

July 2, 1957

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2,798,008

ELECTROSTATIC COATING METHOD

Filed Dec. 16, 1953

2 Sheets-Sheet 1

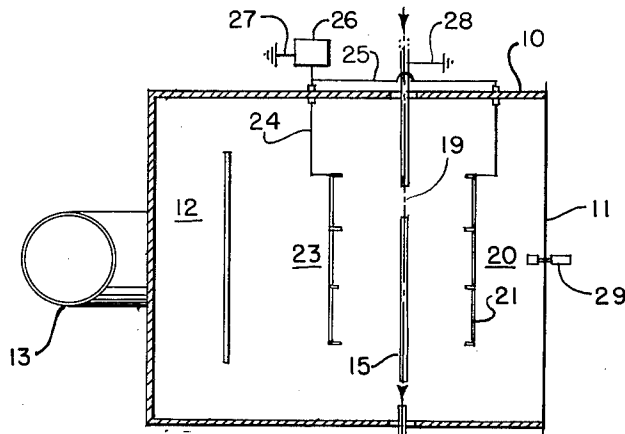


Fig. 1

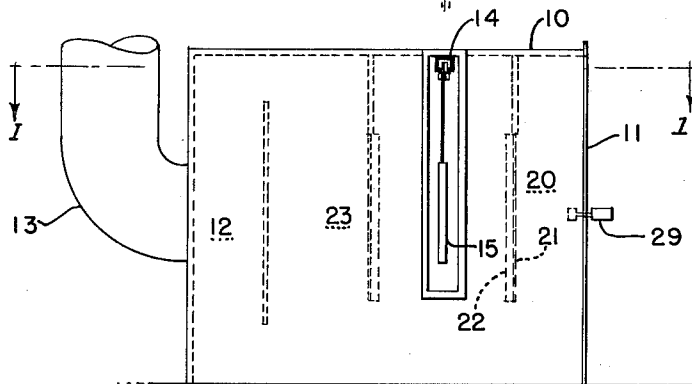


Fig. 2

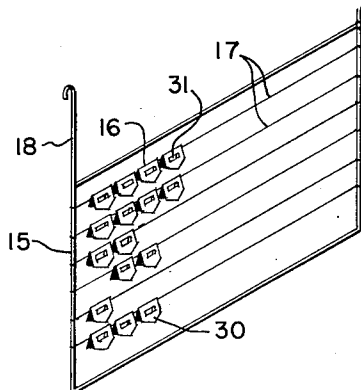


Fig. 3

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2 Sheets-Sheet 2

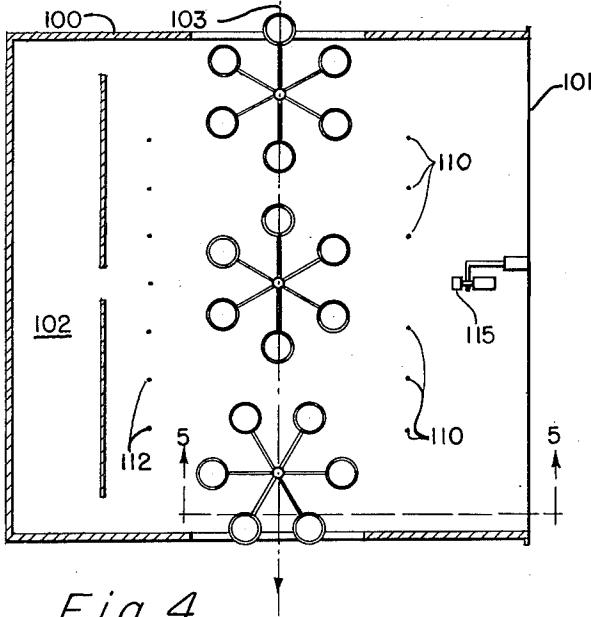


Fig. 4

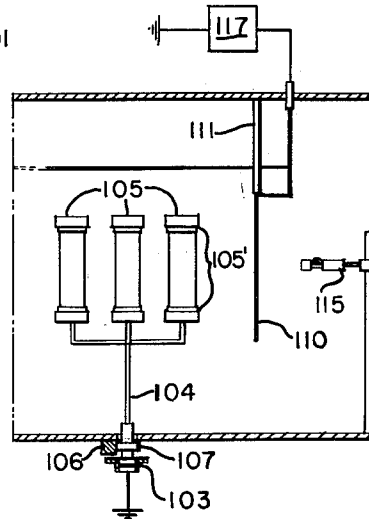


Fig. 5

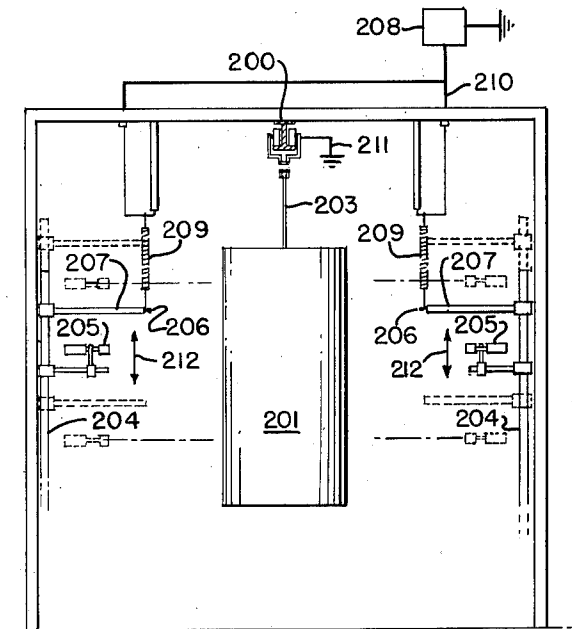


Fig. 6

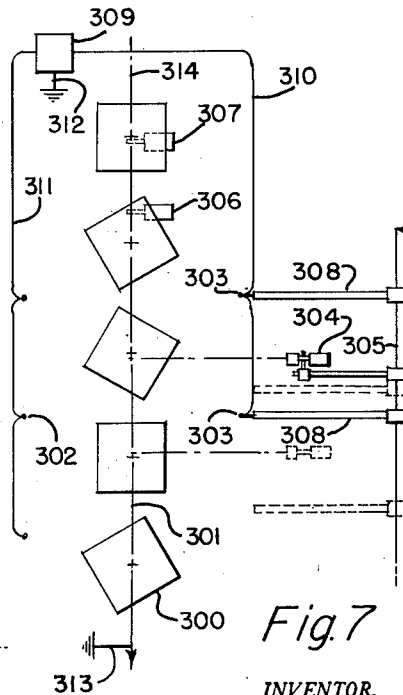


Fig. 7

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2,798,008

ELECTROSTATIC COATING METHOD

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Application December 16, 1953, Serial No. 398,524

2 Claims. (Cl. 117—93)

This application is a continuation-in-part of my prior application Serial No. 194,995, filed November 10, 1950, now patent No. 2,741,218, and relates to improvements in methods and apparatus for electrostatically coating articles of manufacture.

The electrostatic method of applying paint and other coating materials, as practiced in industry for a number of years, involves the production of a spray of electrically charged coating material particles and the electrostatic deposition of such charged particles on the articles to be coated. In one rather widely used process, the articles to be coated are moved successively by a conveyor past a discharge electrode between which and the articles an electrostatic field is maintained, and a spray of the coating material is discharged into such field from a spray gun using a blast of air both as an atomizing medium and as a particle-transporting medium. Generally speaking, apparatus for practicing such process has usually been designed so as to minimize as far as practical the possibility that the air blast would carry the coating material particles out of the depositing field. With that object in view, the Ransburg et al. United States Patents Nos. 2,247,963 and 2,334,648 proposed arranging the spray gun or guns to discharge generally parallel to the conveyor, thus reducing the likelihood that spray particles would be carried through the spaces between articles and therebeyond out of the field. The generally parallel spray further tended to insure that the majority of the sprayed particles, when they lost their initial momentum, would still be close to the path followed by the articles and hence would be effectively subject to the depositing action of the field.

Where coating with a parallel spray was carried out in a spray booth which was exhausted in such a manner as to create an air current moving generally parallel to the spray, some of the sprayed particles might be carried for inordinate distances before being deposited. In such a situation, it was proposed (Ransburg et al. Patent No. 2,463,422) to move the articles over an L-shaped path, to discharge the spray along one leg of such path toward the other leg, and to place on the remote side of such other leg an electrode which would cause the relatively few slowly moving particles passing between articles and approaching it to reverse their direction and be deposited.

While the arrangements above described resulted in substantial savings of coating material, there were cases in which they left something to be desired. Thus, with the spray directed generally parallel to the article path, some particles were deposited much more quickly than were others, there was considerable variation among the particles in respect to their dryness at the time of deposit, and it was therefore necessary to use in the coating material a solvent sufficiently slow to insure that the driest of the deposited particles would not be too dry. Further, the parallel spray sometimes resulted in an inadequate coating of article-portions which were electrically shielded by other article-portions.

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Another expedient for reducing the number of particles carried out of the field by their initial momentum is disclosed in Ransburg et al. Patent No. 2,546,701, where the spray gun was arranged to discharge past a particle-charging discharge electrode perpendicularly to the article path. Such a gun, if operated continuously and in fixed position, would project much of the sprayed material through the spaces between articles and beyond the field; and to prevent such a loss of coating material, the patentees proposed to arrange the gun for manual manipulation and control, so that it would be maintained aimed at a passing article and shut off completely when there was no articles within direct range of the spray. This apparatus had advantages over those disclosed in the patents earlier mentioned in that the particles reached the work at substantially the same degree of dryness and in that the gun could be so directed as to cause coating material particles to be projected onto electrically shielded areas under their own momentum; but, because it required manual operation of the gun, it entailed relatively high labor costs.

Ransburg Patent No. 2,567,781 discloses a method and apparatus designed to retain the efficiency of electrostatic coating while eliminating hand labor and providing for the projection of coating material onto electrically shielded article-portions. While this arrangement eliminated manual gun-manipulation and did provide an adequate coating on electrically shielded areas, there was still a wide variation in the dryness of the particles at deposition.

It is an object of this invention to produce an electrostatic coating method and apparatus which will in large measure preserve the advantages and eliminate the disadvantages of the prior systems above described. More specifically, it is an object of the invention to promote uniformity in the state of dryness of electrostatically deposited coating material particles, to provide an adequate coating of electrically shielded areas, and to preserve the relatively high paint-utilization efficiencies characteristic of prior electrostatic coating methods such as have been described above. Another object of the invention is to reduce the floor space required for electrostatic coating apparatus and to permit the use of paint booths and exhaust systems of a simple type heretofore used in non-electrostatic coating methods.

One feature of the invention is directed to a coating method in which a series of articles is conveyed along a predetermined path in spaced relation to and between two electrodes which are held at a high electrical potential relative to the articles to ionize and precipitate upon the articles particle coating material from a source directed approximately normal to said path at the position of closest approach of the path to said source and past and along side of one of said electrodes toward said articles. The articles are thus presented directly to the spray to collect by mechanical impingement a portion of the coating material and are so positioned with respect to the electrodes as to collect by electrical precipitation particles not so impinged and other particles which cross the path of travel of the articles. By thus combining the two coating forces, high coating efficiencies are obtainable.

Another feature of the invention resides in spacing the articles along the path in such a manner that a portion of the coating material particles pass between the articles to that side of the article path which is opposite the spray source and will then be reversed by the electrostatic action of an electrode on that side of the path and be precipitated upon those surfaces of the articles which are not in facing relationship to the spray.

A further feature resides in having the electrode adjacent the spray source composed of at least two parts, one

on either side of said spray, so that the spray in moving toward the article passes between and comes under the charging influence of one or the other of these parts. A similar multi-part electrode can be placed on the side of the article path remote from the spray source to precipitate particles moving through the spaces between articles.

The invention further contemplates that the spray source can be reciprocated or oscillated about a mean position so that the bulk of the issued coating material will impinge directly upon the article as it moves along its predetermined path. In addition it contemplates that the electrode might also be similarly oscillated or reciprocated in coordination with the spray source.

In all the above features it is contemplated that the coating material will be directed toward the article path in a direction which is approximately normal to the path. It is further contemplated that this direction will be generally normal at the position of closest approach of the path to the source of the spray of coating material. In this way the material will be initially applied to the article by mechanical forces directly from the spray sources and by electrical forces on both sides of the path as soon as possible after leaving the atomizer and the tendency will be to have a full wet coat of material built up on the article promptly.

This quick formation of a wet coat is advantageous over normal electrostatic methods since it permits the coating material to be formulated with faster solvents and thus overall drying requirements are reduced.

While in certain of its aspects the invention contemplates that the spray source directs coating material toward the articles over a path which is alongside of but still in particle-charging relation to the electrode, it is preferable that the electrode not be exposed to the direct blast of the wet spray particles from a closely positioned source so that the electrode will not accumulate by direct impingement coating material which later under the influence of the field will string off and be carried to the parts as objectionable slugs.

These and other features of the invention will be made apparent from the following specifications and claims.

In the accompanying drawings:

Fig. 1 is a plan view of one embodiment of the invention as used for finishing index tabs and is taken along line 1—1 of Fig. 2,

Fig. 2 is a side elevation of the apparatus of Fig. 1,

Fig. 3 is an isometric view of the rack used to hold the tabs during the painting operation,

Fig. 4 is a plan view of another embodiment of the invention in which elongated cylindrical articles arranged in clusters are coated,

Fig. 5 is a partial elevation taken along line 5—5 of Fig. 4,

Fig. 6 is a front view of apparatus embodying another modification of the invention as incorporated with an overhead conveyor, and

Fig. 7 is a plan view of a modification of the invention in which the spray gun is moved simultaneously with one of the electrodes.

As illustrating one modification of the invention, there is shown in plan view in Fig. 1 and in side elevation in Fig. 2 a spray booth 10 having an open side 11 and an exhaust plenum 12 which is connected to exhaust duct 13. Passing through this both from one side to the other is a conveyor 14 to which are attached frames 15 holding the articles 16 to be coated. These frames as shown in detail in Fig. 3 have a series of wires 17 stretched across them and have two attachment members 18 by which they are supported from the conveyor. The articles 16, here shown as metal index card tabs, are supported saddle-wise on these wires, one next to another, on all wires. The frame can be filled or not as desired. These frames are supported on the conveyor and carried by it through the spray booth in the direction of the arrows 19 in Fig. 1. In the booth, on one side of the conveyor and spaced

from it, is located an electrode 20 comprised of conducting frame 21 which serves to support under tension the charging or ionizing elements 22. A similar electrode 23 may be positioned on the opposite side of the conveyor from electrode 20. These two electrodes, by conductors 24 and 25, are electrically connected to each other and to the one terminal of a high voltage source 26 whose other terminal is grounded as at 27. Since the conveyor, the carrying frames, and the articles on the frames are all electrically connected, grounding the conveyor as at 28 serves to ground the articles to be coated.

Under this arrangement an electrostatic field is established between the electrodes and the articles when the source of high voltage is energized. The gradient of this field is high adjacent the electrodes 20 and 23 because of the nature of the ionizing elements and thus any particles in their vicinity will become charged and be repelled by the field toward the articles which are connected to the other terminal.

Coating material in finely atomized form is introduced into this field from outside by an atomizing device 29 positioned to direct the spray past and adjacent electrode 20 into the field and generally normal to the path of travel of the conveyor at the position of closest approach of the articles to the gun. As the articles 16 are carried through the spray booth their front side 30 is thus subject to and receives coating material from the direct mechanical impingement action of the spray as well as from the precipitating action of the field. They also receive on their front sides material which has become charged by passing the front electrode but which has escaped being attached to the article because of "air bounce" or turbulence. Such particles, after bouncing off the article, are reversed again and urged toward the articles by the action of the field. Still other particles from the atomizer 29 will pass between the articles on the frame and enter the field between the back side of the articles and the second electrode 23. Under the action of this field most of these particles will have their direction reversed and will be returned to the articles to supply the coating on their back side. This phenomenon of material being redirected to coat surfaces not in the direct impingement pattern of the atomizer is referred to as "wrap around" and accounts in a large measure for the added efficiencies obtained by the method of this invention. Lateral surfaces, such as the sheared edges of the tabs shown herein, are also coated by this action. Any coating material particles escaping these multiple forces of precipitation are carried with the evaporating solvent fumes into the plenum 12 by the exhaust.

This method is particularly suited for finishing this article since it is desirable that the inside surface of the back leg of the tab immediately behind the tab window 31 be coated to present a good appearance when a legend card is not in the tab. The direct action of the atomizer acting on the front of the tab carries coating material to this area through the window opening while the overspray coats the remaining portions of the article. One atomizing unit thus suffices to do the complete operation. By mechanical spraying alone, three atomizers are needed for this same coating operation.

If it is desired to increase the area of the support frame and thus increase the number of articles which can be sprayed per foot of conveyor, the atomizer can be moved up and down in a plane parallel to the plane of the article support frame and thus distribute its material over a larger area than is permitted by a simple divergence of the spray pattern.

Another modification of the invention is shown in plan view in Fig. 4 and further detailed in Fig. 5 which is a partial elevation along lines 5—5 of Fig. 4. In this modification a spray booth 100, which may be of a type commonly used in non-electrostatic spray painting, is arranged with an open face 101 opposite an exhaust plenum 102. A floor supported conveyor 103 enters one side of this

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booth, passes through the booth, and emerges through the other side. The conveyor carries a series of upwardly projecting spindles 104 each shown as adapted to support an annular series of vertically disposed, generally cylindrical articles 105, which might be cartridge tanks. Preferably, the spindles 104 are rotatably mounted on the conveyor and means such as a stationary friction bar 106 engaging with rotator wheels 107 on the spindles is provided for rotating the clusters of articles 105 as they pass through the booth. Between the open side 101 of the booth and the path followed by the articles I provide a plurality of vertically extending discharge electrodes 110, preferably fine wires, supported from insulators 111 in horizontally spaced relation in a plane parallel to the article path. A similar set of electrodes 112 is arranged on the opposite side of the article path.

Supported in fixed position outwardly beyond the electrodes 110 is a spray gun 115 oriented to discharge generally horizontally and directly toward—i. e., substantially perpendicular to—the article path. This spray gun, which is capable in itself of projecting atomized coating material particles well beyond the article path, is conveniently of the type employing compressed air as an atomizing and particle-transporting agent. The gun is located to discharge between two of the electrode elements 110, and such elements are spaced far enough apart to be out of the spray projected from the gun.

The electrodes 110 and 112 are connected in common to a terminal of a high voltage source 117 the other terminal of which is grounded; and as the articles 105 will be grounded through the conveyor, an electrostatic field will exist between the articles on the one hand and the electrodes on the other. The particles of coating material passing between electrodes 110 will be electrically charged and urged toward deposition on the articles by the electrostatic forces of the field. Many of the particles will escape deposition initially and will be carried by their preserved initial momentum across the article path, but such particles will be repelled, reversed and redirected toward the articles by the electrodes 112. It is possible that some particles passing close to the articles but escaping deposition thereon will suffer a loss or diminution of their charges; but since the atmosphere around the electrodes 112 will be ionized, such particles will be quickly recharged and made subject to the repelling effect of those electrodes.

As will be obvious, the space within a cluster of articles 105 will be rather effectively shielded electrically, and any electrostatic depositing effect in such space will be relatively weak. Nevertheless, a substantial number of the coating material particles will be carried by their own momentum into and across the interior of the cluster to impinge on the inner surfaces of articles on the remote side of the cluster, and thus all portions of the surface of each article may be adequately coated. If the particles possessed less momentum, the field would be more effective in deflecting them from their original course; and as the field is much stronger over the exterior of the cluster than within it, the outwardly presented surfaces of the articles would receive a heavier coat and the inwardly presented surfaces a lighter coat.

The articles 105 are shown as provided at their ends with annular beads or heads 105'. The corners at the bases of such beads are electrically shielded and hence tend to receive a relatively light coat of electrostatically deposited material. However, by my invention, the same high momentum which causes some of the spray to be deposited on the surfaces presented inwardly of the article-cluster causes other particles to be projected on to the electrically shielded areas at the base of the beads.

Fig. 6 illustrates another modification of the invention. In this drawing, which is a front view of the apparatus, a conveyor 200 carries articles 201 into and through a spray booth 202. The front of the booth is open and at

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its rear there is an exhaust plenum (not shown). The conveyor enters the side of the booth, turns and travels away from exhaust plenum toward the front of the booth. Articles 201, indicated here as external jackets for water heaters, are supported from the conveyor by hanger 203 and are carried by it through the booth.

In the booth, on both sides of the conveyor, there is an oscillating mechanism 204 which carries a spray gun 205 and an electrode element 206 in spaced relation to the article surface. The electrode is supported by insulator 207 which serves to isolate it from the oscillating mechanism so it can be connected to one terminal of a high voltage source 208 by spring connection 209 and conductor 210. By means of this source the electrode is maintained at a high electrical potential with respect to the article which is grounded as at 211 and a field therefore exists between them which has a gradient capable of charging particles adjacent the electrode.

A spray of coating material is introduced past the electrodes by the spray gun 205 and travels essentially normal to the article. Being charged by proximity to the electrode, it is then put onto the article surface by the combined mechanical action of the spray and the electro-depositing action of the electrostatic field.

To obtain distribution over the article surface, the oscillator 204 is caused to move the electrode and spray gun up and down in a vertical plane parallel to the article surface between the extreme positions of the gun and electrode shown in dotted lines and as indicated by the arrows 212.

With this arrangement a single gun and electrode assembly on each side of an article can be used to simultaneously and efficiently coat opposite sides of single articles. If the object is cylindrical it can be rotated while passing the gun stations to have its entire surface coated or, if it is rectangular, it can be indexed and carried past another similar station to have its other two sides finished. The exhaust air moving parallel to the path of conveyor travel serves to carry away evaporating solvent fumes and any material which might escape deposition.

Fig. 7 illustrates in plan view another modification in which articles 300 move along a conveyor, illustrated by line 301, past and between fixed electrodes 302 and movable electrode 303, a spray gun 304, movable with and mounted on the same support mechanism 305 as are electrodes 303, is arranged to be turned off and on by the action of switches 306 and 307. It is aimed to direct a spray of coating material between the two electrodes 303 toward and normal to the path of travel of articles 300.

In operation switch 307 is tripped by an object supporting spindle on the conveyor as the conveyor moves in the direction of arrow 314 and turns on the spray from gun 304 when the gun is aimed directly at a preceding article on the conveyor. By an arrangement not shown, support mechanism 305 is arranged to move parallel to and in step with conveyor 301 when switch 307 is tripped. It continues this motion and the gun continues to spray until switch 306 is activated, at which time the gun is turned off and the support 305 returns rapidly to its original position. The cycle is repeated when switch 307 is again tripped by the following spindle. By this arrangement the spray gun and the precipitating electrode 303 are moved with the conveyor from the position shown in full lines to the position shown in dotted lines while the spray is activated and directed for normal impingement upon an article and they return to their original position past the spaces between the articles with the spray turned off.

The detailed characteristics of the apparatus may vary to suit circumstances. In general, I have found it convenient to maintain an average potential gradient of 8,000 to 10,000 volts per inch between the electrodes and the articles. For most work, a distance of about ten

inches between the articles and electrodes charged to 90,000 volts will be satisfactory. The space between adjacent ones of the electrode elements, such as the wires 110 and 112 of Figs. 4 and 5, preferably approximates their distance from the work. The electrodes desirably extend for some distance above and below the tops and bottoms of the work, and both series of electrodes desirably extends along the article path to, or even beyond, the limits of the billowing spray discharged from the spray gun.

While I have shown all the electrodes as discharge electrodes capable of ionizing the adjacent atmosphere, it may be noted that the electrode on the remote side of the work from the spray gun may be non-ionizing. Ionizing electrodes on both sides of the article path are preferred, however, because of their capability of charging or recharging the coating material particles which approach them.

From the above described modifications it will be evident that the invention allows added efficiencies of coating application to be obtained by combining in a parallel manner the mechanical action of a spray jet and the precipitating action of an electrostatic field. It is also apparent that surfaces facing the atomizer, as well as those not facing it, can be coated simultaneously and that the particles will all be deposited promptly and with substantially the same degree of dryness. Because of this prompt deposit of all particles, it is possible to use relatively volatile solvents for the coating material, thus reducing the time required to dry the finished coating.

I claim:

1. A method of electrostatically coating articles each having an electrostatically shieldable portion of relatively large area and, spaced from said shieldable portion, an electrostatically shielding portion of smaller area, comprising moving the articles over a fixed predetermined path past and in spaced relation to electrodes located in facing relationship on opposite sides of the article path, one of which electrodes is of ionizing character, maintaining the articles as they pass between said electrodes so oriented that the shielding portion of each article is disposed between the shieldable portion and said ionizing electrode whereby said shieldable portion becomes electrostatically shielded, forming at a point on the opposite side of said ionizing electrode from said path a spray of finely divided liquid coating material, maintaining a high difference of electrical potential between said electrodes and articles to create an electrostatic field between the electrodes and the articles, with said field creating an electrostatic shield over said shieldable portion of an article, propelling said spray approximately normal to said path at the position of closest approach of the path to said formation point toward both said electrodes and past, and in particle charging proximity to said ionizing electrode to cause particles passing the ionizing electrode to acquire an electric charge opposite in sign to that of the articles and thereby to cause a portion of the spray to be electrostatically deposited on article surfaces presented toward said ionizing electrode, with another portion of said spray being propelled toward at

least a part of said shielded portion and past said shielding portion with a velocity sufficient to cause deposition on such part of said shielded portion of the last mentioned portion of the spray in spite of the existence of said electrostatic shield, said articles being spaced apart to permit a further portion of the spray to enter the space between the articles and become electrostatically deposited on article surfaces presented towards said other electrode, with all of the portions of the spray being deposited substantially simultaneously to prevent excessive drying of any of said portions.

2. A method of electrostatically coating articles each having an electrostatically shieldable portion of relatively large area and, spaced from said shieldable portion, an electrostatically shielding portion of smaller area, comprising moving the articles over a fixed predetermined path past and in spaced relation to an electrode of ionizing character located on one side of the article path, maintaining the articles as they pass between said electrodes so oriented that the shielding portion of each article is disposed between the shieldable portion and said ionizing electrode whereby said shieldable portion becomes electrostatically shielded, forming at a point on the opposite side of said path from said electrode a spray of finely divided electrostatically charged liquid coating material, maintaining a high difference of electrical potential between said electrode and the articles to create an electrostatic field between the electrode and the articles, with said field creating an electrostatic shield over said shieldable portion of an article, propelling said spray toward said articles and electrode in a direction approximately normal to said path at the position of closest approach of the path to said formation point thereby to cause a portion of the spray to be electrostatically charged and deposited on article surfaces presented toward said spray, with another portion of said spray being charged and propelled toward at least a part of said shielded portion and past said shielding portion with a velocity sufficient to cause deposition on such part of the shielded portion of the last mentioned portion of the spray in spite of the existence of said electrostatic shield, said articles being spaced apart to permit a further portion of the spray to enter the space between articles and become electrostatically deposited on article surfaces not presented towards said electrode, with all of the portions of the spray being deposited substantially simultaneously to prevent excessive drying of any of said portions.

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