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ELECTROSTATIC COATING METHOD AND APPARATUS

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Fig. 1

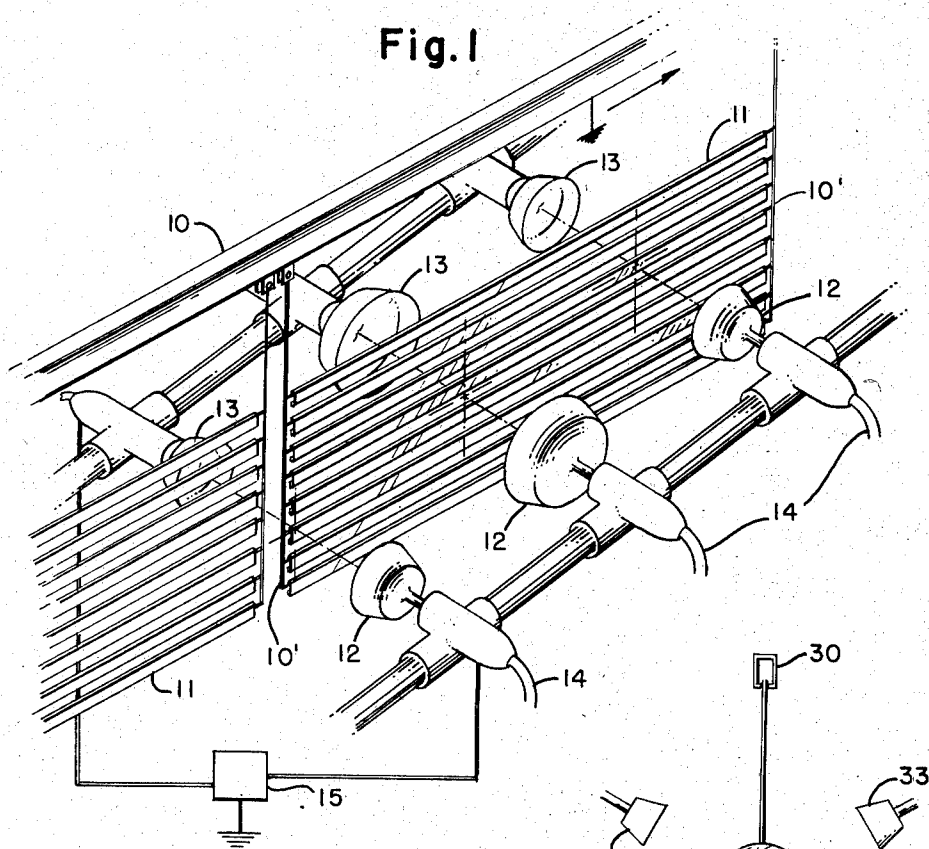


Fig. 2

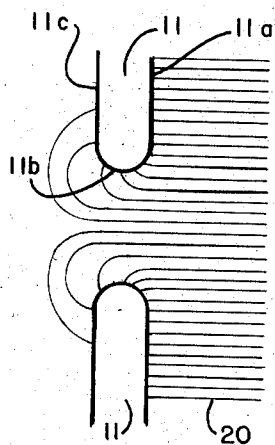


Fig. 3

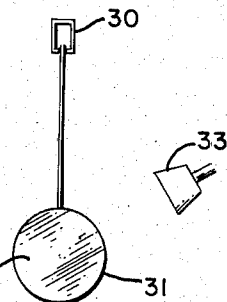
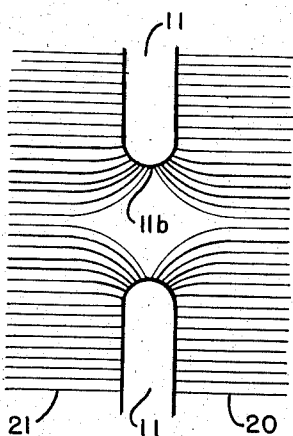


Fig. 4

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1

2,883,302

ELECTROSTATIC COATING METHOD AND APPARATUS

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2 Claims. (Cl. 117-93)

This invention relates to a method and apparatus for electrostatically applying coating material to articles of manufacture, and more particularly to methods and apparatus in which the articles are moved successively through the coating zone. In certain electrostatic coating operations, especially where the spray of electrically charged particles is projected generally normally to the path over which the articles move, difficulty is encountered in coating surface portions having an extent in a direction generally parallel to that in which the spray is projected. Such difficulty is encountered, for example, in the coating of relatively thick sheet-like articles and rod-like articles of elongated cross-section passed in their own plane through the coating zone, the edges of such articles frequently acquiring a coating objectionably lighter than that deposited on the sides of the articles. This effect is believed to be due to the fact that the lines of electrostatic force which terminate on the edges of the articles are so sharply curved adjacent such edges that the charged coating-material particles, as a result of the momentum they possess, are unable to follow those lines of force and are carried past the article-edges without becoming deposited thereon.

It is the object of this invention to overcome the difficulty just noted and to improve the uniformity of coating-material deposition on electrostatically-coated articles.

Practice of the invention involves utilization of the expedient of reshaping the pattern of the electrostatic field existing over the surface of the article being coated, and especially over and adjacent those surface portions of the article which, as noted above, tend to receive a relatively light coating. Such reshaping may be accomplished either through the use of one or more electrodes disposed adjacent the path of article travel or by utilizing the electrostatic effect of certain of the undeposited charged coating-material particles to modify the electrostatic forces acting on others of such particles. In the preferred embodiment of the invention, use is made of both the field-shaping electrode or electrodes and the mutual interaction of similarly charged coating-material particles.

In carrying out the invention in its preferred form, the articles to be coated are passed successively over a predetermined path between spaced electrostatic atomizing heads, which may be of previously known type, the heads on opposite sides of the article path being located substantially in alignment with each other and maintained at a substantial difference of electrical potential relative to the articles which pass between them. As a result of such potential difference, there exists between the article and the head or heads on each side of the path an electrostatic field capable of electrostatically atomizing liquid coating material supplied to the heads and of electrostatically depositing the atomized coating material on the article as it passes between the heads. In such an arrangement, the pattern of the lines of force extending from each head to the article is modified both by the presence of the head or heads on the opposite side of the article path and by the presence of the electrically charged

2

particles emanating from the latter head or heads. The net result is that each field is repatterned in such a way that the charged particles of coating material approaching the article-path in regions just beyond the edges of the article are directed less across the article-path and more toward the article than would otherwise be the case.

The accompanying drawing illustrates the invention: Fig. 1 is a perspective view illustrating a preferred embodiment of the invention; Figs. 2 and 3 are diagrammatic views illustrating the principle of the invention; and Fig. 4 is a diagrammatic elevation of a modified form of apparatus.

In the apparatus illustrated in Fig. 1, an overhead conveyor 10 carries through a coating zone a succession of articles 11 to be coated, such articles being shown as curtain rods about one inch in width and three-eighths of an inch in thickness supported in horizontal positions and in vertically spaced relation by supports 10' depending from the conveyor. Arranged in opposed relation on opposite sides of the path followed by the articles 11 are two sets of electrostatic atomizing heads 12 and 13. Each head comprises a generally cup-like member arranged to be rotated about a horizontal axis and to be supplied with liquid coating material through a suitable conduit 14. A source of high voltage 15 having one terminal grounded and its other terminal connected to the heads 12 and 13 creates an electrostatic field between each head and the articles 11, which are grounded through the supports 10' and the conveyor 10. Liquid supplied to each head through the associated conduit 14 spreads out under the influence of centrifugal force on the inner surface of the head to form an annular film, and the electrostatic forces existing at the edge of such film atomize the coating material into fine, charged particles which generally follow the lines of force of the field and become deposited on the articles 11.

The apparatus illustrated and described in Fig. 1 is capable of applying to the curtain rods 11 a coating which is distributed with satisfactory uniformity over the sides and edges of each rod.

It will be noted from Fig. 1 that each head 12 on one side of the article-path is located substantially directly opposite a head 13 on the other side of such path. This is an important feature of the invention; for if the two groups of heads were spaced from each other along the article-path, the edges of the curtain rods would be inadequately coated. With the groups of heads arranged opposite each other, the edges and sides of the rods acquire a satisfactorily uniform coating.

For an explanation of the basis of the statements just made, reference may be had to the diagrammatic and somewhat idealized illustrations constituting Figs. 2 and 3. In Fig. 2, I have illustrated the condition existing when the rods 11 pass an atomizing head or heads located on but one side of the rods. The electrostatic field which is maintained between the rods on the one hand and the head or heads on the other has lines of force which follow the general pattern indicated by the lines 20. Most of the lines of force emanating from the head or heads will terminate on those side surfaces 11a of the rods which are presented toward the head, some will terminate on the edges 11b of the rods, and others will pass between the rods, curve around, and terminate on the rear rod-surfaces 11c. The electrostatic forces of the field act along the lines of force 20; and the particles, which possess no significant initial momenta or quickly lose any they do happen to possess, therefore tend to follow the lines of force of the field and do follow those lines of force except to the extent that their acquired momenta modify their respective directions of movement in regions where the lines of force of the field are relatively sharply curved. Such regions exist adjacent the edges 11b of

the rods and beyond the plane of the rods where the lines of force curve to terminate on the rear surfaces 11c.

The lines of force which terminate on the side surfaces 11a are relatively straight for their entire length, and charged particles which initially lie on those lines follow them rather closely until the particles are deposited. The lines of force which terminate on the edges 11b and rear surfaces 11c, although relatively straight for most of their length, eventually curve in more or less sharply toward the rod-surface. A charged particle lying initially on any of the latter lines follows it closely as long as it is straight; but when the curved portion of the line is reached, the momentum which the particle has acquired causes it to be carried beyond that line. As a result, the density of particle-deposition on the edges 11b will be less than that on the sides 11a. The particles which thus escape deposition on the edges 11b continue under the influence of the field, and many of them will consequently be deposited on the back surfaces 11c of the rods. In conditions such as that shown in Fig. 2, it is not unusual to find a materially heavier coating on the back sides 11c of the rods than on the edges 11b; and in some instances the edges 11b may be substantially bare.

In Fig. 3, I have shown the condition existing when there is added to the arrangement illustrated in Fig. 2 a second head or set of heads located oppositely to the head or heads which create the field 20. Such a second head or set of heads creates a field having lines of force as indicated at 21. This is the condition existing in Fig. 1, where the two sets of similarly charged heads 12 and 13 are located substantially in opposed relation on opposite sides of the path followed by the rods as they receive their coating. It will be noted that the pattern of the lines of force 20 in Fig. 3 is substantially different from the pattern in Fig. 2. The second head or set of heads has acted, as it were, to push the terminal portions of the lines of force 20 back toward their origin until none of them crosses the plane of the rods to terminate on the remote sides thereof. Further, the general directions of the terminal portions of those lines of force which terminate on the edges 11b has been altered so that those terminal portions slope less across the plane of the rods and more toward the edges 11b than do the terminal portions of the corresponding lines in Fig. 2. As a result of the altered pattern of the field 20 in the region adjacent the edges 11b, the particles occupying that region are more effectively accelerated toward the edges 11b and, in consequence, a materially higher proportion of the particles will be deposited upon those edges.

From a different point of view, the net force acting on a charged particle in the condition illustrated in Fig. 2 may be regarded as the resultant of a repulsion exerted by the head or heads on the one side of the rods and an attraction exerted by the rods. For those particles which were initially directed beyond the edges of the rods, or toward the spaces between rods, such repulsion militates against deposition of the particle on the edge 11b. When, however, there are heads on both sides of the rods, as in Figs. 1 and 3, the particle emanating from any head is acted upon by a third force-component—namely a repulsion exerted by the head or heads on the opposite side of the rods. The two repulsive forces respectively exerted on the particle by the oppositely disposed heads 12 and 13 act generally in opposite direction and approach equality as the particle approaches the article-plane. Accordingly, because of the presence of the heads 13, the repulsive force exerted by a head 12 becomes less of a factor and the attraction exerted by the article becomes more of a factor in determining the path of the particle.

Added to the repulsive effect exerted by the head 13 on the particles emanating from the head 12 is a repulsive effect of generally similar direction exerted on those particles by virtue of the charges on the particles emanat-

ing from the head 13. These tend further to reduce the force-component normal to the article-plane and to increase the relative effect of the attraction exerted for the particle by the adjacent rod.

Obviously, when electrostatic atomizing heads are arranged in directly opposed relation as in Figs. 1 and 3, the heads 12 and the charged particles emanating from them have the same effect on the particles discharged from the heads 13 as do the heads 13 and the particles emanating therefrom on the particles discharged from the head 12. It follows, therefore, that the heads of either set may be regarded as precipitating electrodes and those of the other set as field-modifying electrodes.

The effect of the head or heads 13 alone on the lines of force 20 will be the same irrespective of whether or not the heads 13 are being used as a source of atomized coating material. In other words, if only the side surfaces 11a and the edges 11b of the rods were to be coated, the head 13 could be replaced by an electrode having any form and impressed with a charge of sign similar to that impressed on the head 12.

It is to be understood that the rods 11 are shown merely as examples of articles which can be coated with advantage by the method and apparatus of this invention. Generally speaking, the invention finds its greatest utility in coating articles which have approximately plane side surfaces and a substantial thickness. In the arrangement shown in Figs. 1 and 3, the effect of each head or set of heads on the field produced by the others, and the interaction of the charged particles on opposite sides of the article, are so pronounced that the opposite sides of an article can be coated with materials of different colors and merging of those colors will be confined to a narrow band on the edges of the article.

Obviously, the effect of a head or heads on one side of the article plane in modifying the pattern of the field existing between the article and a head or heads on opposite sides of such plane will be of especial consequence in controlling the distribution of deposited coating-material particles in situations where the paths of the particles are substantially entirely determined by the electrostatic forces of the field. To attain that condition to the fullest extent, it is necessary that all the particles be charged and that they either lack or quickly lose any substantial initial momentum. Both these requirements are adequately satisfied in apparatus of the type illustrated, where both atomization and deposition are effected by electrostatic forces; but it is to be understood that other forms of apparatus may be used if desired.

When both sides of the article are being coated by charged particles emanating from sources located in opposed relation and on opposite sides of the article, the electrostatic interaction of the two sprays will be independent of the nature of the means employed in forming and charging those sprays. That is, the charged particles on one side of the article-plane and beyond the limits of the article will repel correspondingly located particles on the opposite side of the article-plane, and hence passage of any particles from one side of the article-plane to the other will be opposed and deposition on the edges of the article will be promoted.

So far as concerns the electrostatic interaction of similarly charged particles on opposite sides of the article, it is immaterial whether or not those particles emanate from spray devices arranged in directly opposed relation. Thus, I have indicated in Fig. 4 an arrangement in which the interaction of similarly charged particles is utilized, although the apparatus does not employ directly opposed spray devices. As indicated, a conveyor 30 moves through a coating zone an article 31 having end surfaces 31b which are to be coated by atomized coating material discharged from three electrostatic atomizing heads 32, 33 and 34 disposed in a common plane normal to the article path and maintained at substantial and similar potential-differences with respect to the article.

5

On that side of the article path remote from the head 32, the other two heads will maintain a cloud or dispersion of coating-material particles bearing electric charges similar to those borne by the particles discharged from the head 32. As a result, passage across the article path of coating-material particles discharged from the head 32 will be electrostatically opposed by the charged particles located on the opposite side of the path and emanating from the other two heads. In similar fashion, each pair of heads co-operates to produce a dispersion of charged particles modifying movement of the particles emanating from the third head in a manner which promotes deposition on the end surface 31b of the article.

I claim as my invention:

1. The method of electrostatically coating articles each having extended side surfaces and relatively sharply curved edge portions comprising moving the articles translationally along a predetermined path with edge portions of adjacent articles in opposed spaced relation and the side surfaces of the articles presented laterally of the path, forming from sources on opposite sides of said path two groups of sprays of similarly charged liquid coating material particles, maintaining said articles at a spray-attracting potential whereby the charged particles will be attracted to the articles for deposition thereon by electrostatic forces, there being three sprays in each group and each spray of one group being similar to and being projected substantially directly toward a spray of the other group along a common axis substantially normal to and bisected by the article path, said axes being spaced along the article path and offset relatively to each other laterally of said path to produce on the side surfaces of the articles partially overlapping bands of coating material and so located that edge portions of the articles pass through at least one pair of coaxial sprays, and maintaining the atmosphere between said spray sources quiescent whereby electrostatic forces will be substantially the sole agency affecting movement of the spray particles and whereby the charged particles on one side of the article path will electrostatically oppose the passage of charged particles from the other side of said path across said path through the spaces between opposed article edge portions to promote deposition of particles of both sprays onto edge portions of the articles.

6

2. Apparatus for electrostatically coating a plurality of articles each having flat-surfaced side portions and relatively sharply curved edge portions comprising a conveyor for moving the articles in prearranged spaced relation translationally along a substantially linear path, three pairs of single-fluid atomizing devices, the devices of each pair of devices being positioned on opposite sides of the article path for projecting two similar expanding sprays of atomized liquid coating material into a quiescent atmosphere and toward the article path along a common axis substantially normal to the article path, the articles passing through said three pairs of sprays in such manner that the flat-surfaced side portions of the articles are substantially normal to said common axes and edge portions of each article lie entirely within the boundaries of at least one pair of sprays as the article moves through said sprays, and means including a high voltage source connected to each one of said three pairs of atomizers and to the spaced articles moving through said sprays to similarly charge all of the sprays of liquid coating material as they are projected from their respective atomizers to a potential substantially different from the articles whereby similarly charged spray particles projected toward each other from opposite sides of the article path will repel each other and be deflected toward and deposited on an adjacent article edge portion to effect substantially uniform coating of such edge portions, the three atomizing devices on each side of the article path being offset from each other laterally of the article path and also spaced from each other along the article path by such distances as to deposit on each of the side portions of each article a composite pattern of substantially uniform thickness.

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