

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 coating material in atomized form on articles.

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 make the article itself (if it is of conducting material) or an electrode within or immediately behind the article, at ground potential; and to provide another electrode at high electrical potential with respect to ground, this latter 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.

When an article, particularly an elongated or extended article, is exposed to the spray issuing from a spraying device in an electrostatic coating system where deposition of 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, difficulty has been experienced in applying a uniform coating around the entire exposed surface of the article. This difficulty is particularly marked when coating the external surfaces of such elongated or extended articles as pipe, chain and cable.

While the invention disclosed herein may be used with advantage for electrostatically coating articles of various shapes and types, it is particularly adaptable for coating pipe and for the purpose of exemplary disclosure will hereinafter be described as employed for such purpose.

In practically all pipe manufacturing operations a thin protective coating is applied to the external surface of the pipe after fabrication in order to protect the pipe from rust and corrosion during shipment and handling operations preceding the actual installation of the pipe. This operation has previously been accomplished in such ways as by passing the pipe through a suitable housing wherein it is sprayed with coating material by high pressure air or mechanical atomizers or where the coat is applied by slushing the material on the pipe from suitable slushing nozzles as it passes through the housing.

The present invention, as an example, contemplates the passage of pipe (or other extended article to be coated) on a suitably grounded conveyor, which may take the form of a series of supporting rolls, through a coating zone wherein it receives a uniform coating, or substantially so, about its entire exterior surface, atomized coating materials being deposited on the pipe by electrostatic forces. One of the principal advantages of the invention is that the waste and mess which necessarily accompanies the former system hereinabove described may be substantially completely eliminated while at the same time the employment of the methods and apparatus of this invention insures a uniform coating of desired thickness, or substantially so, over the entire exterior surface of the article.

The present invention contemplates passing the pipe or other article along a predetermined path which is surrounded a plurality of times by a multiplicity of atom-

izing sources so as to provide a zone in which the pipe receives coating which extends an appreciable distance along the path. Thus each portion of the exterior surface of the pipe as it passes through the coating zone is moved past each of a series of atomizing sources so that, in effect, successive layers of coating are applied until the desired thickness has been achieved.

It has heretofore been found that coating material may be atomized electrostatically from an edge and an atomizing head employing an annular atomizing edge is 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. Passing an article to be coated through the center of an annular spray, but provided by apparatus and methods different from that shown and claimed here, is disclosed and claimed in the copending application of Merton Miller, Serial No. 258,213, filed November 26, 1951.

The apparatus of this invention may include the use of an edge from which coating particles are atomized by electrostatic forces, and features of the invention are the employment of a novel method of feeding coating material to such an atomizing edge and the use of a plurality of atomizing sources surrounding the article and spaced along its path of travel.

In the form of the invention illustrated in the accompanying drawings and hereinafter described in detail, the path along which the article is passed is surrounded a plurality of times by an atomizing edge. For this purpose the edge may be in the form of a continuous helix which encircles the path a number of times or may be in the form of a plurality of annular edges which are parallel to each other and spaced along the path, again so as to encircle the path a plurality of times by a discharge edge. By maintaining such atomizing edge at high potential with respect to ground, coating material fed to the edge tends to form into a plurality of minute cusps and it is from these cusps, which may be considered atomizing sources, that the coating material in atomizing form is projected onto the article. By moving the article along a grounded conveyor and into field coating relationship with the edge coating material fed to the edge is atomized therefrom and thence deposited on the article.

The above and other features of the invention will be readily apparent from the following description and drawings, in which:

Fig. 1 is an isometric view (partially broken away for clarity of illustration) of an apparatus embodying the invention;

Fig. 2 is a sectional view of one of the annular atomizing edges shown in Fig. 1;

Fig. 3 is a view, somewhat schematic in character, of a modified form of the apparatus shown in Fig. 1; and

Fig. 4 is a view similar to Fig. 3 showing a third embodiment of the invention.

While three different forms of apparatus are illustrated in the accompanying drawings and will be described hereinafter as providing means for practicing 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 spraying device illustrated 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 a cylinder 10 rotatably mounted upon a base 11 which is supported above the floor by insulating supports 12. The cylinder 10 is provided with an opening, such as the opening 13, at each end thereof and is carried at one end by a plurality

3 of rollers 14, each journaled in a suitable pillow block 15. The rollers 14 are carried at one end of shafts 16, each of which carries a spur gear 17 at its opposite end. The gears 17 support the other end of the cylinder and mesh with an externally toothed ring gear 18 secured thereto. One of the gears 17, designated 17a, meshes with a drive spur gear 19 driven through suitable reduction gearing 20 and right-angle drive 21 by a drive shaft 22 of insulating material connected to a suitable driving motor (not shown). Secured along the interior surface of the cylinder 10 is a series of ring members 25, each of which carries at its inner extremity an atomizing edge 26. In the form shown in Figs. 1 and 2, the atomizing edges 26 are arranged in a plurality of annuli which are parallel to each other and normal to the path of movement of an article, which is illustrated as the pipe section 27, passing through the cylinder along a predetermined path which coincides with the axis of the cylinder.

Since the entire assembly is supported on the insulating supports 12 and since the power for rotating the cylinder is transmitted through the insulating shaft 22, the entire assembly can be maintained at high voltage with respect to ground, and for this purpose is connected to the output terminal of a high voltage supply 23 by way of a lead 29. The other terminal of the high voltage supply is connected to ground as indicated at 30.

With the entire assembly at high voltage with respect to ground, coating material fed to each of the atomizing edges 26 may be atomized therefrom for deposition by electrostatic forces upon the exterior surface of the pipe, it being understood that the pipe is grounded, as indicated at 37, preferably by being carried on a suitably grounded conveyor. Because the pipe is surrounded a plurality of times by an atomizing zone, that is a zone from which atomization takes place, it is possible to secure a very even and uniform distribution of coating material about the entire exterior surface of the pipe, and the actual coating zone in which coating takes place is substantially equal in length with the length of the cylinder so that coating is carried on during the passage of the pipe along an appreciable portion of its path of movement.

While other forms of feeding coating material to the atomizing edges 26 may be employed, there is shown a system which is particularly adaptable to the apparatus illustrated. Still referring to Figs. 1 and 2, there is provided a flexible feed tube 32 which is made of insulating material and connected at one end to a suitable source of coating material (not shown) such as a tank and the like. Coating material is flowed through the tube to the interior of the cylinder either by gravity or by force feed so as to form a pool 33 of coating material in the bottom of the cylinder. It will be noted that each of the ring members 25 is provided with a plurality of cutout portions or notches 34 so as to provide a flow path along the bottom of the cylinder for flow of coating material from end to end thereof and to provide for substantially equal distribution of liquid coating material along the bottom of the cylinder. The openings 13 at each end of the cylinder are formed in closure members 35 over which coating material is fed into the cylinder and which serves as dams to maintain the pool therein. As the pool will remain at the bottom of the cylinder, it is clear that rotation of the cylinder, and hence rotation of the ring members 25, causes a portion of such members continually to dip into the pool. As rotation of the cylinder is continued, coating material is picked up on the ring member for flow by gravity to the atomizing edges 26. Preferably the pool is maintained so that its top is substantially coincident with the inner extremity of the edge 26 when the edge is at its lowermost position and thus the height of the pool above the interior surface of the bottom of the cylinder is substantially equal to the distance from the edge 26 to such interior surface.

Preferably the speed reducing drive 20 is adjustable so that the speed of rotation of the cylinder may be adjusted

to suit coating materials of varying viscosity and, when properly adjusted, the flow of coating material from the ring member 25 to the atomizing edge will be of a quantity sufficient to produce the desired coating without causing drips or droplets to fall on the exterior surface of the pipe. The thickness of the coating is, of course, related to the speed of the pipe through the apparatus and to the overall length of the coating zone. The higher the speed the thinner will be the coating for a fixed length of apparatus and for a fixed speed the thickness of coating will be increased in proportion to the length of the cylinder, that is to the length of the coating zone, and also in proportion to the number of times the pipe is surrounded by an atomizing edge.

It will be clear from the foregoing that the feed of coating material to the atomizing edge is greatest during the first 180° of its rotation after the portion of the ring member 25 adjacent thereto has been immersed in the pool. Consequently there is a lessened flow during the final 180° travel before re-immersion in the pool, which lessened feed or flow under some circumstances may result in a thinner coating being applied to the portion of the pipe adjacent the downwardly moving atomizing edges. In such circumstances the apparatus shown in Fig. 3 may be employed which includes a pair of ring members 25a, each supporting an atomizing edge 26a with the ring members being mounted for rotation to dip into a pool of material 33a. The members 25a may be mounted in a cylinder, such as the cylinder 10, which is rotated in the manner described for the embodiment shown in detail in Fig. 1. Immediately adjacent the ring members 25a is a second pair of ring members 25b, each of which is provided with an atomizing edge 26b and which are mounted for rotation in a direction opposite to the direction of rotation of the ring members 25a. During such rotation the ring members 25b are dipped in a pool 33b of coating material. Because of the opposite rotation of the ring members, all sides of the pipe receive substantially equal coating inasmuch as the opposite sides of the pipe which receive respectively a maximum and minimum coating thickness from the first pair of rings receive a coating from the second pair of rings whose thickness varies in the reverse relationship.

A still further modification of the apparatus is shown in Fig. 4. In this form the atomizing edge 26c is provided on a helical member 40 which may be secured to the interior of a cylinder, such as the cylinder 10, and is formed into a plurality of turns so that the atomizing edge carried thereby encircles the pipe a plurality of times, thereby to all effects and purposes, providing a plurality of annular atomizing zones surrounding the pipe and spaced along its path of movement. During rotation of the cylinder and hence of the helical member 40, the same is carried through a pool 33c of coating material so as to supply coating material to the atomizing edge for atomization therefrom as previously described.

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 applying coating material to an article by electrostatic deposition which comprises passing the article along a horizontal path, encircling the path with means providing a plurality of annular vertically arranged atomizing edges, continuously rotating said means, and continuously dipping the lower portion of the means in a pool of coating material to feed the material to said edges and creating an electrostatic charge differential between the article and the coating material at said edges of sufficient strength to be capable of electrostatically atomizing said material and electrostatically depositing the atomized material on the article.

2. The method of claim 1 in which at least one of said annular edge providing means is rotated in a direction opposite to the direction of rotation of another annular edge providing means.

3. The method of applying coating material to an article by electrostatic deposition which comprises passing the article along a path, encircling the path with a member having a continuous atomizing edge arranged in the form of a helix whose axis is coincident with said path, maintaining a pool of coating material adjacent the lower portion of the member, continuously rotating the member to dip the lower portion thereof into said pool to feed coating material to said edge and creating an electrostatic charge differential between the article and the coating material at said edge of sufficient strength to be capable of electrostatically atomizing said material and electrostatically depositing the atomized material on the article.

4. Apparatus for electrostatically depositing coating material on an article which comprises an open-ended cylinder, a member having an atomizing edge encircling the interior of the cylinder, means for maintaining a pool of coating material in the cylinder, means for rotating the cylinder repeatedly to dip portions of said member into the pool, and means for creating an electrostatic charge differential between coating material on the atomizing edge and the article sufficient to atomize said material and to deposit the atomized particles on the article.

5. Apparatus for electrostatically depositing coating material on an article which comprises an open-ended substantially horizontally arranged cylinder, a plurality of spaced annular inwardly extending members having discharge edges mounted on the interior of the cylinder, with said edges being parallel to each other and normal to the axis of the cylinder, means for passing the article from end to end through the cylinder, means for maintaining a pool of coating material in the cylinder, means for rotating the cylinder continuously to dip at least the lower portion of each member into the pool, and means for creating an electrostatic charge differential between coating material on the discharge edges and the article sufficient to atomize said material and to deposit the atomized particles on the article.

6. Apparatus for electrostatically depositing coating material on an article which comprises an open-ended cylinder, means secured to the interior of the cylinder defining a discharge edge encircling said interior a plurality of times to provide a coating zone extending substantially from end to end of the cylinder, means for feeding coating material to said edge, means for passing an article from end to end through the cylinder, and means for creating an electrostatic charge differential between coating material on the discharge edge and the article sufficient to atomize said material and to deposit the atomized particles on the article.

7. Apparatus for electrostatically depositing coating material on an article which comprises a base, an insulated support for the base to insulate the same from ground, a horizontally arranged open-ended cylinder rotatably mounted on the base, drive means for rotating the cylinder, a plurality of annular members having discharge edges secured to the interior of the cylinder with said edges being in spaced parallel arrangement and lying in planes normal to the axis of the cylinder, means forming a flow path for liquid at the bottom of the cylinder, means for supplying coating material to the cylinder to form a pool thereof in the bottom of said cylinder, means for rotating the cylinder continuously to dip at least the lower portion of the members in said pool, means for passing an article to be coated from end to end through the cylinder, and means for creating an electrostatic charge differential between coating material on the discharge edges and the article sufficient to atomize said material and to deposit the atomized particles on the article.

8. Apparatus for continuously depositing coating mate-

rial by electrostatic deposition on an article moving along a predetermined path which comprises means defining a discharge edge encircling said path a plurality of times to provide a coating zone extending an appreciable distance therealong, means for feeding coating material to said edge for electrostatic atomization therefrom, and means for creating an electrostatic charge differential between coating material on the discharge edge and the article sufficient to atomize said material and to deposit the atomized particles on the article.

9. Apparatus for electrostatically depositing coating material on an article which comprises, means for passing the article along a predetermined path, a rotatable member having an edge in the form of a figure of revolution surrounding the path, means for maintaining a pool of said material adjacent the path, means for rotating the member to dip a portion thereof into the pool to pick up material for gravity flow to the edge with continued rotation thereof, and means for atomizing the material at said edge and for creating an electrostatic charge differential between the atomized particles and the article sufficient to deposit the atomized particles on the article.

10. Apparatus of the character described in claim 9 including a second rotatable member having a discharge edge in the form of a figure of revolution surrounding said path in spaced relationship from the first edge, means for rotating the second member oppositely to the direction of the first member to dip a portion thereof into a pool to pick up material for gravity flow to the second edge with continued rotation thereof, and means for atomizing the material at said second discharge edge and for creating an electrostatic charge differential between the atomized particles and the articles sufficient to deposit the atomized particles on the article.

11. The method of applying coating material to an article by electrostatic deposition which comprises maintaining a pool of coating material, moving a member carrying an annular atomizing edge along a path which includes said pool to dip the member into the pool to collect coating material thereon for transfer to said edge, passing an article through approximately the center of the annulus, and creating an electrostatic charge differential between the article and the coating material at said edge of sufficient strength to be capable of electrostatically atomizing said material and electrostatically depositing the atomized material on the article.

12. The method of applying liquid coating material to an article by electrostatic deposition which comprises passing the article along a predetermined path, encircling the path with means providing a plurality of annular atomizing edges arranged substantially normal to said path, providing a supply of liquid coating material, continuously rotating said means, continuously dipping said means into said supply of coating material to feed the coating material to said edges for atomization therefrom, and creating an electrostatic charge differential between the article and the coating material atomized at said edges sufficient to deposit the atomized particles on the article.

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