, as illustrated in my copending application, Serial No. 519,333, for Method and Apparatus for Spray Coating Articles, filed January 22, 1944, now U. S. Patent No. 2,425,652, which issued August 12, 1947.

A conveyor, indicated generally by the numeral 20, has extending upwardly therefrom a series of rotatable spindles 21 each provided across its top with a cross bar 22 having upwardly bent fingers 23 at each end. Cross bar 22 may be welded or otherwise secured to the top of the spindle. A pair of downwardly bent spring fingers 24 and 25 are spot welded to the rod on diametrically opposite sides and parallel with cross bar 22. The spindles 21 are rotated in their passage through the electrostatic field by

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any suitable means, such as an endless moving belt 26 passing over a pulley 27 and engaging pulley 28 on spindle 21.

The object to be coated, for the sake of illustration, is shown as a stove handle 29 (Figs. 1, 4 and 5) of generally curved shape. The handle may be of sheet metal formed to suitable shape and have suitably secured therein inserts 31 and 32 at each end with spaces 33 therebetween. A handle is secured to the spindle 21 by hooking one spring finger 25 into a space 33 at one end of the handle, and by pushing the handle upwardly against the bias of the spring finger, a finger 23 may be hooked into the other slot 33 at the opposite end of the handle. As illustrated, there are two handles mounted on each spindle, which are diametrically oppositely located with the faces of the inserts 31, 31 and 32, 32 of each in spaced opposed relation.

The electrodes 15, 17, may be connected in any suitable manner as by wire 35 passing through an insulator 36 in the spray booth wall to a suitable source of high voltage electricity (not shown). One or more spray heads or guns 37 may be employed, which preferably are of the air atomizing type. They are suitably secured on a bracket (not shown) preferably at the forward end of the booth and are directed at angles toward the objects which are to be coated, to direct streams of coating material particles supported in carrier air currents into the electrostatic field.

In operation, the articles to be coated mounted on the spindles 21 form a column which preferably enters the booth at one end, passes around a deflecting pulley (not shown) and is directed toward the opposite end of the booth through the electrostatic field between the two electrode frames 15 and 17. The stream of particles from the spray guns, which preferably are directed at angles to the column of articles, is thus introduced into the electrostatic field and by the electrostatic forces the particles are compelled to deposit on the stove handles 29. However, by reason of the spacing of the handles 29 relative to each other, and rotation of the spindles 21, each handle in its progress through the booth will traverse a cycloidal path thus presenting all of its surfaces toward the electrodes 15 and 17. The spray will thus wrap around and reach all portions of the handle, excepting that the complementary inner faces of the inserts 31 and 32, which require only a light coating, will, because of their oppositely disposed proximity to each other, receive less coating material than other surfaces of the handles. This is so, even though the exposed surface contours of inserts 31 and 32 each separately have a normal affinity as influenced by the field for the oppositely charged coating particles because when these flat surface contours are so oppositely disposed with a proper degree of spacing therebetween, each modifies the field influenced affinity of the other to lower the affinity of each an extent sufficient to reduce the deposition of coating particles thereon.

In the modification illustrated in Fig. 6 there is shown a pair of objects 40 and 41 in the shape of door knobs, the central portions of whose surfaces need be coated only lightly or not at all. The lower knob 40 is suitably secured on a rotatable spindle 21 of a conveyor. A suitable upstanding bracket 43 welded or otherwise secured at its lower end to the spindle 21 projects outwardly around the lower knob, and extends

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upwardly. The upper end of the bracket is turned inwardly and downwardly to support the upper knob 41, by spring fingers 44, in oppositely disposed, spaced relation to the lower knob. The space 45 between the knobs is such that while coating material is deposited on the peripheral contours no, or at least relatively few, particles are attracted to the adjacent included area or surfaces 46 and 47 of the knobs. Because of the rotation of spindle 21 and the objects, the bracket 43, which moves in a cycloidal path, does not shield the curved peripheral contours of the objects, since there are periods when the spray is being directed into the space 48 between the bracket and the objects.

The relatively sharp curvatures of the peripheral contours of the knobs have a higher degree of field influenced affinity for the oppositely charged coating particles than is possessed by the adjoining flat portions 46 and 47. When the knobs are disposed as shown in Fig. 6, the mutual effect of these field influenced higher affinity surfaces is such that all, or substantially all, of the oppositely charged coating particles are attracted to and deposited upon the curved peripheries before having opportunity to enter into the space 45 for deposition upon the oppositely disposed flat faces.

Extremely sharply defined, projecting, pointed contours would normally be considered to have the highest degree of affinity for the oppositely charged particles because the absence of an extended surface in the plane of the projecting point isolates the latter and thus tends to cause a high concentration of the field action thereon. Such concentration may rise, and often does, to such a degree that the air in the immediate vicinity becomes ionized to the same polarity as the point. When this occurs, the coating particles pick up by collision with the ionized air, an electrical charge which is of the same sign as the point and thereby become repelled so that an affinity, which would normally be expected to be exceedingly high may not even exist under the conditions above described.

In the modification illustrated in Fig. 7, a pointed object, as for example a flash light case 50, is suitably secured on spindle 21 by means of a disc 51 secured to the end of the spindle, and the bracket 43 carries a spring 44 which secures a second case 52 with its pointed end in oppositely disposed, spaced relation above the lower case. The action occurring in this arrangement will depend on the degree of sharpness of contour of the pointed ends of each case 50. If a point should be so sharply defined as to create ionization in the absence of the opposed case, coating material particles would be repelled from the pointed end; and juxtaposing two cases with their pointed ends in oppositely disposed relation, promotes uniformity of coating thickness by modifying the field influenced affinity of such contours in a manner to prevent reionization and thereby permit of or increase the deposition of oppositely charged particles on the pointed ends. On the other hand, if the pointed end is not sufficiently sharp to cause ionization, such a contour might tend to receive an excess of coating material in the absence of the other case; and in such instance, uniformity of coating is promoted by decreasing the deposition on the pointed ends.

In the modification shown in Fig. 8 there is provided a rotatable hanger 60 supported from an overhead conveyor (not shown) which hanger includes an open ended cylinder or sleeve 62 of

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conducting material having radial hanger rods 63 welded or otherwise secured therein, and spring tongues 64 extending below the bottom portion. The lower edge of the sleeve 62 is held in aligned spaced relation above the beaded edge 67 of the metal bucket 68 to be coated, such bucket being supported by spring fingers 64 extending into the ribs 71 thereof. In this modification the sleeve 62, corresponds in its effective function to the useful portion of another bucket. The lower edge of the sleeve, especially if sharpened, inhibits the deposition of coating material on the upper part of the beaded edge and on the interior of the bucket by reducing the field influenced high affinity of such a sharply curved surface contour and thereby reducing "wrap around" action. By providing the sleeve 62 with an outer covering of insulating material, such as rubber, "Bakelite," or other material capable of accumulating and retaining a surface charge, the sleeve will not become rapidly coated, probably because the covering acquires a surface charge of like polarity to the approaching particles of coating material. The lower edge of the covering 66 is preferably chamfered as indicated at 66.

In the modification illustrated in Fig. 9, a sheet 80 to be coated is suspended by wires 81 or the like from a strip 82 which is in turn suspended by wires 83 from an overhead conveyor diagrammatically illustrated at 84, and at the bottom, a strip 85 is similarly suspended from the sheet 80. At each end of the sheet 80 is located either a similar sheet 90 or a strip 86. Strips 92 and 95, similar to strips 82 and 85, are located above and below the sheet 90 and so on throughout the series where a group of sheets are to be coated. The plates 80 and 90, as well as the strips 82, 85, 86, 92, and 95, are of electrical conducting material.

The disposition and spacing of strips 82, 85 and 86 and the spacing of sheet 80 from sheet 90 control the amount of "wrap around" obtained on sheets 80 and 90 at their edges. In addition, these strips and the spacing of the sheets 80 and 90 provide for the desired thickness of coating at and adjacent the edges of sheets 80 and 90, and prevent ionization from occurring at such edges. In its function of controlling the thickness of coating at and adjacent the edge of sheet 80, the strip 86 may be considered as a deflecting electrode which maintains a deflecting electrostatic field in the region of the advancing particle stream so that the trajectory of the particle stream is modified to increase the deposition of coating particles on and adjacent the advance edge of sheet 80 as it approaches the discharge electrodes 15-17 and sets up the effective field action. Sheet 80 also serves as a deflecting electrode for sheet 90 in a similar manner. The deflecting electrode thus may be a member, or a part of the conveyor, and moves with the article to be coated, but it will be understood that under certain conditions a fixed deflecting electrode may be employed which is positioned in the region of the advancing particle stream to deflect the particle stream toward the object to be coated. A strip similar to the strip 86 may be supported in spaced relation from the aft edge of the last sheet of a series to be coated to prevent wrap-around or excessive thickness of coating on the aft edge of said last sheet.

The invention may be embodied in various other forms without departing from the principles herein described.

I claim:

1. In a method of electrostatically coating a sheet of conducting material, the steps of moving the sheet edgewise of itself over a predetermined path past and in spaced relation to a discharge electrode, maintaining between the sheet and the discharge electrode a high difference of electrical potential to create an electrostatic field over the surface of the sheet, supplying finely divided coating material to such field for electrostatic precipitation on the sheet, and moving over such path in advance of the sheet a deflecting electrode of conducting material maintained in spaced relation to the leading edge of the sheet and at the same potential to accelerate toward said path particles of coating material in advance of the sheet, the distance between the sheet and the deflecting electrode being less than the distance between the article and the discharge electrode.

2. In a method of electrostatically coating a sheet of conducting material, the steps of moving the sheet edgewise of itself over a predetermined path past and in spaced relation to a discharge electrode, maintaining between the sheet and the discharge electrode a high difference of electrical potential to create an electrostatic field over the surface of the sheet, supplying finely divided coating material to the field for electrostatic precipitation on the sheet, and moving over such path in following relation to the sheet a deflecting electrode of conducting material spaced from the trailing edge of the sheet and maintained at the same potential as the sheet to deflect from the trailing edge of the sheet coating-material particles which otherwise would be deposited thereon, the distance between the sheet and the deflecting electrode being less than the distance between the article and the discharge electrode.

3. In a method of electrostatically coating a sheet of conducting material, the steps of moving the sheet edgewise of itself over a predetermined path past and in spaced relation to a discharge electrode, maintaining between the sheet and the discharge electrode a high difference of electrical potential to create an electrostatic field over the surface of the sheet, supplying finely divided coating material from a source to such field for electrostatic precipitation on the sheet, and maintaining adjacent said path and in the field a deflecting electrode having the same potential as the article, said deflecting electrode while it is serving to deflect coating material being located closer to the sheet than the distance between the sheet and the discharge electrode and nearer the coating material source than is the sheet, whereby coating-material particles in the region between the two electrodes will be accelerated toward said path to be intercepted by the moving sheet.

4. In a method of electrostatically coating a sheet of conducting material having an extended longitudinal edge, the steps of moving the sheet over a predetermined path past and in spaced relation to a discharge electrode while maintaining said extended edge generally parallel to said path, maintaining between the sheet and the discharge electrode a high difference of electrical potential to create an electrostatic field over the surface of the sheet, supplying finely divided coating material to the field for electrostatic precipitation on the sheet, and moving past the discharge electrode with the sheet an auxiliary electrode of conducting material positioned in parallel spaced relation to said longitudinal edge of

the sheet and maintained at the same potential as the sheet to reduce the amount of coating material electrostatically deposited on the sheet at the longitudinal edge, the distance between the sheet and the auxiliary electrode being less than the distance between the sheet and the discharge electrode.

5. In a method of electrostatically coating a planar surface of a conducting article wherein the article moves over a predetermined path edgewise of such surface while electrically charged particles of coating material are deposited on it by the action of an electrostatic field maintained between the article and an electrode disposed at one side of said path in opposed, spaced relation to said planar surface, the step of moving past said electrode with the surface an auxiliary electrode of conducting material positioned in parallel spaced relation to an edge of said surface and maintained at substantially the same electrical potential as the surface, the distance between the auxiliary electrode and the surface-edge parallel to it being less than the distance between said surface and said electrode, whereby electrostatic lines of force which in the absence of the auxiliary electrode would terminate on the article beyond said planar surface will terminate on said auxiliary electrode.

6. The invention set forth in claim 5 wherein said auxiliary electrode includes a second planar surface generally co-planar with and having an edge generally parallel to the edge of the planar surface of the article.

7. In a method of electrostatically coating a planar surface of a conducting article wherein the article moves continuously and translationally over a predetermined path, the steps of moving such surface edgewise of itself while electrically charged particles of coating material are deposited on it by the action of an electrostatic field maintained between the article and a first electrode disposed at one side of said path in opposed spaced relation to said planar surface, and providing and moving past said first electrode with the surface an additional electrode of conducting material positioned in parallel spaced relation to an edge of said surface in the plane of said surface and maintained at substantially the same electrical potential as the surface, the distance between the additional electrode and the surface edge parallel to it being materially less than the distance between said surface and said first electrode whereby electrostatic lines of force which in the absence of the additional electrode would terminate on the article will be caused to terminate on said additional electrode in regions beyond the limits of the article.

8. A method of the character claimed in claim 7, wherein the additional electrode is an adjacent translationally moving similar article.

9. In a method of electrostatically coating a planar surface of a conducting article wherein the article moves continuously and translationally over a predetermined path, the steps of moving such surface edgewise of itself while electrically charged particles of coating material are deposited on it by, and at respective locations substantially entirely determined by, the action of an electrostatic field maintained between the article and a first electrode disposed at one side of said path in opposed spaced relation to said planar surface, providing and moving past said first electrode with the surface an additional electrode of conducting material positioned in parallel spaced relation to an edge of said surface

in the plane of said surface and maintained at substantially the same electrical potential as the surface, the distance between the additional electrode and the surface-edge parallel to it being a small fraction of the distance between said surface and said first electrode whereby electrostatic lines of force which in the absence of the additional electrode would terminate on the article will be caused to terminate on said additional electrode in regions beyond the limits of the article.

10. A method of the character claimed in claim 9, wherein the additional electrode is an adjacent translationally moving similar article.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
645,786	Buck -----	Mar. 20, 1900
1,855,869	Pugh -----	Apr. 26, 1932
2,247,963	Ransburg -----	July 1, 1941
2,334,648	Ransburg -----	Nov. 16, 1943
2,421,787	Helmuth -----	June 10, 1947
2,425,652	Starkey -----	Aug. 12, 1947
2,442,986	Ransburg -----	June 8, 1948