

June 4, 1957

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2,794,751

ELECTROSTATIC DEPOSITING METHOD

Filed Nov. 12, 1953

2 Sheets-Sheet 1

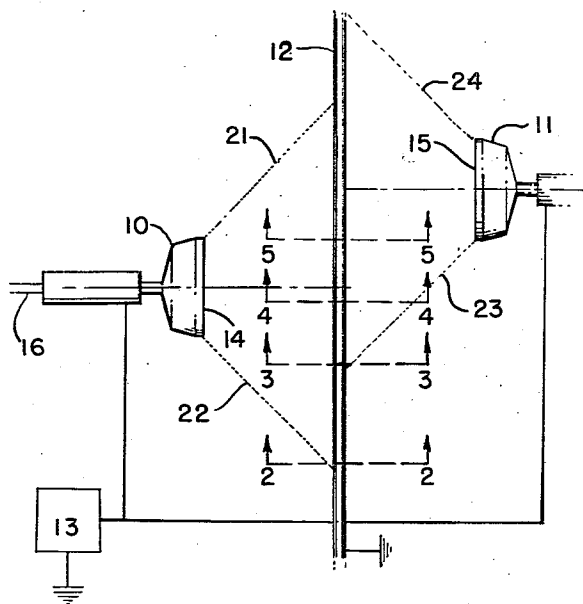


Fig. 1

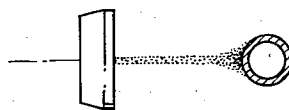


Fig. 2

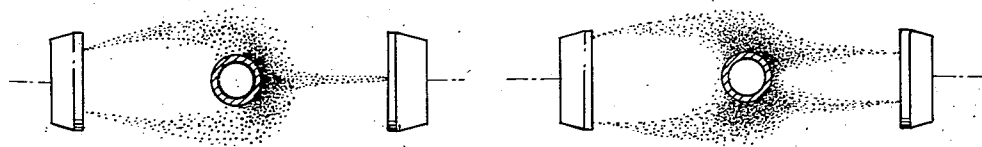


Fig. 3

Fig. 4

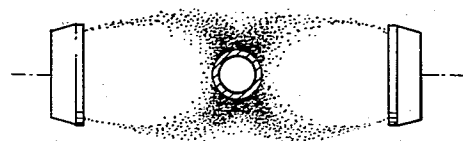


Fig. 5

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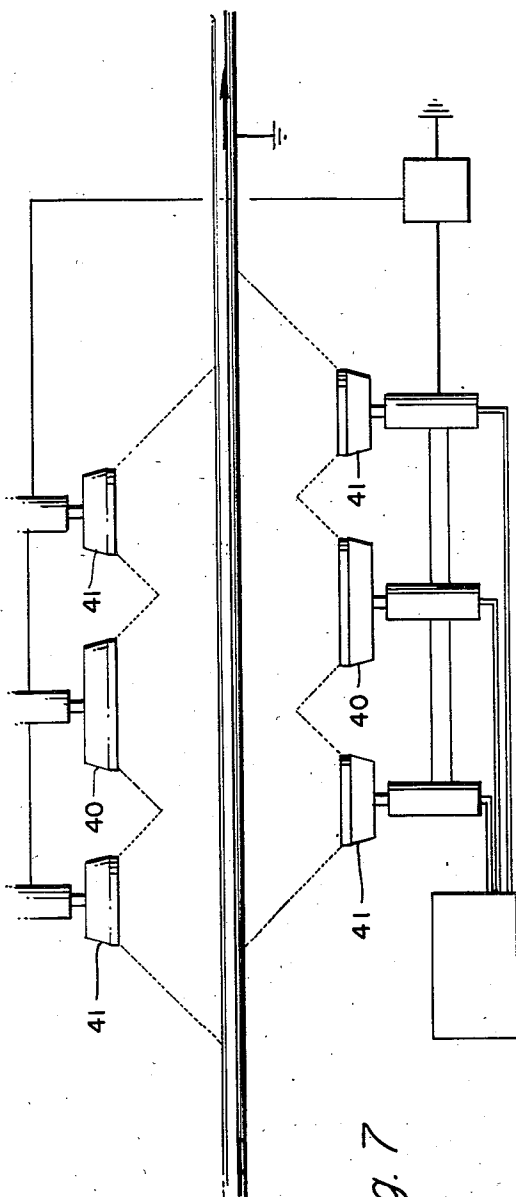
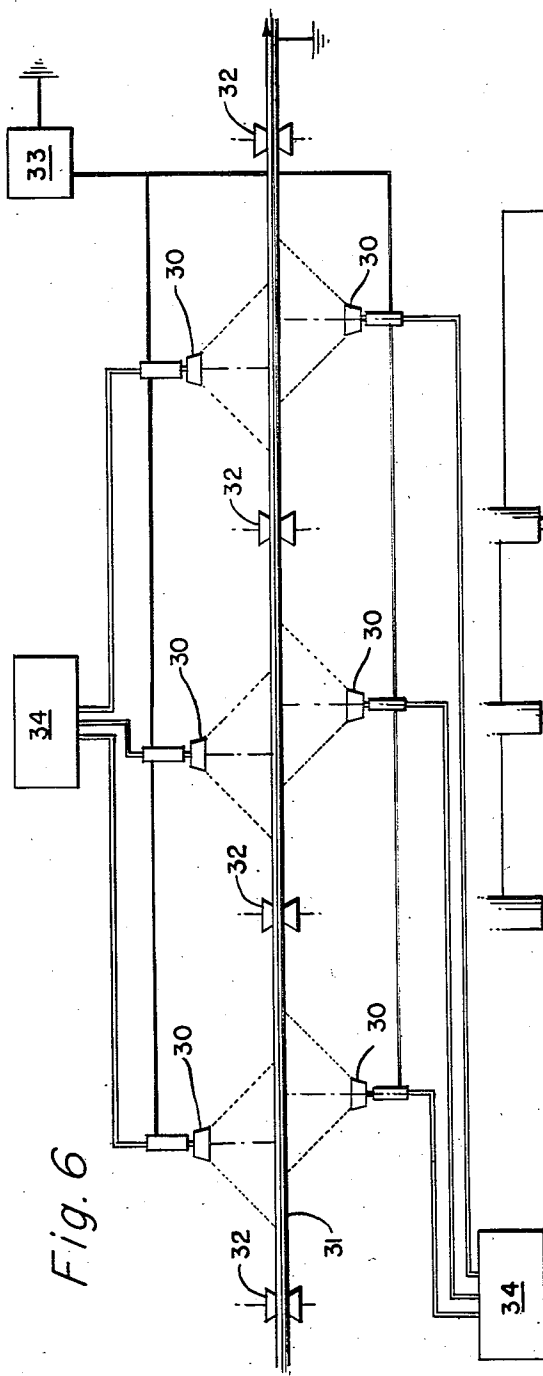
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2 Sheets-Sheet 2



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ELECTROSTATIC DEPOSITING METHOD

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Application November 12, 1953, Serial No. 391,404

1 Claim. (Cl. 117—93)

My invention relates to electrostatically depositing particles of liquid material and more particularly to improvements in apparatus for controlling the path of movement of charged atomized particles.

When an article of manufacture is moved through a coating zone and exposed to a spray of liquid coating material particles which have an electrical potential in relation to the article, the liquid particles are deposited onto surfaces of the article largely as the result of electrostatic forces. Particularly in electrostatic coating in a quiescent atmosphere the finely divided coating material particles are deposited over the surfaces of the article generally in direct proportion to the number of electrical lines of force terminating on the various surface portions of the article, so long as the concentration of lines of force is not sufficient to cause ionization of the air adjacent the surface portion. When the article is three-dimensional and a uniform coating over the surface of the article is desired, it is apparent that difficulties are often encountered due to the irregular electrical characteristics of such a surface which may militate against the even distribution of lines of force and hence of coating material particles over the article surface. The problem is often accentuated where the coating apparatus includes as one terminus of the depositing electrostatic field the edge of an atomizing head from which atomized spray particles are projected, since the electrical relation between such atomizing edge and the surface of the article to be coated must be taken into account.

One very efficient commercial type of such an atomizing head is that described in the co-pending application of E. M. Ransburg, Serial No. 143,994, filed February 13, 1950, which utilizes a rotating bell-shaped atomizing head in which liquid coating material is fed to the interior of a charged, bell-shaped rotating head resulting in finely divided particles of coating material being atomized from the annular edge of the rotating head which lies generally in a plane parallel to the path of article movement. The charged particles of coating material atomized from the annular edge of the head will be projected into the quiescent atmosphere of the coating zone to be moved toward and deposited on the surfaces of the article largely in accordance with the pattern of the lines of electrical force projecting from the head and terminating on the article. "Quiescent" is used in the sense that the atmosphere or air through which the charged particles move as they near deposition on the work is free from air currents of such velocity and volume as to overcome, for many of the coating-material particles, the electrostatic attraction thereof and cause a substantial proportion of the particles to escape deposition on said work.

Particularly in coating arrangements where the article is an extended three-dimensional object whose maximum dimension normal to the path of article travel is somewhat less than the like dimension of the charged

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atomizing means, the coating material may be deposited on the moving article as a number of laterally spaced bands of non-uniform thickness which would render the coating commercially unacceptable. In coating pipe or cable of rather small diameter or similar articles moving axially through a coating zone and past an atomizing head of the type previously mentioned, it has been found in certain instances an extremely heavy deposition of coating material is built up as a band along the extent of the pipe on the reverse side from the atomizing head. As one specific example, when pipe having an outside diameter of approximately three fourths of an inch is spaced approximately twelve inches from and moved axially past a single six inch diameter bell-shaped atomizing head whose axis is substantially horizontal, the coating material will be deposited fairly heavily on the front of the pipe (that is, on the pipe surface nearest the atomizing head), lightly on the top and bottom surfaces of the pipe, and very heavily on the reverse side of the pipe. This results in a composite coating comprising laterally spaced bands of non-uniform thickness.

While the following theory does not constitute a part of my invention nor is my invention limited thereto, I believe the foregoing phenomenon is explained in the fact that the lines of electrical force emanating from the discharge edge of the atomizing head, which lines of force in large measure determine the paths of the coating material particles, radiate outwardly in a generally frusto-conical arrangement due perhaps to their mutual repulsion. If the article to be coated were a large flat sheet rather than a pipe of smaller diameter than the atomizing head, the spray particles would be deposited on the sheet as an annular or "doughnut" shaped band whose diameter is in the order of three times the diameter of the atomizing head. Thus, approximately 90% or more of the spray particles comprising such a pattern would be projected from the head in a direction which, except for the electrical attraction between the particles and the pipe, would never reach a pipe of such diameter. While a portion of the particles are abruptly drawn to the front of the pipe, the major portion of the particles follow curving lines of force which cause the particles to "wrap around" and become deposited on the reverse side of the pipe to build up into a heavily coated band as the pipe moves through the coating zone.

The use of two atomizing heads located along a common axis and facing each other from opposite sides of a horizontally moving pipe whose diameter is somewhat less than the vertical dimension of the heads may also result in a non-uniform deposition of coating material over the surface of the moving article in that in some cases there appears to be built up two very heavy axially extending bands of coating material along the top and bottom of the pipe. In like manner as that described above, in the electrostatic spray coating of other articles a similar problem of non-uniform coating may be encountered.

It has been found that charged particles moving toward an article from a given point of origin can influence the paths of similarly charged particles moving toward the article from another point. The uniformity of distribution of coating material on pipe, cable and other articles whose major dimension normal to the path of article travel is somewhat less than either the like dimension of the atomizing means facing the article or the maximum cross sectional dimension of the spray normal to the path of article travel may be improved by a proper mutual arrangement of a plurality of separate charged sprays and the article to be coated. Thus if a plurality of charged sprays directed toward such an article are in proper electrically interfering or overlapping relation the resulting

pattern of deposition on the article is a composite coating over the article surface having variations in thickness substantially less than that of an individual spray, or of two diametrically opposite sprays, or of two opposite atomizing heads positioned so that their sprays are not in overlapping relation. One specific example, which will hereinafter be more fully described, comprises two similar sprays which originate from sources on opposite sides of a moving article to be coated and with the sprays moving toward and generally normal to the path of article movement with their respective spray axes properly offset from each other along the article path and with the projections of their spray patterns partially overlapping each other.

It is, therefore, an object of my invention to provide improvements in the electrostatic spray coating of articles having two relatively small dimensions.

Another object of my invention is to provide means to effect a generally uniform rearrangement of the lines of electrical force existing in an electrostatic coating apparatus for pipe and similar articles.

A further object is to provide an arrangement utilizing presently commercially available apparatus for obtaining a substantially uniform coating over the surface of extended three-dimensional articles being moved through a coating zone.

A still further object is to provide a simple arrangement for coating a pipe of relatively smaller diameter than the transverse extent of an atomizing means.

Apparatus for accomplishing the above stated and related objects of my invention will be hereinafter fully described with reference to the accompanying drawings wherein:

Fig. 1 is a partial diagrammatic plan view of one embodiment of my invention;

Fig. 2 is a diagrammatic cross-sectional view taken along line 2—2 of Fig. 1;

Fig. 3 is a diagrammatic cross-sectional view taken along line 3—3 of Fig. 1;

Fig. 4 is a diagrammatic cross-sectional view taken along line 4—4 of Fig. 1;

Fig. 5 is a diagrammatic cross-sectional view taken along line 5—5 of Fig. 1;

Fig. 6 is a plan view diagrammatically showing an alternative embodiment of my invention; and

Fig. 7 is a plan view diagrammatically showing a further embodiment of my invention.

While my invention may be practiced in many different forms, there are shown in the drawings and will be described in detail several embodiments utilizing annular atomizing heads. These embodiments are to be considered merely as exemplifying the principles of the invention, which may also utilize other types of atomizing devices. The scope of the invention will be pointed out in the appended claim.

Referring first to Fig. 1, there is provided a pair of generally identical atomizing heads 10 and 11 generally horizontally arranged and lying on opposite sides of an article to be coated, shown as pipe 12. Pipe 12 is carried through the coating zone between atomizing heads 10 and 11 on grounded conveyor means (not shown) so that the pipe will itself be grounded. The heads are of the type previously disclosed and are equally spaced from moving pipe 12 with their axes preferably parallel, normal to the pipe axis and lying in generally the same plane. In connection with the positioning of the heads, best results have been obtained with the head axes parallel, in the same plane as the axis of the pipe, and substantially normal to the pipe axis. However, it has been found satisfactory results can be obtained with the head axes not parallel but at an obtuse angle as small as 120°, or with the head axes parallel but at a substantial angle such as 30° or more to the pipe axis. Such arrangements, however, result generally in a lower percentage of atomized paint particles being deposited on the articles to be coated than the percentage obtained with the preferred

embodiment illustrated and now being described in detail. In those alternative embodiments where the head axes are not substantially normal to the pipe axis, different offsets of the head axes along the pipe axis will be required to obtain optimum coating uniformity.

Heads 10 and 11 terminate in annular atomizing edges 14 and 15 respectively and the heads and edges are maintained at a high electrical potential in relation to grounded pipe 12 by connecting the heads in parallel to a high voltage terminal of a convenient source of high voltage 13. The axes of the heads are offset from each other along the path of movement of pipe 12 a distance which will depend upon such variable factors as the type of coating material used, the voltage gradient and spacing between the atomizing heads and the article, and the speed of head rotation. For proper operation, the spacing should be between $\frac{1}{2}$ to 3 times the diameter of the annular edge from which atomization takes place. In the preferred embodiment now described an offset of approximately the diameter of either annular atomizing edge 14 or 15 is illustrated. Heads 10 and 11 are rotated about their respective axes by connection to suitable driving means (not shown) while liquid coating material is fed from supply means such as tubes 16 (only one of which is shown) to the interior bell-shaped surfaces of the rotating heads. Electrically charged finely divided particles of liquid coating material are thereupon atomized from head edges 14 and 15 into the electrostatic field existing between the edges and pipe 12.

In operation of the foregoing apparatus pipe 12 is moved axially through the coating zone and exposed to the sprays of charged coating material particles emanating from heads 10 and 11, resulting in the production of a substantially uniform coating on the surface of the pipe emerging from the coating zone. Figs. 2 through 5 illustrate successive steps in the coating process and represent diagrammatically the deposition of coating material on the surface of a small circular or ring-like section of pipe as the section moves successively into positions located along lines 2—2, 3—3, 4—4, and 5—5 respectively as indicated in Fig. 1. In each of Figs. 2 through 5 the pipe diameter has been exaggerated for convenience of illustration.

As a given circular section of the pipe first enters the coating zone (the boundaries of the coating zone illustrated in Fig. 1 by dotted lines 21, 22, 23, and 24) the surface of the pipe section will first receive coating material particles from the closest portion of atomizing edge 14 to the pipe section. As this ring-like section of pipe reaches the position indicated by lines 2—2 in Fig. 1, the particles atomized from a small arc of atomizing edge 14 bisected by the horizontal plane containing the axis of pipe 12 will be projected toward and deposited on the surface of the pipe closest to edge 14 in the manner shown in Fig. 2. In order to illustrate the portion or arc of the atomizing head from which coating material is supplied to the pipe section in Fig. 2, and also in Figs. 3—5, the atomizing heads are shown in these figures although the heads do not actually lie in the planes of the figures.

As the pipe section moves forward into the position indicated by line 3—3 it will be within the coating zone defined by boundary line 23 and originating from head 11 so sprays of coating material will be projected toward the pipe section from both heads simultaneously. As shown in Fig. 3 the portion of the spray from head 11 which is projected toward the section in this position originates from the small arc or portion of edge 15 substantially bisected by the horizontal plane of the axis of pipe 12 and coating material from this portion of head 11 will be projected generally horizontally and deposited on the surface of the pipe directly facing head 11. At the same time coating material projected from head 10 toward the pipe section in Fig. 3 will originate from two arcs of the head edge lying respectively somewhat

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above and below the horizontal plane of pipe 12 as shown. Coating material from these two arcs will tend to follow generally the lines of electrostatic force which are moving gradually outward from the head axis and either upward or downward away from the horizontal plane of pipe 12. As these particles approach the vicinity of the pipe they will tend to "wrap around" and in increasing measure will move toward and become deposited on the surfaces of the pipe in the manner illustrated.

It is seen that as the circular pipe section moves into the position indicated by line 4—4 the areas of heaviest spray particle deposition will have moved circumferentially around the surface of the pipe section from the areas shown in Figs. 2 and 3 to the areas indicated in Fig. 4. The lines of force from the head 11 have now spread out and exhibit a tendency to repulse the lines of force originating from head 10 and as shown the areas of heaviest deposition are now nearer the top and bottom of the pipe. By the time the pipe section reaches the position of line 5—5, lying equally between the axes of heads 10 and 11, the principal areas of spray deposition will be directly at the top and bottom of the pipe since the spray particles originate from like portions of the respective atomizing edges and the patterns of the lines of force therefrom will be substantially similar. This condition is illustrated diagrammatically in Fig. 5.

After the pipe section reaches the position shown by line 5—5 it will move through the remaining half of the coating zone while coating material particles are deposited principally over the half of the pipe facing head 10 in a similar manner to that shown progressively in Figs. 4, 3, and 2. It is apparent from the foregoing description that the lines of force directing the deposition of coating material move circumferentially over the surface of the pipe as it moves the length of the coating zone to achieve a resulting coating of substantially uniform thickness.

In order that pipe may travel at a relatively high rate of speed during the coating operation and yet receive a predetermined thickness of coating material an arrangement as shown in Fig. 6 may be used. Three separate coating zones, each comprising two identical atomizing heads 30 having annular atomizing edges six inches in diameter, are employed for coating pipe whose outside diameter may vary from approximately one-half to four inches. The pipe 31 moves successively through the three coating zones supported and grounded on conveyor rollers 32. The atomizing edge of each head is maintained at high potential by connection to voltage source 33 and each edge is spaced approximately twelve inches from the axis of the pipe; the head axes are preferably normal to the pipe axis; and the axes of the heads in each coating zone are offset one from the other in the direction of pipe movement a distance of about nine inches. The coating zones are spaced approximately five feet apart. Liquid coating material is supplied from tanks (not shown) by means of pumps 34 to the heads 30 at a controlled uniform rate. Where pipe of approximately two inch outside diameter is coated with paint of a common pigmented type, the paint may be delivered to each

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atomizing head at the rate of about 85 cubic centimeters per minute. With such an arrangement pipe can be run along the conveyor at approximately 300 feet per minute to achieve a satisfactory coating of substantially uniform thickness.

Fig. 7 shows a further embodiment of my invention wherein there is utilized on opposite sides of the conveyor-borne article to be coated a "triple head" unit consisting of a central bell-shaped atomizing head 40 of somewhat larger diameter than the two outer heads 41 of equal diameter. These three heads on each side of the article path are spaced sufficiently close together as an integral "triple head" unit so there is some electrical shielding between the neighboring edges of adjacent heads. In one commercially used "triple head" unit the heads are spaced with their axes eighteen inches apart and the outer heads are six inches in diameter and the central head is eight inches in diameter. It has been found that where two such "triple head" units are placed on opposite sides of the article path generally facing each other and with the axes of heads on one side being offset approximately the distance between adjacent head axes on the opposite side of the article, the composite arrangement of the lines of force emanating from the six heads and terminating on the surface of the article to be coated will result in a substantially uniform coating over the surface of a pipe, chain, cable or other articles of relatively small diameter moved through the coating zone.

I claim:

The method of electrostatically spray coating an elongated article such as a pipe or the like which comprises moving the article parallel to its major axis along a predetermined path; arranging a pair of atomizers, each provided with an annular atomizing edge greater in diameter than the minimum external diameter of the article, on opposite sides of said path; issuing an annular spray of electrostatically charged coating material particles from each of said edges; said atomizers being spaced apart longitudinally of the path of article movement a distance of between one-half and three times the diameter of said edges to cause portions of the spray patterns issuing from the atomizers to overlap in the region of the path of article movement, and maintaining the article at a particle attracting potential to cause the charged particles to be electrostatically deposited thereon.

References Cited in the file of this patent

UNITED STATES PATENTS

2,114,377	Goss	Apr. 19, 1938
2,247,963	Ransburg	July 1, 1941
2,580,406	Caltor	Jan. 1, 1952

FOREIGN PATENTS

599,466	Great Britain	of 1948
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OTHER REFERENCES

No. 2 Electrostatic Process, Ransburg Electro-Coating Corp., Indianapolis, Ind., 1951, 12 pages.