Fig. 3
This invention relates to electrostatic spray coating of articles by a method and apparatus wherein the coating material is atomized, dispersed and deposited upon the articles being coated; and in particular relates to the coating of those portions of articles which comprise adjacent divergent surfaces, as the flanged bottoms of certain articles, which portions are not readily satisfactorily coated by electrostatic coating methods heretofore employed.

In the electrostatic coating of articles with which we are here concerned the particles are atomized from the head under the influence of an electrostatic field and are then dispersed in a certain pattern and eventually deposited on the article, normally maintained at a substantial potential differential from the head. Under normal conditions the article is substantially spaced from the atomizing head and accordingly, the angle intercepted by a small diverging surface, as a flaange around the bottom of the article, is relatively small; and further a flange extending directly toward the atomizing head has its inner surface substantially parallel to the general line of movement of the spray particles at a substantial distance from the head, where they normally move substantially parallel to the axis of the head. These factors contribute to insufficient coating of the inner surface of a vertical flange, for example.

The present invention provides method and apparatus for satisfactorily coating this particular portion of an article; and, in conjunction with other coating methods and apparatus heretofore used, enables a coating of substantial thickness to be applied to the entire surface of the article, including a flanged bottom portion, for example. Generally speaking, this is accomplished by locating the diverging surfaces (as a flanged container bottom) fairly close to a spray source so that the coating spray is relatively highly concentrated per unit area and has a general line of movement which is still diverging sharply outwardly from the head (i.e., outwardly from the axis thereof); so that the field electrode cooperating with the diverging or flanged surface lies to the inside of and fairly close to the flange, with a relatively large number of lines of force passing to the inner flange surface; so that the projection of the diverging surface, as a vertical flange, subtends a relatively greater angle in the spray pattern, particularly as related to the general line or direction of spray movement; and so that the field strength at the juncture line between the flange and the area from which it extends is large enough to cause a substantial deposition of the coating material.

The present invention further provides apparatus and a method wherein surfaces having flanged borders (such for example as the bottom surfaces of some containers) can be completely coated satisfactorily through the use of an electrostatic coating system employing only atomizing heads which have proved particularly efficient commercially.

One form of electrostatic coating arrangement which has proved very satisfactory commercially makes use of an atomizing head with a circular atomizing edge, as the edge of a conical member maintained at a potential with respect to its surroundings, and rotates this edge so that liquid coating material is supplied through an opening in the apex thereof. The material flows in the form of a thin film along the interior of the cone to the edge thereof, is atomized from this edge, and under the effect of an electrostatic field having the head as one electrode passes to the article to be coated. The article is usually conducting and mounted on a grounded conveyor to comprise the other electrode. Such a rotary conical type atomizing head is more fully disclosed and claimed in the copending application of Edwin M. Ransburg, Serial No. 143,994, filed February 13, 1950. The "natural pattern" delivered from a head of this type normally is "bell shaped" in cross-section through the axis of the head, with the general line of movement of the spray initially diverging sharply outwardly from the head and then curving inwardly until ultimately, at a substantial distance from the atomizing head, it is substantially parallel to the axis thereof; and the pattern transverse to the axis is in the form of a "doughnut" or annular band having a central portion which is completely or relatively void of coating material, a pattern band which has a more concentrated distribution of coating particles near the center line thereof than near the edges. The "natural pattern" (sometimes hereinafter referred to as merely the "pattern"), to which reference is here being made, is the pattern which the spraying device would provide on a large flat sheet of conducting material of relatively infinite size arranged normal to the general line of movement of the spray particles and acting as the other field electrode.

Rotary heads providing an annular pattern of this type have proved particularly satisfactory in electrostatic coating of large articles or large surfaces, particularly when grouped in sets of three in the manner more particularly described and claimed in my copending application Serial No. 257,741, filed Nov. 23, 1951. However, when this type of atomizer which produces a bell-like cone of spray resulting in an annular spray pattern is used in heretofore normal manner, the side walls of recessed areas, as the side walls of flanges and their junction line with the surface from which they diverge, will frequently be so lightly coated relative to the remainder of the article as to be insufficiently protected. The present invention, however, by using the methods and apparatus hereinafter more fully described in conjunction with other arrangements for coating other areas, results in a satisfactory coating of these portions while still retaining the coating efficiencies and convenience of such an electrostatic coating system, and without the necessity of over-coating other areas.

The foregoing and other features of this invention will be apparent from the following specification and the drawings in which:

Figure 1 is a perspective view of one form of coating apparatus embodying this invention, illustrating the application of coating material to the exterior surfaces of large cylindrical containers (as five gallon cans) with flanged bottoms;

Figure 2 is a diagrammatical view illustrating the spray pattern and its relation to the flanged portions while they are particularly being coated;

Figure 3 is a perspective view of a modified or other coating arrangement more particularly designed for applying coating material to containers of the type normally termed "blitz" cans; and

Figures 4 and 5 are diagrammatical views of the coating of different portions of the flanged bottoms of such "blitz" cans.

While two different arrangements of coating systems
are illustrated in the accompanying drawings and will be hereinafter more fully described, it will be understood that these are in all respects representative embodiments only. It is to be understood that other embodiments of the method and apparatus here disclosed, alone or in combination with other coating arrangements, 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 is hereinafter set forth.

Referring now more especially to the particular embodiment of the invention illustrated in Figure 1, the articles 10 to be coated (here illustrated as cylindrical cans or drums with flanged bottoms) are inverted over and carried by spindles 11 which are mounted for suitably spaced traversing movement, as by being mounted on a chain 12 longitudinally movable in a channel member 13. The spindles are arranged to be rotated as they are traversed, the rotation being effected by virtue of engagement of spindle portions with a belt 14 passing over pulleys 15 and 16 in the particular form shown. The articles are then traversed along the floor mounted conveyor as illustrated, and rotated suitably during such movement to increase the uniformity of distribution of coating. Adjacent one side of the conveyor in the form here illustrated is a three-head atomizing arrangement for effecting the major portion of the coating operation, although it will be understood that in practice a similar system might be used on the opposite side of the conveyor to enable faster conveyor operation. The main coating arrangement illustrated comprises stands 17 and 18 from which rise vertical columns 19 and 20, in turn carrying between them an annularly arranged support member comprising the parts 21, 22, 23 and 24. These in turn carry three conical rotating atomizing heads here identified as 25, 26 and 27, adapted to be rotated through suitable drive connections by a motor 38. These heads are preferably of different diameters and suitably spaced to secure the optimum uniformity of distribution of coating material, as is more fully described and claimed in the above mentioned application of James W. Juvinall. The three heads are raised to a desired electrical potential, as by being connected together by having the support sections 23 and 25 of conductive material and by having a cable connection 28 to one terminal of a high potential power pack 29, which may have its other terminal grounded as indicated at 30. These heads are also suitably supplied with liquid coating material, as by the hoses 31, 32 and 33 from a controlled positive feed pump 34 drawing its liquid coating material from a container 35 forming a reservoir thereof. Since the articles are grounded, suitable field conditions (as by having the heads spaced 12 inches from the nearest surface of the articles and at a voltage differential of 100,000 volts with respect thereto) result in atomizing the coating material from the heads and depositing it upon the side walls of the containers; and further causes a substantial coating of the bottom of the container, at least as to all portions except those comprising the inner vertical surfaces of the flanges and the closely adjacent bottom areas, which comprise a critical area that will not be satisfactorily coated by the three head arrangement illustrated at the sides of the articles without overheating of other areas.

In addition, to provide such adequate coating, the present invention contemplates the use of an additional head positioned above the article being coated thereby and in a particular relation thereto and of a diameter specifically related to the diameter of the bottom of the can, this additional head being illustrated to the left of Figure 1. If this head were located and arranged similarly to the heads heretofore just described, it would have a tendency to provide a general coating over the article. Consequently, it is contemplated that specific locations and relationships will be provided such as to satisfactorily coat the adjacent diverging surfaces at and near the juncture line of the flanges with the large bottom area of the can. Referring now more particularly to Figure 2, it will be seen that if a head 40 of 6 inch diameter were arranged at about twelve inches from the article, as in conventional commercial practice, the flange 10a (as illustrated in dotted lines at the lower left of the figure) would extend over only a very small fraction of the width of the head, and the portion of spray movement where the general line of movement is parallel to the axis of the head, and with the juncture line between the surface and the flange 10a at or near the center line of the pattern band (and preferably a little to the outside thereof), the inner surface of the flange will both subtend a greater angle with respect to the diverging spray particles, receive more field force lines, and lie in a relatively denser portion of the spray, and a portion where the general line of movement of the spray is still substantially outwardly. This is particularly true if the portions to be specially coated by this latter head are moved in or through the pattern band with the line of juncture between the diverging surfaces at or near that center of the annular band, preferably slightly outside thereof and parallel thereto (or parallel to a line tangent to such center line at any instant).

Referring now more particularly to Figure 1 again, it will be seen that the additional head 40 is supported by a suitable insulating shaft 41 from the vertical post 42 and adapted to be rotated by the motor 43. The head is connected through the cable 44 to the power pack 29 to be raised to a suitable potential with respect to ground and is supplied with liquid coating material from the pump 34 through the hose 45. In the particular example illustrated the head 40 might be so located as to be 4½ inches away from the closest portion of the article moving along the conveyor, and would be at a lesser potential differential from ground than the other heads, as 50,000 volts.

The vertical post or column 42, and thus the entire assembly carried by it, is mounted on a block 46 in turn mounted on "ways" or guide members 47, these in turn being supported in desired relation to the conveyor, as by stands 48. Two compression coil springs 49 are here shown as arranged above the ways 47 in such a manner as to bias the block 46 toward the right (as illustrated in Figure 1). A shaft 50 driven by and in synchronization with the conveyor chain 12 is here shown as having a worm 51 at the lower end thereof driving the worm gear 52 on the shaft 53. This is here shown as driving through sprockets 54 and 55, chain 56 and a reduction gear arrangement 57, a cam here identified as 58 cooperating with a follower pin 59 on the block 46.

Movement of conveyor chain 12 to the left causes rotation of the cam 58 in a counterclockwise direction (as the parts are viewed in Figure 1), and this in turn causes traversing movement of the head 40 in synchronization with such movement of the particular article 10 being coated, so as to maintain the head and article in the relationship illustrated in Figure 2 for a substantial period. During this period the article is rotated about its own center with the center of rotation substantially coinciding with the center of the annular system being delivered by the conical atomizing head. After this desired relationship has been maintained for a sufficient period, the cam will have reached the position illustrated in Figure 1, whereupon the head 40 and its supporting arrangement will have moved back toward their farthest right hand position as viewed in the drawing, and will shortly traverse the bottom and again establish its relationship with the next article. During this traversing movement of the head relative to the article bottom,
there will be a further coating of the central portions of the bottom surface by the head 40 supplementing the coating previously received from the other atomizing heads.

Referring now more particularly to Figures 3, 4 and 5 an alternative arrangement is illustrated which is particularly designed to coat the flanged bottoms of fuel containers commonly used by the military services and sometimes known as "blitz" cans. In this form the containers 65 to be coated are supported from an overhead conveyor arrangement comprising carriers 66 movable along a rail 67 in properly spaced relationship by a chain 68, hooks 69 extending down and supporting the cans. It is to be assumed that the cans have previously had their side and end walls and portions of their top and bottom surfaces coated by suitable arrangements, as by a three head arrangement of the character illustrated in Figure 1; and that such supplementary additional coating as has been necessary has been given to the tops thereof, the present illustration and description being concerned with coating the flanged bottoms thereof. The bottom area of such cans is rectangular with a small flange entirely therearound, its bottom cross-section in the narrow direction being illustrated in Figure 4, and that of its long direction being illustrated in Figure 5.

To insure adequate coating of the inner wall of the flange and the adjacent bottom surface of the can in the narrow direction, as illustrated in Figure 4, a special spraying device or atomizing head 70 is provided; and to effect satisfactory coating of the inner wall of the more widely spaced flanges and the adjacent surface of the bottom portion, another and larger diameter atomizing head 71 is provided. Referring now more particularly to Figure 3, it will be seen that the heads 70 and 71 are supported by insulating support members 72 and 73, with rotation of the heads being provided by the motors 74 and 75, and the whole arrangement being supported by suitable stands 76 and 77. Appropriate electrical potential is applied to the heads through the cable 78 from the high potential power pack 79; and liquid coating material is delivered to the interior of the conical heads through the hoses 80 and 81 from the pump 82, drawing its supply of coating material from the container 83. Again the containers are grounded through the conveyor so a suitable field is developed between the atomizing heads and the containers for atomizing and depositing the coating material.

Racing now more particularly to the right hand side of the system (as shown in Figure 3) and to Figure 4, it will be seen that the atomizing head 70 is so chosen as to size and so spaced from the bottom of the container that the flanges on the opposite sides of the narrow dimension thereof are coated as such spaced portions travel through the opposite sides of the annular pattern provided by this atomizing device, the direction of motion being directly into or directly out of the paper as the parts are illustrated in Figure 4. The diverging surfaces of the inner walls of the flanges 65a and the adjacent portions of the bottom surface of the can pass through a concentrated portion of the spray pattern, preferably having its juncture line slightly outside of and moving parallel to the center line of the pattern band at the opposite sides thereof. This location and relative movement coupled with the close relation to the head, results in adequate and satisfactory coating of this portion.

At the center of the arrangement, as illustrated in Figure 3, they are rotated 90° by engagement of rotating members 66 with the fixed stop member 85 so that they now traverse along their path of movement but in a different relationship (as illustrated to the left of Figure 3) which is 90° to their original one. While in this latter position they pass in coating relationship to the head 71, so that the more widely spaced flanges portions 65b are coated as illustrated in Figure 5. Again the closeness to the atomizing head, the relatively long period of travel through the pattern band, and the location of the flanges therein, result in a satisfactorily sufficient deposition of coated material on said opposite flange portions and adjacent bottom surface portions.

As will be apparent from the foregoing description, the correct choice of the size of the head and its spacing is important in order that the field relationships and the size of the pattern be correctly related with the particular spaced portions to be coated. It is further to be seen that the use of a relatively close spacing of the head from the work, preferably a spacing less than the head diameter, enables a concentrated spray pattern; and the location of the diverging flange surface near, but preferably in the outside of the center line of the spray pattern provides a desired angular relationship for increasing the coating thickness. The operating voltages must, of course, be correctly chosen to stay below those which would cause sparking or arcing at the head spacings used. It is seen therefore that the invention resides not only in moving the spaced portions being coated through opposite sides of the annular spray pattern band but also in the correct correlation of head size, head spacing and operating voltage relative to the article surface being coated. Further the utilization of suitable spacings and head diameters, relative to the distance between the flange portions, is of importance in having the spray particles travel outwardly rather than straight toward the article as they approach the flanges, insuring better coating of the inner surfaces of vertical flanges.

While I have shown and described certain embodiments of my invention, it will 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. Apparatus for electrostatically coating that part of an article comprising a rectangular surface of substantial size with a relatively small flange diverging therefrom entirely therearound, comprising: a first atomizing head for providing a spray of coating material in a pattern which is an annular band; a second atomizing head for providing an annular band of different diameter adjacent said sprayer for traversing said article past said first and second atomizing heads and for rotating it 90° therebetween about an axis parallel to the general line of spray movement; and means providing an electrostatic field from each of said heads to the portions being coated, the juncture lines between said surface and opposite flanges being substantially tangent to opposite portions of the center lines of said pattern bands in each case during at least a portion of the article movement.

2. Apparatus of the character claimed in claim 1, wherein the spacing between the article and head is less than the spacing between opposite flanges.

3. A method for electrostatically coating a pair of spaced portions of an article wherein each of said portions comprises adjacent divergent surfaces, comprising: providing from a single fluid atomizing head a spray of coating material in a pattern which is an annular band; providing an electrostatic field from said head to said spaced portions being coated; and traversing said article during such coating so that said spaced portions move through opposite sides of said annular band with the center lines between the divergent surfaces passing substantially tangent to opposite portions of the center line of said annular band during at least a portion of the movement, the distance between the divergent portions and the atomizing head being such that the general line of movement of the spray is still diverging sharply outwardly from the head.

4. A method for electrostatically coating an article having a portion comprising adjacent divergent surfaces, comprising: providing from a single fluid atomizing head a spray of coating material in a pattern which is an annular...
band; providing an electrostatic field from said head to said portion being coated; and traversing said article during such coating so that said portion moves through said annular band with the center line between the divergent surfaces passing substantially tangent to the center line of said annular band during at least a portion of the movement, the distance between the divergent portions and the atomizing head being such that the general line of movement of the spray is still diverging sharply outwardly from the head.

5. A method of the character claimed in claim 4 wherein there are sufficient lines of force of the electrostatic field extending to all portions of the divergent surfaces being coated and adjacent to the center line therebetween to cause a substantial deposition of the coating material on said divergent surfaces.

6. A method of the character claimed in claim 5 wherein the electrostatic field has an average potential gradient of the order of ten thousand volts per inch.

References Cited in the file of this patent

UNITED STATES PATENTS

1,861,475 Hopkins --------------- June 7, 1932
2,098,857 Buckingham ------------ Nov. 9, 1937
2,179,473 McDevitt --------------- Nov. 7, 1939
2,261,138 Bullerjohn -------------- Nov. 4, 1941
2,277,092 Fink ------------------ Mar. 24, 1942
2,442,986 Ransburg --------------- June 8, 1948
2,509,448 Ransburg et al. ------ May 30, 1950
2,495,328 Harrison ------------- Jan. 24, 1950
2,568,611 Crouse ------------- Sept. 18, 1951