Feb. 5, 1957 R. C. JUVINALL 2,780,565

ELECTROSTATIC SPRAY COATING SYSTEM AND METHOD

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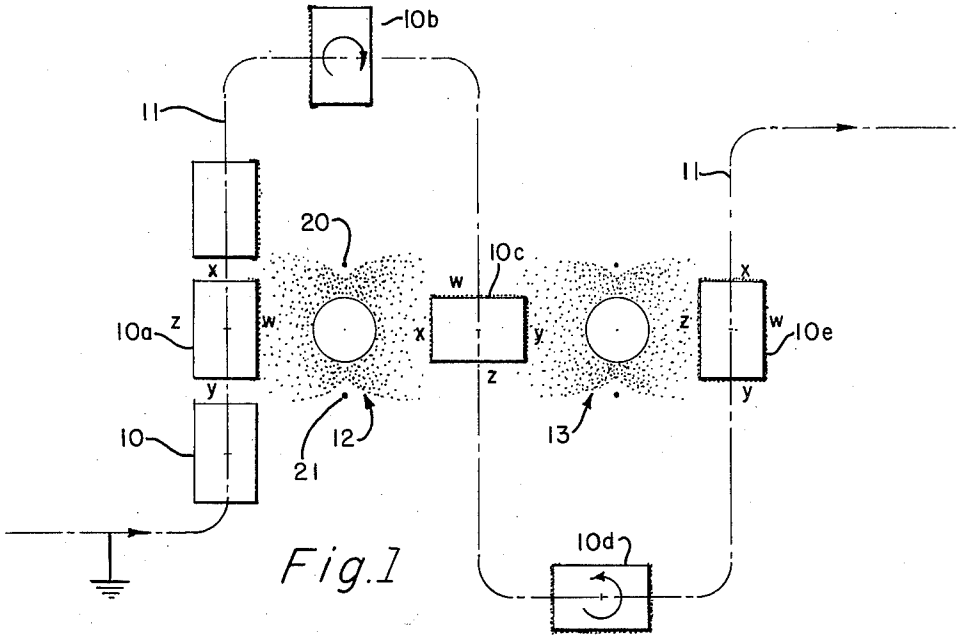

Fig. 1

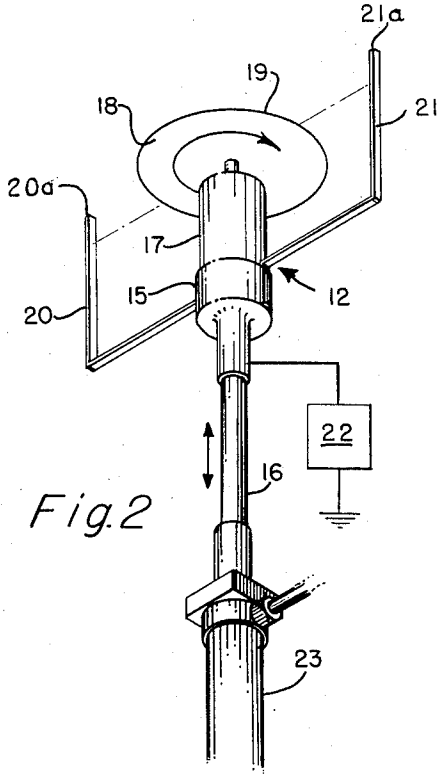

Fig. 2

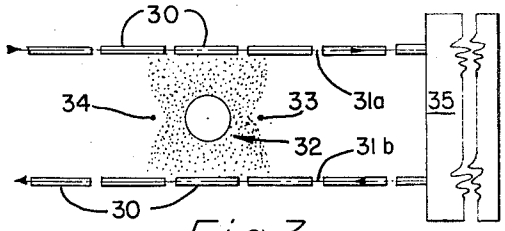

Fig. 3

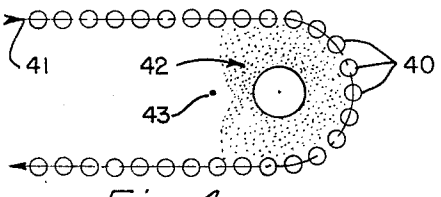

Fig. 4

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ELECTROSTATIC SPRAY COATING SYSTEM AND METHOD

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8 Claims. (Cl. 117—93)

This invention relates to the atomization and electrostatic deposition of a spray of liquid coating material particles from an atomizing device and more particularly to methods and apparatus for controlling the deposition of such projected spray particles.

The electrostatic deposition of a spray of finely divided particles of liquid material such as paint, lacquer, and the like, to form a coating on articles of manufacture has many advantages in paint savings, coating uniformity, and ready adaptation to conveyorized production methods. In electrostatic coating the elimination of the uncontrollable turbulent air blasts of conventional compressed air atomizing guns has been found very advantageous since such elimination results in the deposition of the coating material being substantially entirely a function of the electrostatic forces operating between the spray particles and the article to be coated. Various electrostatic coating systems have been suggested to eliminate the objectionable compressed air atomizing guns. Rotating annular atomizing devices, for example, may be used in conjunction with a special conveyor for passing a series of articles to be coated substantially around the rotating atomizing device and such use is described in the copending application of C. C. Simmons, Serial No. 274,909 filed March 5, 1952.

Many instances may arise where it is desired to electrostatically coat articles utilizing an atomizing device which operates without using compressed air, wherein it is not practical or possible to move the articles on a conveyor traveling substantially around the atomizing device. The articles may be of such length or shape that they could not be moved about the atomizing device along a circular path having a restricted radius. Moreover, the shape of the articles may be such that it is not feasible to rotate them about their axes during coating and yet it may be desired to coat more than the side of the article which in fixed position would face toward the atomizing device. Such coating would involve one or more indexing or turning operations which would be most conveniently accomplished outside the coating zone. Likewise, in some coating processes it is necessary to permit a substantial period of drying after the application of a light primary coat of paint or lacquer and then to expose the article to a second or finish coating of the same paint or lacquer. In such processes economies can be effected if the same atomizing device can be simultaneously utilized for both the primary and finish coating.

Existing facilities in many industrial plants include a conveyor system having two more or less closely spaced parallel conveyor track portions which may or may not be connected by a U-shaped section of conveyor. Such closely spaced parallel or U-shaped conveyor systems are sometimes employed in connection with non-electrostatic coating systems or electrostatic coating systems of an older or less efficient type than one utilizing a rotating annular atomizing device and a quiescent atmosphere in its coating zone. The term "quiescent atmosphere" does

not mean absolute stillness or freedom from air movement since rotation of the head, the electric wind and other factors may cause some movement. However, the coating zone is free of turbulent air blasts such as those created by conventional compressed air spray guns. Economies in installation may often be effected if parallel or U-shaped conveyor systems can without major modifications be adapted for electrostatic coating with a rotating atomizing device, particularly a substantially flat rotating disc for use in a quiescent atmosphere as described in the prior mentioned application of C. C. Simmons. However, the use of such an atomizing device with the existing parallel or U-shaped conveyor may without further modification result in an undesirable loss of the coating material projected into the area or areas not presenting a closely adjacent article in relation to the edge portion of the atomizer. Such coating material particles may be projected out of the effective electrostatic depositing field of the coating zone and hence reduce the overall efficiency of the system.

A feature of the present invention permits the use of a rotating annular-edged atomizing device in conjunction with a conveyor which moves articles past only a portion of the edge of the atomizing device and, therefore, the invention may be used to obtain the desirable objects expressed in the preceding paragraphs. It has been found that one or more properly designed deflecting electrodes spaced from the rotating atomizing device and maintained at an electrical potential of the same sign or polarity as that of the atomizing device itself will cause the deflection of particles atomized and projected generally toward said deflecting electrode so as to redirect such spray particles in a predetermined desired manner and especially to direct the particles toward articles to be coated. Such a deflecting electrode is particularly useful to prevent the escape of particles of coating material not initially projected toward articles which move through a coating zone along a conveyor path past only a portion of the edge of an annular atomizing device.

The particular design, spacing and electrical potential of the deflecting electrode or electrodes in relation to the annular edge of the atomizing device will in each instance depend upon the coating requirements of the system. In some cases it has been found convenient to connect one or more deflecting electrodes to the housing supporting the rotating atomizing device and thereby to maintain it at the electrical potential of the device. Where a particularly wide band of coating material is to be applied to an article the atomizing device and deflecting electrode or electrodes may be reciprocated together as an integral unit in relation to the conveyor-borne articles. In any event, the electrodes should be shaped and located with respect to the atomizing edge of the device so as not to unduly deteriorate the quality of atomization of the liquid coating material issuing from the atomizing edge, and so as to avoid the coating of the electrodes themselves.

Other features and objects of this invention will now be described in detail in connection with the accompanying drawings, in which:

Fig. 1 is a top plan view, somewhat diagrammatic, showing two atomizing devices utilizing the invention in an electrostatic coating system designed for coating large rectangular articles;

Fig. 2 is an isometric view of one embodiment of a disc-type atomizer and associated deflecting electrodes;

Fig. 3 is a top plan view, somewhat diagrammatic, showing the invention used in conjunction with two parallel rectilinear conveyor tracks; and

Fig. 4 is a view like Fig. 3 showing a modified form of the invention used in conjunction with a U-shaped conveyor system.

The invention may assume many different forms. There

have been shown in the drawings and will now be fully described several specific embodiments which it is understood are illustrative of the principles of the invention without limiting the invention to the embodiments as shown and described. The full scope of the invention is set forth in the appended claims.

Referring first to Figs. 1 and 2, a conventional overhead conveyor system (not shown) is employed to move a plurality of regularly spaced articles, shown as rectangular automatic washing machine cabinets **10**, in seriatim along a predetermined path whose center line is designated by broken line **11**. Article path **11** is shown as having a number of rectilinear path portions arranged to move articles **10** successively through several coating zones lying on opposite sides of two atomizing devices shown generally as **12** and **13**.

A given article first enters a coating zone as it moves adjacent to atomizing device **12** into the position shown by article **10***a* so that side *w* of the article is presented in coating relation to atomizer **12**. The article then moves along path **11** out of the first coating zone and into the position shown by article **10***b* where the article is indexed or rotated 90° about its central axis in a clockwise direction by suitable indexing means (not shown). Thereafter the article moves along the conveyor path through the second coating zone where opposite sides *x* and *y* of article **10***c* are in coating relation to atomizers **12** and **13** respectively. The article next moves along the article path into the position shown by article **10***d* where, in a non-coating zone, the article is indexed 90° this time in a counterclockwise direction so that side *z* is presented in coating relation to atomizer **13** as the article reaches the third coating zone in the position shown by article **10***e*. Thereafter the article, returned to its original orientation as before entering the coating area, moves along path **11** out of the coating area for drying, baking or other subsequent processing.

Atomizing devices or heads **12** and **13** are shown as having substantially identical rotating annular-edged flat horizontal disc atomizing members. Head **12** only is shown in detail in Fig. 2 although head **13** is generally of similar construction. A head housing **15** is supported on a hollow column **16** of insulating material such as polyethylene or polyester bonded Fiberglas. Housing **15** supports motor assembly **17**. The upper end of the shaft of the motor assembly is connected to a substantially flat rotatable disc **18** approximately 15 inches in diameter. Liquid coating material is fed through a conduit (not shown) running interiorly of column **16**, housing **15**, and the motor shaft through a hole in the center of disc **18** to the upper surface of the disc. Two substantially identical deflecting electrodes **20** and **21**, which may be constructed of ⅜″ x ⅛″ metal bar stock with slightly radiused edges, are mounted on opposite sides of housing **15** and extend outwardly somewhat beyond edge **19** of disc **18**. The terminal portions **20***a* and **21***a* of electrodes **20** and **21**, which are preferably smoothly rounded, lie diametrically across disc **18** somewhat above the plane of the disc itself and are approximately midway between the parallel article paths on either side of atomizer **12**.

In order that the atomization of the liquid coating material, hereinafter to be described, will not be unduly deteriorated by the electrostatic field established about electrodes **20** and **21**, terminal portions **20***a* and **21***a* should be spaced a sufficient distance away from disc edge **19**. In the embodiment shown it was found desirable to position terminals **20***a* and **21***a* from the disc edge a distance in the order of one half the diameter of disc **18** and in such position commercially satisfactory atomization of the coating material from the disc edge was obtained without appreciable coating of the deflectors.

Power supplied to motor **17** causes the rotation of disc **18** while liquid coating material is fed at a controlled rate by conventional means as previously described to the

upper surface of rotating disc **18**. Disc **18** and electrodes **20** and **21** are maintained at substantially the same high electrical potential by electrical connection to a high voltage terminal of a voltage source **22**. An electrostatic field of high potential gradient is thereby established between disc edge **19** and deflecting electrodes **20** and **21** which are of one polarity and adjacent articles **10** which are grounded through their supporting conveyor system. It is not, of course, essential that the disc and electrodes be at a high potential and the articles grounded although such arrangement is commercially the most desirable. An alternative would be to have the disc and electrodes grounded and the articles at high voltage and the invention encompasses such arrangement. In the system described liquid coating material fed to the surface of the rotating disc will flow as a thin film over the surface to the disc edge. Material projected from disc edge **19** will be atomized into the quiescent atmosphere of the electrostatic field existing about disc edge **19** as a spray of finely divided particles in an annular pattern generally in the plane of disc **18**.

The particles of coating material projected from those portions of disc edge **19** which lie most closely adjacent sides *w* and *x* of articles **10***a* and **10***c* respectively will be attracted to, moved toward and become deposited on the surfaces of articles in the first and second coating zones. However, some of the particles of coating material from disc **18** will not initially move toward an adjacent article surface as, for example, particles projected generally toward deflector **20**. These particles, projected at least initially outwardly from the edge of disc **18**, except for the presence of deflector **20**, would tend to move out of the effective electrostatic depositing field and become subject to gravity and vagrant air currents. These particles, therefore, might never be deposited on the surface of an article as desired. Such a loss of coating material is substantially entirely prevented by the use of deflectors such as **20** and **21**. Connection of the deflectors to a source of high potential of the same polarity as that of the atomized spray particles will create regions about the deflectors which serve to repel spray particles projected theretoward and to redirect said particles toward adjacent article surfaces for deposition thereon, thereby to increase overall coating efficiency.

Other types of deflectors or deflecting electrodes may be used with annular-edged atomizing devices which will serve to electrostatically repel spray particles. Fine metal wires independently supported without reference to the atomizer, but in spaced relation thereto, may be strung vertically midway between the conveyor paths so as to extend well above and below the atomizing edge. A wire of small diameter, as in the order of 0.010″ diameter, connected to a voltage source of substantially the same potential as that of the discharge edge will create a cylindrical zone about the wire of ionizing intensity which will electrostatically repel spray particles moving away from the coaoting zones and redirect these particles into one of the coating zones. The exact position of the deflectors will depend on such factors as their diameter, electrical potential, and the distance between the adjacent conveyor tracks, and the diameter of the atomizing edge.

Where the width of the article surfaces to be coated is greater than the normal spray band width of a substantially horizontal atomizing edge, the edge may be tilted in relation to the article path in order to present a greater band width or the atomizing device may be reciprocated along its axis in order to effectively increase the band width. In either case the deflecting electrodes should be maintained in substantially the same relative position in relation to the atomizing device as previously described. For reciprocating a disc as shown in Fig. 2 there may be employed a pneumatic reciprocator **23** which moves the entire atomizing device **12** and attached electrodes as an integral unit vertically on shaft **16**.

Fig. 3 illustrates an embodiment of the invention par-

ticularly useful and economical where the coating process requires the application of two coats of the same paint or lacquer on the surface of an article but with an intermediate period for drying or setting of the primary coat. Articles **30** to be coated are passed first along a rectilinear path portion **31***a* by an overhead conveyor system (not shown). Articles **30** moving along path portion **31***a* are successively presented in coating relation to a portion of the edge of a disc-type electrostatic atomizing device **32** which may be substantially of the same construction as the device previously described and shown in Fig. 2. The desired coating liquid is projected from the edge of atomizer **32** and with the assistance of high potential deflectors **33** and **34** approximately half of the atomized coating material projected from said edge is ultimately directed toward and deposited as a primary coating on the articles moving along path portion **31***a*.

On the opposite side of atomizer **32** from path portion **31***a* lies conveyor path portion **31***b* which serves to move articles **30** which have previously received their primary coating. As articles **30** move along path portion **31***b* they will move into a second coating zone adjacent atomizer **32** to receive a finish coating of spray particles projected generally from the most adjacent edge portion of the atomizer. Intermediate between the primary and finish coating operations articles **30** move into and through a drying area **35** which may include an oven in order to permit the desired setting of the primary coat. Thus a single atomizer **32** in cooperation with the deflectors **33** and **34** is used to apply both the primary and finish coating to articles **30**.

The spray of coating material from an annular-edged atomizing device is diverging, that is, the mutual repulsion exhibited by the spray particles as they leave the edge f the atomizer and perhaps other forces acting on the particles serves to disperse them into a generally continuously widening band during movement of the spray toward articles to be coated. The greater the distance of travel, therefore, between the edge of the atomizer and the articles, the wider the band of coating material which is deposited on articles. Where the article path through the coating zone does not remain at a constant distance from the atomizer, as rectilinear path portions **31***a* and **31***b*, it will be apparent that the band width of the coating material being deposited on articles will vary as the articles move through the coating zone.

Thus in the system shown in Fig. 3 articles as they approach and leave the portion of the coating zone immediately adjacent the edge of disc **32** will be coated with a wider band of coating material than will the articles when they are immediately adjacent the edge of disc **32**. The closer deflectors **33** and **34** are to disc **32** the less tendency there is for spray particles to deposit on articles located relatively remotely from the disc edge, since the deflectors tend to move such particles toward more closely adjacent articles. The positioning of deflectors **33** and **34**, insofar as their distance from disc **32** is concerned, will in considerable measure control the width of the band of coating material deposited on articles **30**. Thus, the width of the spray pattern can be somewhat reduced by positioning deflectors **33** and **34** closely adjacent disc **32** or, conversely, the band width increased by moving the deflectors further away from the disc.

Fig. 4 shows an annular-edged atomizer in conjunction with a conventional U-shaped conveyor system. Articles **40**, which may be cans or other similar round or cylindrical articles, are moved by a spindle conveyor along U-shaped article path **41**. In order to achieve uniform coating on all sides articles **40** may be rotated about their axes during the coating operation. Lying substantially concentric with the circular portion of article path **41** is an annular edged atomizer **42** which may take the form of any of the atomizers shown in the prior mentioned patent application of C. C. Simmons. A deflecting electrode **43** maintained at an electrical potential of the same polarity as that of atomizer **42** is positioned adjacent that

portion of the atomizer edge which is not closely adjacent one or more articles to be coated. Where a single deflecting electrode is used as shown in Fig. 4 the electrode may lie substantially midway between the parallel rectilinear portions of article path **41**. However, in certain instances especially where the distance between the parallel path portions is relatively large, two or more deflecting electrodes may be employed, in order that a more extensive electrical spray repelling zone adjacent the atomizer edge might be established.

In operation the articles **40** are moved along path **41** and are simultaneously rotated about their axes. The spray of atomized liquid coating material from the annular edge of atomizer **42** will be projected in a substantially annular pattern toward adjacent articles principally on the curved portion of conveyor path **41** and also toward deflecting electrode **43**. That portion of the spray projected generally toward electrode **43** will tend to be repelled therefrom and will be redirected substantially parallel to the plane of the edge of atomizer **42** toward one or the other of the side portions of the U-shaped article path for deposition on articles **40** moving on said portions of the article path.

I claim:

1. Apparatus for electrostatically coating articles comprising a conveyor for moving articles to be coated in a U-shaped path, a rotating disc lying within and substantially in the plane of said U-shaped path, means for supplying liquid coating material to the surface of said disc for flow to and atomization from the edge of said disc as a spray of liquid coating material particles expanding outwardly generally in the plane of said disc, a deflecting electrode spaced from said disc edge in the direction away from the base of the U, said deflecting electrode being positioned at least in part in the path of a portion of said spray, and means including a high voltage source for establishing between said deflecting electrode and disc edge on the one hand and the conveyed articles on the other a difference of electrical potential to move said atomized liquid coating material from said disc edge toward and to become deposited on the articles, that portion of the spray projected toward the deflecting electrode being split into two segments each deflected toward an adjacent leg of said U-shaped path to be deposited on articles moving therealong.

2. A method of electrostatically coating articles which comprises forming an expanding annular spray of coating material particles, moving articles along predetermined path portions on opposite sides of the center of said spray, creating an electrical potential difference between the coating material particles and the articles electrostatically to attract some of the spray particles toward said articles passing along said path portions for deposition on the articles, and providing between said article path portions and on opposite sides of the center of said spray two zones of particle-repelling potential electrostatically to split the annular expanding spray into two segments each being electrostatically directed toward one of the article path portions.

3. A method of electrostatically coating articles comprising flowing liquid coating material at a controlled rate to an annular atomizing zone for atomization and projection therefrom as an expanding annular spray of coating material particles, moving a plurality of articles to be coated along two opposite path portions each in coating relation with an oppositely directed portion of the spray projected from said atomizing zone, establishing a difference of electrical potential between said atomizing zone and the moving articles to charge the spray particles and cause them to move toward and be deposited on the articles, and establishing adjacent to diametrically opposite portions of the atomizing zone spaced from said article path portions two zones of substantially the same electrical potential as that of the atomizing zone to repel spray particles of coating material projected theretoward

and thereby to divide said spray into two substantially separate distinct portions, one spray portion being directed toward one of said article path portions for deposition on articles moving therealong and the other spray portion being directed toward the other of said article path portions for deposition on articles moving therealong.

4. An electrostatic spray coating apparatus comprising a rotatable disc, means for rotating said disc about its axis, means for flowing liquid coating material onto the surface of said disc for atomization therefrom as an annular spray of liquid coating material particles expanding outwardly generally in the plane of said disc, a conveyor for moving articles in coating relationship with said disc along two substantially rectilinear path portions located on opposite sides of said disc, a pair of spray-splitting electrodes spaced on opposite sides of said disc intersecting said plane and lying at least in part in the normal path of travel of portions of the atomized spray particles and substantially halfway between the article path portions, means including a high voltage source for establishing between said disc and the conveyed articles an electrostatic field of sufficient force to cause atomized spray particles to move toward and be deposited on the articles, and means for connecting the spray-splitting electrodes to said high voltage source to maintain said electrodes at substantially the same potential as said disc electrostatically to split those portions of the spray projected toward said electrodes into two segments each directed toward one of the article path portions.

5. Apparatus as set forth in claim 4 with the addition of means for reciprocating said disc and spray-splitting electrodes together along the axis of said disc.

6. An electrostatic spray coating apparatus comprising an atomizer, means for supplying liquid coating material to said atomizer for atomization therefrom as an expanding spray of liquid coating material particles generally surrounding said atomizer, a conveyor for moving a plurality of articles in coating relationship with said atomizer along a substantially U-shaped path passing through a major segment of the expanding spray, a spray-splitting electrode lying at least in part in the normal path of travel of that segment of the spray projected away from the base of the U-shaped path, means including a high voltage source for establishing a particle-depositing electrostatic field between the atomized spray particles and the articles, and means for connecting said spray-splitting electrode to said high voltage source to maintain said electrode at the same polarity as the spray particles electrostatically to split that segment of the spray projected toward said electrode and to direct spray particles of said segment toward articles moving along an adjacent leg of said U-shaped path for deposition on such articles.

7. An electrostatic spray coating apparatus comprising an annular-edged atomizer, means for supplying liquid coating material to the annular edge of said atomizer for atomization therefrom as a radiating spray of liquid coating material particles expanding outwardly from said edge, a conveyor for moving articles in coating relationship with said atomizer edge along two path portions located on opposite sides of said atomizer, a pair of spray-splitting electrodes spaced on opposite sides of said atomizer edge and lying at least in part in the plane thereof and in the normal path of travel of a portion of the atomized spray particles, means including a high voltage source for establishing between said atomizer edge and the conveyed articles an electrostatic field of sufficient force to cause atomized liquid coating material particles to move toward and be deposited on the articles, and means for connecting the spray-splitting electrodes to said high voltage source to maintain said electrodes at substantially the same potential as said atomizer edge to split those portions of the spray projected toward said electrodes into two segments each directed toward one of the article path portions.

8. A method of electrostatically coating articles which comprises supplying liquid coating material at a controlled rate to a central atomizing zone for atomizing and projecting into a quiescent atmosphere a spray of liquid coating material particles radiating from the atomizing zone outwardly across substantially the entire circumference of an annular region surrounding said atomizing zone, moving articles to be coated along a predetermined path having a portion lying in coating relation with only a portion of said spray, creating an electrical potential difference between the coating material particles and the articles electrostatically to attract some of the spray particles toward said articles passing along said article path portion for deposition on the articles, and providing on opposite sides of the central atomizing zone and in the paths of portions of the spray two electrically charged zones of particle-repelling potential, each repelling zone electrostatically directing toward the articles moving along said article path a substantial portion of the spray projected toward said repelling zone to deposit said substantial spray portion on the articles.

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