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METHOD AND APPARATUS FOR SPRAY COATING OF ARTICLES

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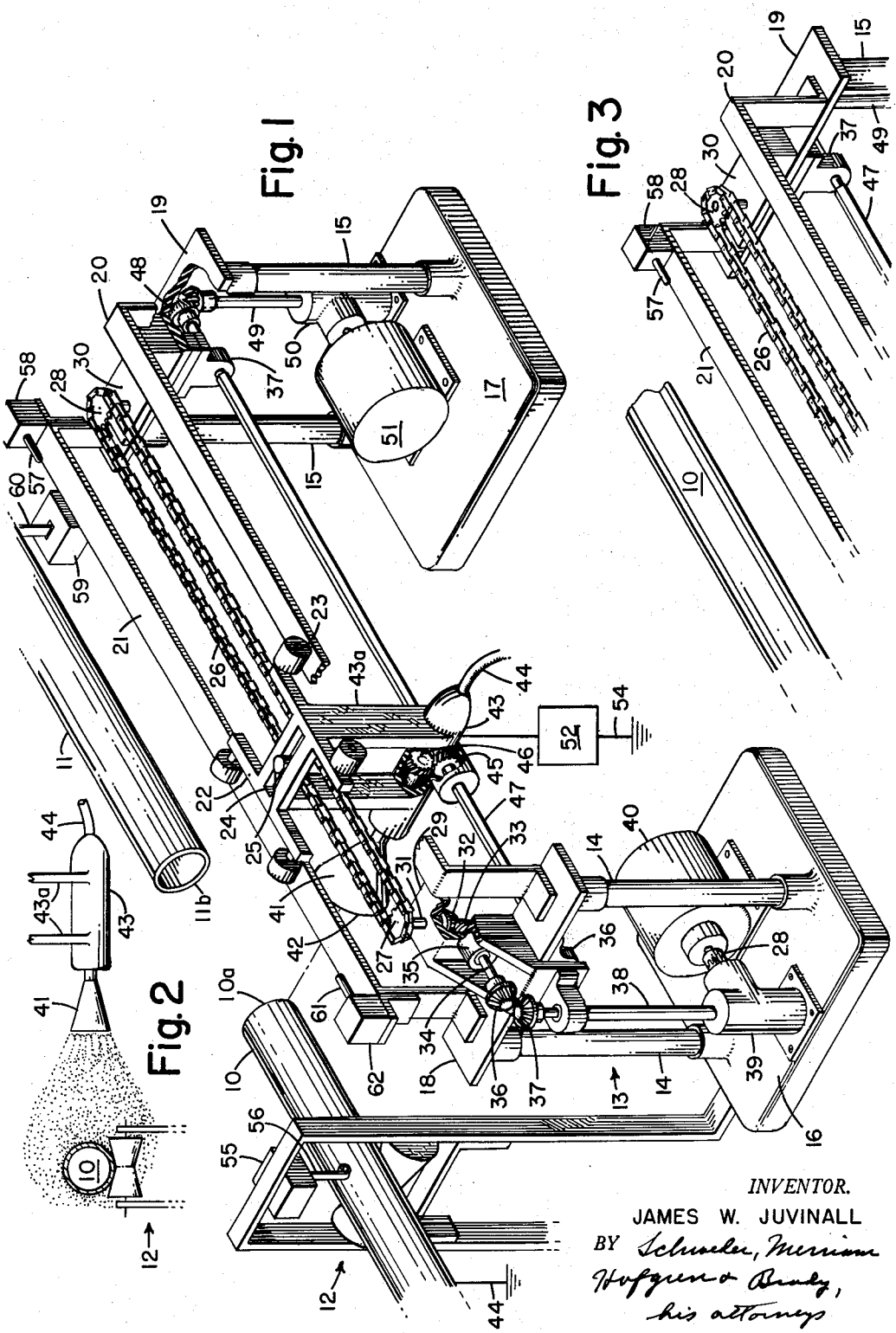


Fig. 1

Fig. 3

Fig. 2

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METHOD AND APPARATUS FOR SPRAY COATING OF ARTICLES

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This application relates to the spray coating of articles and more particularly to the electrostatic deposition of liquid coating material on articles.

When spaced articles are successively exposed to the spray issuing from a spraying device in an electrostatic coating system where deposition of the coating material particles is primarily the result of electrostatic forces and where the particles are given an electric charge at the time they leave the spraying device or shortly thereafter, the commercial practicability of handling the articles on a rapidly moving conveyor has heretofore sometimes resulted in the deposition of coating on the articles in an uneven manner resulting in undersprayed or oversprayed areas.

In a majority of electrostatic coating systems a field of electrostatic force is set up which includes the article being coated and the atomized coating material particles in movement toward such article. In normal commercial practice it is desirable to mount the article on a grounded conveyor and thus to make the articles themselves (if they are of conducting material) or electrodes within or immediately behind the articles, at ground potential; and to provide another electrode at a high electrical potential with respect to ground, this electrode sometimes being the spraying device and sometimes being a separate electrode near or past which the spray passes in its movement toward the article.

Various means may be used for producing the atomized particles, such as pneumatic spray guns and the like, or the atomizing means may take the form of the extremely efficient spraying device including an electrostatic atomizing head with a circular atomizing edge of the rotary conical type such as disclosed and claimed in the copending application of E. M. Ransburg filed in the United States Patent Office on February 13, 1950, as Serial No. 143,994.

Where the articles are closely spaced on the conveyor, the coating zone, which is the zone defined by the electrostatic field created between the electrode carrying the high potential and the article, follows the nearest article and as such article is moved away from the atomizing means the field, and hence the coating zone, quite suddenly transfers to the next succeeding article, resulting in a relatively small change in direction of movement of the particles moving through the electrostatic field and hence without substantial interruption of the coating operation. Where the articles are widely spaced on the conveyor, however, the next following article may be too far removed to act as an electrode to draw the field to it, and thus there is created a period during which the particles are not following a well-defined field and the coating zone is substantially nonexistent. When such a situation is coupled with rapid movement of the articles along the conveyor, the next succeeding article will, upon its approach, draw the electrostatic field instantaneously to itself. However, a finite time elapses before the particles may accommodate themselves to the new field and be moved therethrough to the article, and such finite time

may under certain circumstances be sufficient to permit the leading edge or front portion of the article to pass completely or almost completely out of the coating zone before the atomized particles can reach it. Under such conditions the leading portion of the article is either uncoated or is insufficiently coated.

A further difficulty has arisen in the coating of articles which are so shaped as to provide certain areas which are more difficult to coat than other areas. The difficulty may arise from the particular shape of the area, such as a flange or the like, or because one area presents more or less surface to be coated during its passage at a given linear speed through the coating zone than preceding or succeeding areas.

One example of an area which is difficult to coat, all such areas hereinafter being referred to as "critical areas," is the leading edge of a pipe section.

It has been found that when pipe sections are fed to a conveyor which is moving at a rapid speed of upwards of 200 feet per minute it is practically impossible consistently to space the sections along the conveyor sufficiently close to each other so that the electrostatic field transfers itself substantially immediately from the trailing edge of one pipe section to the leading edge of the following pipe section and thus the leading end of the pipe receives insufficient coating as it passes the atomizing means although the following noncritical areas of the pipe receive an adequate coating. It is believed that the failure of the critical area of the pipe to receive adequate coating is due to the fact that while the electrostatic field between the leading end of the pipe and the atomizing head is created substantially instantaneously as the pipe end nears the head, the inertia of the atomized particles is such as to require a certain amount of time before they can reach the pipe end, during which time such pipe end moves beyond coating range so that the particles coat other areas of the pipe. The extent of the critical area is thus further dependent, at least partially, upon the speed of movement of the article to be coated and it has been found that when coating pipe section, the area at the leading end of the pipe which is undersprayed may extend backwards therefrom a considerable distance, which distance is increased as the speed of movement of the pipe is increased.

The particular problem just discussed is often encountered in electrostatic coating systems in which the particles are atomized at least in part by electrostatic forces and is not normally found in systems using more conventional atomizing means. Thus, for example, where compressed air is employed to atomize the coating material, the atomized particles are carried by a current of air into the electrostatic field and toward an article to be coated and the inertia of the air stream is sufficient to carry atomized particles into the path along which the article to be coated will be moved. This is true even though at a particular instant an article is not present in the path. Thus in a system where the atomized particles are carried in a current or stream of air, the air may be turned on long prior to the arrival of the leading edge of the article at the coating zone and thus, in effect, a stream of atomized particles may be directed at and through the path of movement of the article to await the arrival of the leading edge, and there is no time loss in the movement of particles toward and onto the leading edge. In electrostatic coating systems employing electrostatic atomization, reliance is had upon the electrostatic field existing between the atomizing means and the article to direct the particles toward the article. For this reason unless an article is present and in field creating relationship with the atomizing means the particles atomized are not directed toward the path of movement of the article, but on the contrary are emitted from

the atomizing means in a rather aimless pattern. Thus the use of electrostatic atomization may result in difficulty in producing coating of proper thickness on the leading edge of an article moved relatively rapidly along a path adjacent the atomizing means.

The above problems and difficulties can be overcome by the use of the methods and apparatus comprising the present invention and articles possessing both critical and noncritical areas can be given coatings of the desired thickness throughout. The present invention contemplates varying the rate of relative movement between the atomizing means and the article to be coated as the critical area is near the atomizing means. The relative speed of movement obviously can either be increased or decreased depending upon the nature of the critical area as to whether it would otherwise receive an overspray or an underspray. Thus the relative speed between the article and the atomizing means may be increased or decreased at the location of the critical area or, as exemplified in the specific embodiment chosen for illustration, the atomizing means itself may be moved, which movement coupled with the movement of the article along the conveyor may be in a direction either to increase or to decrease the relative movement therebetween.

Thus the general object of this invention is to provide a method and apparatus for producing a spray coating of predetermined thickness by electrostatic means upon an article having critical and noncritical areas. This and other features and objects of the invention will be readily apparent from the following description and drawings, in which:

Fig. 1 is a perspective view of one form of coating apparatus embodying the invention;

Fig. 2 is a side elevation, somewhat schematic in form, showing a portion of the apparatus; and

Fig. 3 is a view of the upper right-hand portion of Fig. 1 showing a modified form of the invention.

While two different forms of apparatus are illustrated in the accompanying drawings, and will be described hereafter as providing means for practising the present invention, it will be understood that these are representative embodiments only. It will also be understood that forms of spraying devices other than the particular electrostatic atomizing devices shown may be utilized, and that other forms of apparatus may be employed; and it is to be understood that other embodiments may be utilized without departing from the contemplated scope of the present invention, and that no limitations are to be implied from such specific description as shall now be provided.

Referring now to Fig. 1, there is shown one form of apparatus embodying the inventions hereof which is illustrated as being employed in the coating of a plurality of pipe sections **10** and **11** moving along a conveyor **12**, which carries the pipe sections in a substantially linear path past a frame **13** which carries the coating apparatus.

The frame includes two pairs of insulated support columns **14** and **15** mounted upon suitable bases **16** and **17** with the supports **14** and **15** carrying at their upper ends plates **18** and **19** respectively. Secured to the upper surface of the plates **18** and **19** is a pair of tracks **20** and **21** which are parallel to each other and to the direction of movement of the pipe sections along the conveyor. The tracks provide a support for a carriage **22** movable along the tracks on wheels **23** provided thereon. Movement of the carriage along the track is accomplished through the medium of a slot **24** provided in the carriage which is engaged by a pin **25** carried by an endless chain **26** which passes around a pair of sprockets **27** and **28** rotatably mounted on angular members **29** and **30** mounted respectively on plates **18** and **19**. Rotation of the sprocket **27** to drive the chain is achieved through a drive shaft **31** which carries at its lower end a bevel gear **32** meshing with a second bevel gear **33** fixed to a shaft **34** and rotatably carried by pillow blocks **35** mounted

on the plate member **18**. The opposite end of the shaft **34** carries a bevel gear **36** meshing with a bevel gear **37** carried at the upper end of an insulated drive shaft **38** connected at its lower end by means of a right angle drive **39** to an electric motor **40**.

It can be seen from the foregoing that operation of the motor **40** through the shafts and gear means just described drives the chain about the sprockets **27** and **28**. Such movement of the chain causes the carriage **22** to move back and forth along the tracks **20** and **21** from one end to the other of the frame **13**.

The atomizing means herein may, as previously noted, be of the type shown in the said copending Ransburg application and includes an electrostatic atomizing head **41** having an atomizing edge **42** and rotatably mounted in a body portion **43**. The atomizing head is suspended from the carriage by a plurality of support members **43***a*. Means in the form of a flexible supply line **44** is provided for supplying liquid coating material to a hollow shaft extending through the body portion and opening at its inner end to an orifice located substantially at the center of the atomizing head. Rotation of the head **41** to flow the coating material outwardly to the atomizing edge is achieved through gear means which includes a pair of right angle spiral gears **45** and **46**. The gear **45** is splined to a shaft **47** rotatably mounted in the frame and driven, through the gear means **48**, insulated drive shaft **49** and right angle drive **50**, by a second electric motor **51**.

A high voltage source **52** is connected by the means **53** to the atomizing head and by means of connection **54** to a suitable ground. Since the supports **14** and **15** and the shafts **38** and **49** are of electrically insulating materials, the entire assembly supported on the plates **18** and **19** can be maintained at a high potential with respect to ground.

In the embodiment illustrated in Fig. 1, let it be assumed that the pipe sections are carried by the conveyor from left to right past the frame **13**. As previously pointed out, the critical areas on such pipe sections are the leading marginal edge, for example the edge **10***a*. As the space between the edge **10***a* and the trailing edge **11***b* of the preceding pipe is normally of such an extent as to prevent the electrostatic field from the edge **42** from "snapping" from the edge **11***b* to the edge **10***a*, movement of the pipe section **10** rapidly past the head **41** causes underspraying of the edge which in some cases may be accompanied by underspraying of the area immediately adjacent the leading edge. To prevent such underspraying, the atomizing head is mounted in the manner just described for movement in a path substantially parallel to the path of movement of the pipe sections and means are provided for initiating movement of the atomizing head as the critical area, in this case the leading edge **10***a*, is near the head.

For this purpose there is provided a microswitch **55** adapted to be operated by a lever arm **56** which is spring urged into the path of movement of the pipe section to be contacted by the leading edge **10***a*. Operation of the switch **55** through suitable wiring connection operates the motor **40** to move the carriage along the track and hence to move the atomizing head from a first position at the left-hand end of the frame to a second position at the right-hand end. The motor **40** is designed to move the atomizing head at approximately the speed of movement of the pipe section so as to maintain the head and the leading edge of the pipe at approximately their position of closest approach during the period required to move the head from its first to its second position. When the head reaches the second position, the carriage contacts the plunger **57** of a switch **58** wired to stop the motor upon such contact. As the remaining noncritical areas of the pipe pass the atomizing head it remains in its second position to coat such areas. To restart the motor **40** to return the head to its first posi-

tion there is provided a microswitch **59** having an actuating arm **60** also positioned in the path of movement of the pipe sections along the conveyor and adapted to be depressed by the leading edge of a pipe section. The switch **59** is so constructed that release of the arm **60** as the trailing edge of the pipe passes the switch actuates the motor **40** to move the carriage toward the opposite end of the track. As the carriage reaches its initial starting position it contacts a plunger **61** to operate a switch **62** again to stop the motor. The following pipe section initiates a similar cycle of operations.

It is clear that as the leading edge, such as the edge **10***a*, of a pipe section enters the coating zone at a high speed of movement relative to the atomizing head, the atomizing head is moved parallel to and in the same direction as movement of the edge **10***a* to permit the atomized particles to travel through the electrostatic field to be deposited on the leading edge. In the particular embodiment of the invention just described, the head moves at substantially the same speed as the leading edge so that the relative movement is approximately zero. When the carriage strikes the plunger **57**, further motion of the carriage along the track is discontinued although the spraying continues along the entire length of the pipe until the trailing edge operates the switch **59** to return the head to its first position.

In the modified form of the invention shown in Fig. 3, the switch **59** and its attendant lever arm **60** are omitted and the switch **58** is designed to reduce the speed of the motor **40**, for example to one-fourth speed (or some other fraction or multiple of the speed on its initial movement) so that the head is returned toward its first position while spraying the noncritical area of the article. The speed of the motor upon the return of the head is so chosen that the remaining areas of the article are substantially completely coated before the carriage strikes the plunger **61** to halt its motion.

In dealing with articles other than pipe sections which are provided with critical areas either at their leading edge or in other portions of the article, the carriage may be moved at a speed equal to or at speeds other than a speed equal to the speed of movement of the article along the conveyor. Thus the atomizing head may be moved, for example at one-half speed, if the critical area is extended in length. Such movement of the carriage, and hence of the head, is initiated as the critical area, wherever it may be located on the article, nears the atomizing head.

While I have shown and described certain embodiments of my invention, it is to be understood that it is capable of many modifications. Changes, therefore, in the construction and arrangement may be made without departing from the spirit and scope of the invention as disclosed in the appended claims.

I claim:

1. The method of coating an elongated article having a critical area along a marginal edge by means of electrostatic deposition of atomized coating material particles by an electrostatic field existing between the article and an electrode spaced from the article which comprises moving the article, with the marginal edge leading, in a path passing adjacent the electrode, moving the electrode generally parallel to said path and in the direction of movement of the article as the critical area becomes the terminus of said field to coat said area and then continuing the movement of the article without so moving the electrode to coat immediately following areas of the article.

2. The method of coating an article having a length many times its width by means of deposition of atomized coating material particles by an electrostatic field existing between the article and an electrode spaced from the article which comprises moving the article longitudinally of its major axis in a path passing adjacent the electrode, moving the electrode generally parallel to said path in the direction of movement of the article and at approximately the speed thereof as the leading end of the article becomes the terminus of said field to coat said end, and then continuing the movement of the article without so moving the electrode to coat the remainder of the article.

3. The method of coating a pipe section by means of electrostatic deposition of electrostatically charged atomizing coating material particles issued from an atomizing means which comprises moving the pipe longitudinally of its axis in a path passing adjacent the atomizing means, moving the atomizing means generally parallel to said path as the leading end of the pipe nears the atomizing means to maintain the atomizing means at a substantially constant predetermined distance from said end during a portion of the movement of the pipe, and then discontinuing such movement of the atomizing means while continuing the movement of the pipe to coat the remainder of the pipe.

4. The method of coating a pipe section by means of electrostatic deposition of electrostatically charged atomizing coating material particles issued from an atomizing means which comprises moving the pipe longitudinally of its axis in a path passing adjacent the atomizing means, moving the atomizing means generally parallel to said path from a first position at approximately the closest approach of the leading end of the pipe to maintain the atomizing means at a substantially constant predetermined distance from said end during a portion of the movement of the pipe, halting the movement of the atomizing means at a second position while continuing the movement of the pipe to coat the remainder of the pipe, and then returning the atomizing means to said first position.

5. The method of coating a pipe section by means of electrostatic deposition of electrostatically charged atomizing coating material particles issued from an atomizing means which comprises moving the pipe longitudinally of its axis in a path passing adjacent the atomizing means, moving the atomizing means generally parallel to said path from a first position at approximately the closest approach of the leading end of the pipe to maintain the atomizing means at a substantially constant predetermined distance from said end during a portion of the movement of the pipe, halting the movement of the atomizing means at a second position, and then returning the atomizing means to said first position while continuing the movement of the pipe to coat the remainder of the pipe.

6. Apparatus for electrostatically coating an article having a length many times its width comprising a conveyor for moving the article generally longitudinally of its major axis in a linear path, atomizing means positioned adjacent said path, means for creating an electrostatic charge differential between the atomized coating material particles and the article, a carriage for carrying the atomizing means along a second path spaced from and parallel to said linear path, means for moving the carriage a predetermined distance along said second path, and means actuated upon the close approach of the leading end of the article to the atomizing means for operating the carriage moving means to move the carriage with said end along said second path.

7. Apparatus for electrostatically coating an article having a length many times its width comprising a conveyor for moving the article generally longitudinally of its major axis in a linear path, atomizing means positioned adjacent said path, a carriage for carrying the atomizing means along a second path spaced from and parallel to said linear path, a motor for moving the carriage a predetermined distance along said second path, control means positioned along said linear path opposite one end of the second path and adapted to be operated by the leading end of the article to actuate the motor to move the carriage parallel to said end along said second path, and a second control means for reversing the motor to re-

turn the carriage to the first mentioned end of the second path.

8. Apparatus for electrostatically coating a pipe section comprising a conveyor for moving the pipe generally longitudinally of its axis in a linear path, electrostatic atomizing means positioned adjacent said path, a carriage for carrying the atomizing means along a second path spaced from and parallel to said linear path, an electric motor for moving the carriage a predetermined distance along said second path, a switch positioned along said linear path opposite one end of the second path and adapted to be operated by the leading end of a pipe to energize the motor to move the carriage parallel to said end along said second path, a second switch positioned at the other end of the second path and adapted to be operated by the carriage as it is moved to said other end to stop the motor, and a third switch positioned along said linear path opposite said other end of the second path and adapted to be operated by the trailing end of the pipe to reverse the motor to return the carriage to the first mentioned end of the second path.

9. Apparatus for electrostatically coating an article comprising a conveyor for moving the article in a linear path, a frame adjacent the path, a track on the frame generally paralleling the path, a carriage movible along the track, atomizing means including a body portion and a rotatable atomizing head mounted on the carriage, a spline shaft rotatably mounted in the frame and extending parallel to and in spaced relationship to the track, gear means in said body portion including a gear meshing with the spline shaft for rotating the head with rotation of the shaft, means for rotating the shaft, an electric motor for moving the carriage along said track, a switch positioned along said linear path opposite one end of the track and adapted to be operated by the leading end of an article to energize the motor to move the carriage parallel to said end along said track, and a second switch positioned at the other end of the track and adapted to be operated by the carriage as it is moved to said other end to reduce the speed of the motor to return the carriage at a reduced speed to the first mentioned end of the track.

10. Apparatus for electrostatically coating an article comprising a conveyor for moving the article in a linear path, a frame adjacent the path, a track on the frame generally paralleling the path, a carriage movable along the track, atomizing means including a body portion and a rotatable atomizing head mounted on the carriage, a spline shaft rotatably mounted in the frame and extending parallel to and in spaced relationship to the track, gear means in said body portion including a gear meshing with the spline shaft for rotating the head with rotation of the shaft, means for rotating the shaft, an electric motor for moving the carriage along said track, a switch positioned along said linear path opposite one end of the track and adapted to be operated by the leading end of an article to energize the motor to move the carriage parallel to said end along said track, a second switch positioned at the other end of the track and adapted to be operated by the carriage as it is moved to said other end to stop the motor, and a third switch positioned along said linear path opposite said other end of the track and adapted to be operated by the trailing end of the article to reverse the motor to return the carriage to the first mentioned end of the track.

11. In a method of electrostatically coating an article wherein atomized coating material is issued at a substantially constant rate from an atomizing means and the atomized particles are deposited by an electrostatic field maintained by a charging electrode having an electrical potential constantly applied thereto and wherein the article is moved along a predetermined path having a portion adjacent the atomizing means and the charging electrode, said article having a critical area causing a change in the field strength in the article path as said area becomes the terminus of said field and wherein such change in field strength causes a change in the concentration of atomized particles deposited on such area, the step which comprises automatically varying the rate of relative movement between the article and said atomizing means directly with said changes in concentration of coating material particles.

12. The method of claim 11 in which said relative movement is generally parallel to said path and along with an article moving therealong.

13. The method of claim 11 in which said critical area is the leading edge of an article and in which said relative movement is generally parallel to said path as the leading edge of an article moving along the path approaches the atomizing means to maintain the atomizing means at a substantially constant predetermined distance from said edge during a portion of the movement of the article.

14. In a method of electrostatically coating an article wherein atomized coating material is issued at a substantially constant rate from an atomizing means and the atomized particles are deposited by an electrostatic field maintained between an article and the atomizing means by constantly applying an electrical potential to said atomizing means, and wherein the article is moved along a predetermined path having a portion adjacent the atomizing means, said article having a critical area causing a change in the field strength of said field, and wherein such change in field strength causes a change in the concentration of atomized particles deposited on such area, the step which comprises automatically varying the rate of relative movement between the article and said atomizing means directly with said changes in concentration of coating material particles.

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