

Oct. 11, 1960

R. M. SCHOTLAND

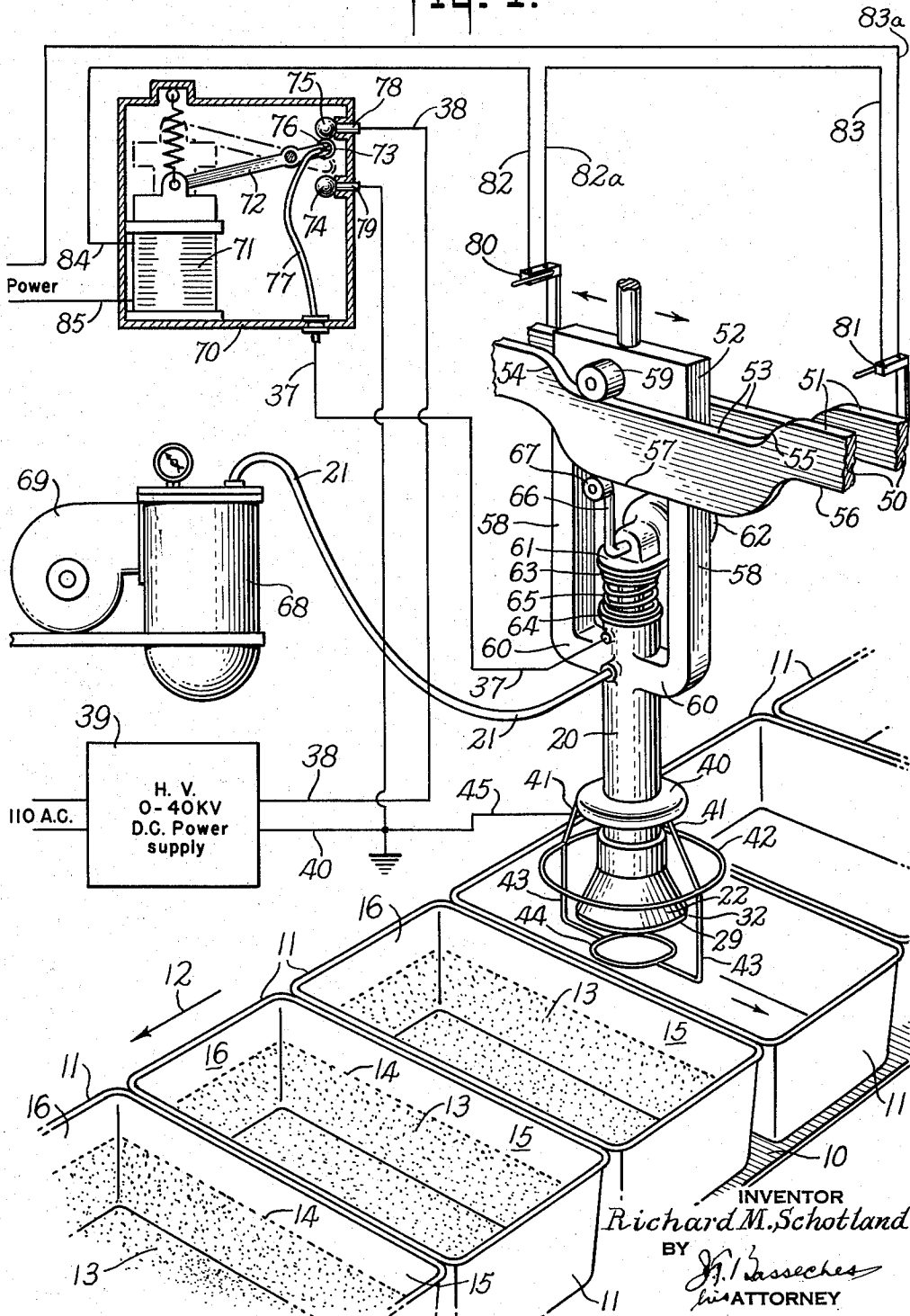
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ELECTROSTATIC COATING APPARATUS

Filed March 19, 1956

2 Sheets-Sheet 1

Fig. 1.



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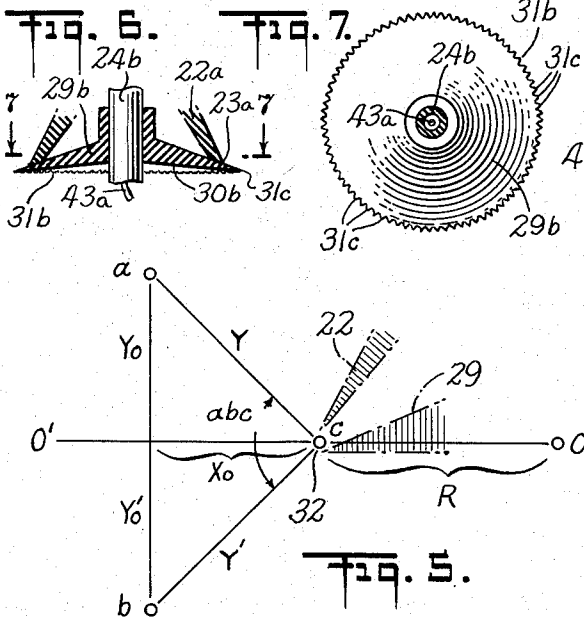
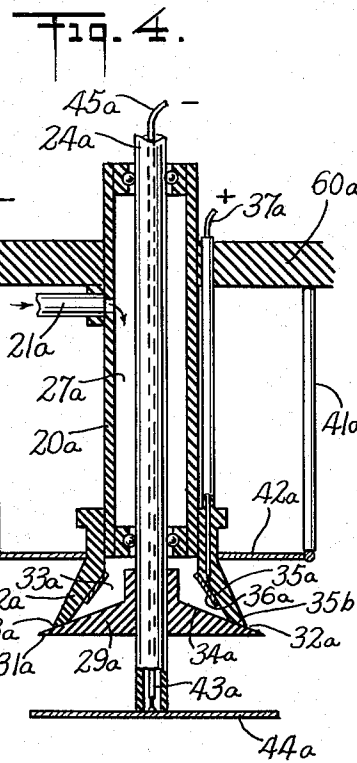
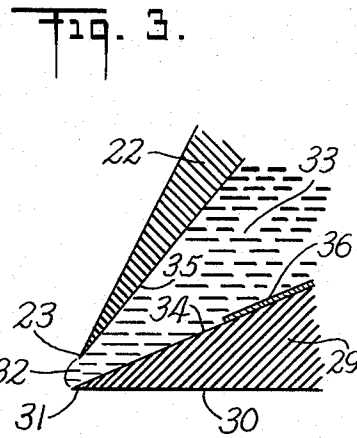
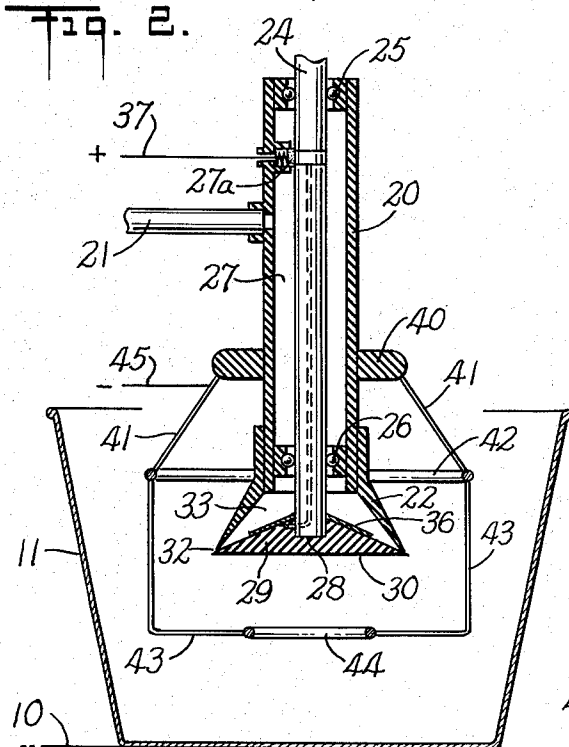
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ELECTROSTATIC COATING APPARATUS

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2 Sheets-Sheet 2



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2,955,565

ELECTROSTATIC COATING APPARATUS

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Filed Mar. 19, 1956, Ser. No. 572,343

11 Claims. (Cl. 118—7)

This invention relates to a method for electrostatic coating and to apparatus for carrying out the same.

The invention relates to the provision of a process for efficiently applying predetermined quantities of coating materials to pans used in the bakery industry, and more particularly to the application of a depanning compound in the bakery field and other fields where similar applications will contribute to improved performance.

Known is the provision of apparatus for greasing in and around the bottom and side walls of bread pans employing shortening compounds or grease to effect the application of this material. Such apparatus furnishes but a rough control of the quantity and the location of the pan greasing material.

Successive applications of such depanning materials engender considerable cost in maintenance of a sanitary condition of the pans as excess grease must be cleansed from the pans, especially in instances where carbonization occurs, further to increase the labor and cost in maintaining a clean and sanitary condition of baking pans and bakery equipment, not to speak of the economic loss by reason of excessive use of the grease or the objectionable condition of the surrounding atmosphere in the uncontrolled application of such materials.

Known also to me is the method of electrostatic atomization of liquids, to produce low velocity particles which may be useful in accelerating chemical reactions by the minuteness of the particles and the charge which is imposed on such particles. Such method produces particles of limited directional trajectory and imparts insufficient directional control for use in selective surface coating operations. This procedure is more particularly disclosed and described in the patent to Darrah 1,958,406, May 15, 1934.

Known also is the coating by electrostatic means and the provision of apparatus to carry out such coating in which electrostatic atomization and projection of coating materials are effected. In such coating operations, the article to be coated is either an electrode in the electrostatic field where a conducting material is employed, or is interposed between electrodes at differential potentials, where a non-conductor material is to be coated directly in conjunction with spray generating means, whether mechanical or electrostatic.

Practice in the bakery field requires such close inspection of the pan charge by reason of an intimate relationship between the character of the depanning material and the dough pieces, or the condition of the dough at the time it reaches the pan that coating means heretofore in practice, particularly electrostatic means, have been determined by me as undesirable in this field of operation.

Thus, electrostatic means heretofore employed for coating engender a hazardous condition to the personnel who may be required to maintain a close inspection and normal operation of pan greasing procedure either automatic, semi-automatic or hand operation.

Dissemination of spray and vapors and uncontrolled dispersion have further offered problems in the coating field which cannot be tolerated in this section of the bakery. Known coating procedures, such as sprays, disseminate a component of the spray which is uncontrolled and therefore produces an unsanitary condition and health hazard to personnel.

I have discovered that electrostatic forces may be controlled to produce novel and highly economical coating operations, particularly useful under the conditions in the preparation of containers, such as pans, tins, sheets of conducting and non-conducting material employed in the bakery field, if a control which I have discovered is employed, limiting the high voltages for the production of an electrostatic charge to an atomization of the materials used for coating, and by the transmission or projection of such electrostatically atomized particles without either air, an extraneous mechanical force, or an electrostatic field, so that a great many highly advantageous, economical and useful procedures may be carried out, having utility generally, but more particularly in the bakery field.

Thus, I have discovered that by the provision of electrostatic forces acting upon dispersible material, to provide a resultant field which is of sufficient magnitude to atomize and provide a resultant force to project directionally the atomized particles out of the field so generated, highly useful coating procedure thus may be obtained, providing a non-hazardous operating condition, permitting localization of deposition for great economy in labor and materials.

Still more particularly, in accordance with my invention, I provide an electrostatic atomizing means which is effective independently of any air carrier or mechanical or centrifugal force whereby compounds, particularly depanning compounds, may be applied in a wide quantitative range, with uniformity and predetermined location of outline, without generating undesirable atmospheric conditions, while eliminating hazardous conditions incident to the use of an electrostatic atomizing force.

I have further discovered, and it is an object of my invention to provide as the sole component, an electrostatic atomizing device in which a fluid including materials ranging into those having relatively high viscosity, may be coated upon an article by being subjected to a minimum mechanical control or influence for embodying a directional force for coating. More specifically, by the use of a plurality of electrostatic fields having a resultant atomization and projecting influence on the atomized particles which is utilized to move the particles out of the atomizing field to a point of deposit which is outside of the atomizing and projecting field, thereby minimizing hazardous conditions of operation, permitting coating on localized areas with uniformity and with quantitative control to effect highly efficient and economical results, so that coating may be effected independently of the dielectric or conducting nature of the article to be coated.

Still more particularly, it is an object of my invention to provide an electrostatic atomizing device wherein any mechanical control is limited to that which merely feeds an extended film in relation to a plurality of electrostatic field forming surfaces which are related to each other to produce primarily the electrostatic atomization of the coating material and to give the resultant particles an accelerated movement away from the nozzle between the field forming surfaces removing the particles from the electrostatic field while controlling the distribution by the directional influence of the field.

Still more particularly, it is an object of my invention to provide an electrostatic atomizing device in which

coatings varying from an extremely fine one to very heavy deposits may be effected independently of the electrical conductivity or dielectric value of the surfaces of the article and independently of the position of the article to be coated avoiding the requirement of being in the field or backed by conducting surfaces to bring the same in the field between a projecting electrode and a receiving surface.

Still more particularly, it is an object of this invention to provide an electrostatic atomizing device in which atomization is effected by correlated field forming surfaces of extended dimensions which influence each other in a symmetrical or unsymmetrical position to the point where the resultant of the field projects the atomized particles from the field to give the same a direction and surface depositing influence over an area which is traversed or scanned whereby a desired surface may be uniformly coated by the rotation, vibration, oscillation or translation of the correlated field forming surfaces to the film forming device at which point atomization begins.

Still further objects of my invention reside in the provision of an electrostatic atomizing device comprising a nozzle head under the influence of electrostatic field forming surfaces acting upon a film forming discharge of the nozzle to atomize the coating material over a wide range of viscosities, the field forming surfaces providing a field in relationship to the film forming nozzle to impart momentum to the atomized particles of a nature to discharge the same in a controlled path from the electrostatic field of which the film forming device and field forming surfaces are components, and by relative motion of the field forming surfaces to the film forming nozzle, areas may be covered with the atomized particles uniformly or alternately by a conjoint motion translation of the nozzle and field forming surface, and distribution of the coating may be effected with localized control while uniformly distributing the same over a wide range quantitatively.

Still further objects of my invention reside in a method of coating in which the coating material is atomized electrostatically in a substantially closed electrostatic field and the atomized coating material is then withdrawn from the field by utilizing the momentum imparted by the electrostatic field to move the atomized material for coating the articles, such as bread pans, baking tins or the like, or any shaped surface or inside of a container, whereby a non-hazardous coating operation may be conducted, and coatings applied in uniform, localized films.

To attain these objects and such further objects as may appear herein or be hereinafter pointed out, I make reference to the accompanying drawing, forming a part hereof, in which

Figure 1 is a perspective view exemplifying an apparatus for carrying out one phase of my invention;

Figure 2 is a diagrammatic view with portions in section to show details;

Figure 3 is a fragmentary magnified sectional portion of Figure 2;

Figure 4 is a fragmentary, diagrammatic section of another embodiment of my invention;

Figure 5 is a diagrammatic outline of an electrode for forming fields;

Figure 6 is a fragmentary sectional view of another embodiment of my invention;

Figure 7 is a plan view thereof, taken on the line 7—7 of Figure 6.

I now make reference to the accompanying drawings wherein my invention is exemplified in conjunction with a pan greasing assembly wherein a conveyor 10 is arranged to receive pans 11 seriatim preferably in groups for speedier handling.

In the illustration, the pans 11 are of the form employed for baking loaves of bread, a series or group of such pans being coupled to feed in the direction of the arrow 12, so that they may be handled economically by

customary bakery procedure. It is desired to apply a depanning material to the bottom and a localized portion of the end and side walls and my invention is exemplified in connection with a depanning coating wherein the depanning compound 13 is applied to the walls of the pan limited along the upper edge line 14, to leave the surfaces of the side walls and end walls 15 and 16, respectively, above said line free from the depanning or pan greasing material.

To carry out the foregoing objective, there is provided an atomizing assembly comprising a nozzle head 20 of insulating material in the form of a conduit which, at one end, has a hose pipe line 21 arranged to be connected to a source of supply of the liquid depanning compound. The conduit 20 terminates in a frusto-conical distributor 22, of dielectric or highly efficient insulating material, merging into a sharply pointed perimeter 23, see Fig. 3. Axially mounted in the conduit 20 there is provided a rotary shaft 24 maintained by the bearings 25 and 26 in spaced relation, affording a circumferential channel 27 from the intake opening 21 to the periphery of the distributor 22.

The shaft 24 carries at its lower edge 28 a control cone 29, whose base 30 has its rim or perimeter 31 terminating substantially co-terminously with the rim 23 of the distributor 22. The rims 23 and 31 thereby provide a circumferential liquid emitting passage 32, and it is desirable to slightly extend the rim 31 for distributing purposes as will appear herein. The passage is controllable as to depth and leads to the conical annulus 33 defined by the upper surface 34 of the control cone 29 and the internal wall 35 of the overlapping distributing cone 22.

The closure control cone 29 is made of insulating material. It carries on its surface 34 a charging surface in the form of a metal foil 36 for purposes of augmenting the conductivity contact of the fluid fed to within the annulus 27 and a brushing commutator 27a may contact the same and be connected to the high voltage power line 37 of negative potential, where direct current is employed. The line 37 is connected to the output 38 of a high voltage power supply 39 which, in accordance with the preferred form of my invention, may be the direct current charges either continuous or pulsating.

Affixed to the conduit 20 is an insulating support 40 from which are extended a pair of brackets 41 of conducting material for the upper field ring 42, to which it is electrically coupled. Leads 43 support the lower field ring 44. In the form shown, it may be fixedly supported where motion scanning, as will be described, is not employed. The supports 41 each have a lead 45 connected to the ground connection 46 of the power supply.

The power supply in the illustration given may provide a source of electrostatic potential which reaches 40 kv. capable of applying average potential gradients of 20 kv. per inch. It is preferred in the illustration given that the source of power for forming an electrostatic coupling with each of the field rings 42 and 44 be unidirectional uninterrupted or unidirectional pulsating, even though, to some extent, an alternating source having an adequate potential for atomization electrostatically may be employed, though not preferred.

The nature of the atomizing influence which provides the unique result may be appreciated by reference to the diagrammatic illustration in Figure 5 which represents a diagrammatic cross-sectional view through the upper ring 42 and the lower ring 44 with reference to the periphery of the nozzle element at the aperture 32. This is a condition representative of the periphery of the distributing nozzle.

By reference to this diagram, it will be seen that the point *c* on the horizontal coordinate *o—o'* corresponds to the peripheral edge of the aperture 32; the points *a* and *b* correspond to the upper and lower rings 42 and 44 respectively. Points *a* and *b* are coupled to low or ground

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potential; point *c* is coupled to the high potential. Liquid at the point *c* will be spaced for a distance X_o , which is in a plane common to the field wires *a* and *b* corresponding to the distances Y_o , $Y'o$ and Y or Y' equalling the radius *R* of the distributor 31.

Where the field wires *a* and *b* are equi-distantly spaced i.e. $Y_o=Y'o$ and the angles equal from the coordinate axis $o-o'$ in a plane common to *a* and *b* substantially normal to the axis $o-o'$, a substantially symmetrical electrostatic field will be formed with the point *c* as the focal point comprising an edge adjacent the aperture 32 for a solid angle as the cone 29 rotates, of predetermined outline. Electrostatic atomization will occur as the lines of force emanate symmetrically from the focal point or emanating surface about the nozzle to the points *a* and *b*, to disrupt the liquid to atomize the same and at the same time project the same with accelerated movement in the direction substantially normal to the plane common to the points *a* and *b*. Accordingly, as the factor X_o within limits is greater than zero, an accelerating field projects the atomized particles toward the plane through and between *a* and *b*. Since the field strength diminishes, the accelerated atomized particles will leave the field adjacent the plane of the electrode components *a* and *b* at a velocity to reach the surfaces of the article governed by the acceleration of particles due to the integrated effect of the potential gradient between the rings and the nozzle and the gravitational influence on such atomized particles.

I prefer that the rim 31 of the base 29 be described by a radius *R* which is substantially the distance Y_o which equals $Y'o$ and offset a distance where X_o equals about ten times the nodules or cusps length in the direction of the article to be coated along the axis $o-o'$ so that the angle *acb* preferably forms approximately a right angle. The limitation of the size of the radius of the control cone 29 takes into consideration the nature of the article to be coated and within which the assembly may be inserted. In relation to one form of my invention as illustrated in the form of pans 11, I may provide an internal atomizing and projecting assembly which is able to enter the pan, and be spaced a distance from the side walls to secure distribution without striations due to the formation of nodules or cusps at the atomizing edge of the control cone by a slow rate of rotation of the cone 29.

A desirable form of depanning compound which I may employ is a fluid of the viscosity of 0.5 poise (c.g.s.), the emitting aperture 32 being about .004" in depth, or varying from .002" to .015".

It will be understood that the closer the positioning of the rings to the emitting aperture, the lower may be the potential employed for atomizing and where the radius of the distributing cone is about 1", effective results have been obtained with an electrostatic potential of about 20 to 25 kv. for a spacing of .004" between the distributor cone and head, with a fluid of the viscosity of 0.5 poise with a hydraulic pressure of about 5 lbs. per square inch on the feed of the fluid.

In order to secure a symmetrical, solid, spherical angle distribution, the field rings 42 and 44 should be symmetrically disposed.

It is well to recognize that the electrostatic force on the emitting aperture tends to form nodules or cusps. For this purpose, as previously indicated, it is desirable to extend the rim 31 so that it extends slightly beyond the rim 23, thereby more fixedly positioning the nodules or cusps.

Accordingly, it is well to space the rings 42 and 44 at such distance from each other and from the emitting aperture 32 that distortions in the field as a result of the formation of cusps or nodules from the more viscous fluids is minimized, in order that the directional projection may be controlled with greater certainty. For this purpose, relative movement of the segments 22 and 29 by rotation of the shaft 24 is preferred so that there is a minimum distortion of the electrostatic field and

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good directional control is thereby secured. It is therefore especially desirable that the distances between the rings 42 and 44 and the X_o factor in the direction of the article be increased toward the article to be coated with more viscous fluids which tend to generate larger nodules or cusps.

Rotation of the distributing cone 29 is of the magnitude in no way to contribute any centrifugal atomization with the viscous depanning compounds mentioned. Rotation at the rate of 200 r.p.m. maintaining uniform distribution of the nodules or cusps that are formed during the electrostatic atomization is suitable.

It will be observed that by the coupling of the field forming rings at low or ground potential, the effective electrostatic field is primarily confined to a triangular band outlined by the focal point at the emitting aperture 32 and the perimeter of the rings 42 and 44.

The atomized material substantially defines a spherical angle of relatively small and accurately outlined dimensions so that the material may be predeterminedly confined to cover a desired area and to exclude deposition on areas which it may be found desirable to maintain clear. The electrostatic fields being primarily confined to the triangular band, as previously described, extraneous conducting elements have little if any effect on the accuracy of the emanating dispersion of coating material. The worker may operate to inspect the results without any hazard since the electrostatic field is confined within the triangular band, as described.

For purposes of covering or scanning an extensive surface and secure a more positive control, I make reference to Figure 1 illustrating the application of the electrostatic nozzle assembly shown in Figure 2 wherein there is disposed over the conveyor 10 guide tracks 50, over the upper edges 51 of which there is guided the supporting head 52. The guide tracks 50 include depressed portions 53, the terminal edges of which 54, 55, extend predeterminedly with relation to the length of the pans 11. The tracks 50 have lower edges 56 which are in parallelism to each side of the terminal portions 54 and 55. Between the terminal portions 54 and 55, the edge 57 has a rise, for purposes which will appear herebelow.

The supporting head 52 carries the conduit 20 by means of the spaced arms 58. Rollers 59 are adapted to ride over the edges 51, alternately to position the support along the edges 51 or depressed portions 53, thereby raising or lowering the supporting head 52 with it. Oscillating means (not shown) guide the head to or from the raised or lowered positions.

The supporting head 52 has its lower branches 60 affixed to the conduit 20, previously described. The free end of the shaft 24 is coupled through the housing 61 to a driving motor 62. The housing has a collar 63 which is maintained spaced from a flange 64 on the conduit by an expansion spring 65, which tends to maintain the control cone 29 in the closed position.

The housing 61, has an arm 66, ending in a follower roller 67 arranged to engage the lower edge 56 and the rise 57 of the guide tracks 50, thereby cyclically to close the aperture 32 at each extreme end of the throw of the supporting head. Thus, in addition to rotation of the shaft 20 during reciprocation of the supporting head 52, the aperture is predeterminedly closed until the head lowers the atomizing assembly within the pans 11, at which point the rise 57 opens the control cone for a predetermined distance.

The conduit 20 is connected through the line 21 to a source of the liquid. In the illustration a tank 68 is the source of the liquid depanning compound or grease, maintained under a predetermined pressure head by the pump 69, assuring a flow of liquid into the conduit 20. While pressure feed is shown, gravitational feed of the depanning compound or like material may be employed, it being understood that the pressure head selected is merely sufficient to feed the liquid to a point adjacent

the apertures 32. Neither the pressure head nor the speed of rotation is intended to eject any fluid, it being the intention by the procedure outlined to electrostatically draw out and atomize the liquid at the aperture 32.

Further control of the distribution in timed relation to the surface scanned is effected to discontinue the projection of the atomized coating material by periodically grounding the liquid in the distributing head and the upper and lower field rings 42, 44. This I accomplish by the limit switch 70.

The limit switch has a solenoid 71, actuating a spring-biased switching lever 72 made of insulating material but carrying a conductor tip 73 which may alternately be brought into engagement with the contacts 74 and 75. The conductor tip 73 has a conductor 76 leading through a flexible lead 77 which is joined to the high voltage line 37, leading to the liquid within the conduit 20.

The contact 75, through the conductor 78, is tapped into the high voltage line 38. The contact 74, through the conductor 79, is coupled to the ground line 45, which in turn is connected to the supports 41 and upper and lower rings 42 and 44 through the conductors 43.

The guide rails 50 adjacent the terminal points 54 and 55 carry switch contacts 80 and 81. These contacts, through the leads 82 and 83, are coupled to the solenoid 71 by the circuit line 84 and 85.

Thus it will be observed that as the supporting head 52 moves from one extreme portion along the rails 50, it will activate the switches 80 and 81, which in turn will operate the solenoid 71. As the head passes to each side of the terminal portions 54 and 55, the solenoid will be activated to bring the arm 72 in position to engage the contact 73 with the contact 74 and thereby short the liquid in the atomizing nozzle with the rings 42 and 44, immediately shutting off the supply of atomizing fluid.

As the supporting head moves within the distance between the terminal portions 54 and 55, the solenoid is activated to throw the lever arm into engagement with the contact 75 and alternatively activate the liquid in the channel 33 and cause its atomization in the manner described. Thus, quick starting and stopping of the flow of the atomized fluid is secured.

While I have shown and described an atomizing assembly in which the upper and lower field forming elements 42 and 44 are rings joined by the supporting conductor 43 at the periphery, which may periodically accumulate or collect the projected atomized fluid therein, to require periodic cleansing to prevent objectionable dripping, I may completely eliminate the peripheral support by the conductors 43. For this purpose, I refer to the embodiment diagrammatically illustrated in Figure 4.

In this construction, the insulator 60a corresponds to the arms 60 for supporting the insulated conduit 20a as in the prior embodiment. The rotatable motor driven shaft 24a of insulating material carries at its lower end a lower electrode ring 44a, electrically connected to the disk 42a by the conductor 43a. The insulated shaft 24a not only supports the lower disk 44a but also the control cone 29a, corresponding to the control cone of the prior embodiment. The control cone 29a is made of insulating material whose periphery 31a is in opposed relation to the sharply pointed perimeter 23a of the distributor 22a.

As in the prior embodiment, the perimeter 31a extends slightly beyond the edge 23a. The distributor 22a is made of insulating material. The frusto-conical annulus 35a carries a charging surface 36a which is coupled to the conductor 37a of the high voltage or high potential side of the power supply, the conductor 37a being maintained in insulated relationship by the walls of the conduit 20a and distributor 22a, which are of insulating material.

Suspended from the supporting arm 60a are a pair of insulators 41a, which support the upper field ring or disk 42a. The ring or disk 42a is electrically connected

through the conductor 43b, which is guided through the insulator 41a to the ground potential or ground lead 45a, as is the conductor 43a.

As in the prior embodiment, the conduit 20a is connected to a source of liquid through a line 21a to couple the same with the circumferential channel 27a and provide the liquid to the conical annulus 33a. The internal wall of the distributor 22a in this instance may, adjacent its perimeter, be formed with a wall 35b in parallelism with the upper surface 34a of the control cone 29a in order that more effective sealing surface may be secured when the control cone 29a is brought into contact with the rim 23a.

In this form of the embodiment, operation may be followed as in the prior form. However, the atomized particles which are projected from the field will have an unobstructed path and, therefore, provide a uniform, drip-free discharge.

By the use of the rings for the low potential of ground electrodes 42a and 44a, a constant pattern of the fields is more uniformly maintained, to assure with greater precision, the projection of the atomized particles in a predetermined pattern, and thereby be able to limit the point of application on the pans and avoid deposition in the areas of the pans desired to be maintained clear.

It is to be understood that while some desirable benefits are secured by the atomization about the small spherical angle furnished by the frusto-conical and conical distributor, rotation of the closure control cone 29, especially where this member has its rim slightly extending beyond the rim of the complementary rim of the distributor, the location of nodules or cusps during electrostatic atomization is distributed peripherally to secure a more uniform flow to the edge by the distributing rotary force.

A variety of liquids, from low to high viscosity materials, may be employed, including dispersions or colloidal suspensions of materials in both solid and liquid phase, to assure that electrophoresis, which may be set up, will break up the particulate matter, providing uniformity of distribution of the atomized fluid. The relatively close positioning of the complementary rims 23 and 31 or the corresponding elements in the other embodiment makes this assembly particularly desirable in the handling of colloidal suspensions, thereby preventing clumping, clogging, coalescing and non-uniform distribution.

Furthermore, the relative movement of the distributing cone and stationary, complementary rims provides a certain amount of turbulence initiated by the relative motion of the edges. This promotes the random formation of the nodules and cusps as well as their obliteration, thereby to result in a more uniform distribution spacially of the spray within the spherical angle of the projected and atomized liquid.

It will be observed that while I have described and illustrated a scanning of extended areas of articles to be coated, such as the internal surfaces of pans, by relative movement of the atomizing assembly bodily into along and out of the pans, it will be understood that scanning of the surface for distribution of the projected liquid may be accomplished by my construction by imparting motion to the field forming surfaces as controlled by the upper and lower field electrodes 42 and 44, or the upper and lower disks 42a and 44a. Such motion may be in the horizontal plane eccentrically directed with respect of the vertical axis or by limited reciprocation in a vertical plane, while concentrically maintaining the rings or disks, or by a combination motion or rotation, vibration, oscillation or bodily translation. This relative movement is intended to change the direction of projection caused by the electrostatic fields with respect to the nozzle aperture as the focal point and thereby change the angle at which the atomized particles are discharged, it being understood that rotation of the nozzle about the vertical axis so that the projected particles or spray thereof from each nodule or cusp traces out a circle which generates uniform cover-

age by the overlap thus provided. This rotation may be used without vertical translation, particularly where flat pans or tins are to be coated.

By the method which has been described by me, a substantially hazard-free installation is secured in that by closely spacing the field-forming electrodes, in the form of rings or disks, to each side and adjacent the edge of the nozzle, the surrounding area is a field-free atmosphere or zone, permitting the assembly to be inserted on the interior of vessels, such as the pans previously described.

Furthermore, since the field-forming members, in spaced relationship as described, are maintained at ground potential or substantially so, there is no problem created by the nature of the article to be coated—whether it is made of electrically conducting or non-conducting material. The shapes of the articles to be coated create no problem in connection with the electrostatic fields and their configuration may be smooth or sharp-pointed, interrupted or continuous, as their coating by the atomized particles is effected due to the initial momentum occasioned by the resultant forces which generates atomization and guides the particles rather than by any electrostatic deposition between the discharge edge and an electrode or the article to be coated.

It is to be understood that the magnitude of deposition of the atomized liquid is dependent upon the degree of scanning of the projected particles so that the article, in accordance with the invention, is coated when its surface is faced toward the projected particles and lies in the path of movement of the atomized material.

While I have shown and described in the embodiments illustrated in Figures 2 to 4 a distributing control cone having a smooth peripheral edge, I may augment the control of the distribution of this member by outlining the edge, particularly that overhanging the peripheral edge 23 or 23a, to provide a serrated edge. This form of construction serves to form the distributed film to outline it into points of concentration, thereby fixing the spray nodules or cusps which have been described.

Such construction is illustrated in Figures 6 and 7 where the distributing cone 29b is shown in detail, isolated from the complete assembly which may otherwise be used in its relationship.

In these figures, the peripheral edge 31b is formed with serrated point-outlining edges 31c, simulating saw teeth.

While I have shown and illustrated in Figures 2 and 4 a closure control cone 29 and 29a, the base of which is flat, I may, particularly in the handling of viscous fluids, provide the surface 30b to be generally conical in outline, with the lowest point adjacent the periphery, thereby minimizing any creeping influence in the direction of the axially supporting member 24b.

The foregoing embodiment has the additional advantage of equalizing the distribution of the atomized material from the distributing edge. This type of construction has particular value in the handling of viscous fluids, dispersions, and materials which tend to clump or coagulate.

It will be further understood that where, in the claims, I mention a "field-free" space, I mean to include thereby an electrostatic field of such low magnitude that the direction of movement of atomized particles therein is not substantially altered by such field and shock hazards are absent.

It will also be apparent that by the method described and the apparatus disclosed, the article to be coated is at no time part of the field and is not in a position between the discharge edge and another receiving or deflecting electrode, nor is the article to be coated part of an electrostatic field-forming component so that at no time is there believed to be a dangerous electrostatic deposition of the atomized particles. The absence of an electrostatic field or electrostatic depositional projecting influence permits of spraying of any interior of any container-like article and permits close contact with the

rings or field-forming members, without hazard and without regard to the electrical conductive or non-conductive qualities of the article to be coated.

Having thus described my invention and illustrated its use, what I claim as new and desire to secure by Letters Patent is:

1. In an electrostatic atomizing assembly for the deposition of liquid on an article maintained in a substantially field-free space, in combination, a liquid control conduit of insulating material having means for supplying low pressure liquid thereto, a discharge head comprising a frusto-conical distributor head merging into a sharply pointed perimeter, a rotatable insulated closure for said head comprising a control cone having a sharply edged base, which base cooperates with the sharply pointed perimeter of said distributor head, thereby to provide a substantially circularly edged film forming aperture when moved to a spaced position, grounded electrode means comprising field-forming members closely adjacent said base, each supported to opposite sides of said head and means to connect the liquid to a source for creating a pair of electrostatic fields between said head and said grounded members for atomizing the liquid adjacent said edge, the atomized particles being guided to and between said members to pass substantially entirely into a field-free space, the field-forming members being closely spaced to said head, thereby providing a substantially field-free zone about said members and between the same and the article to be coated.

2. An electrostatic atomizing nozzle assembly for use in coating of liquid upon a surface of an article comprising a rotatable insulated discharge member having a controlled liquid aperture and a distributing edge forming a continuous film, and means to connect said film forming edge to an electrostatic source for electrostatically charging the liquid, grounded electrode field-forming means mounted on and axially carried by said insulated discharge member closely spaced to and on opposite sides of said discharge edge to provide an electrostatic field between and divergent from said edge as the focal point and the said grounded means electrostatically to atomize the film and discharge the same divergent from said grounded means, the atomized particles being projected substantially entirely between and to one side of said field-forming electrode means into a field-free space, within which space the article to be coated is maintained.

3. An electrostatic atomizing nozzle in accordance with claim 2 wherein said discharge member comprises a frustum of a cone having a sharp base cooperating with a complementary, conical closure rotatably mounted in respect of each other.

4. An electrostatic atomizing nozzle in accordance with claim 2 wherein said discharge member comprises a frustum of a cone having a sharp base cooperating with a complementary, conical closure rotatably mounted in respect of each other, one of said conical members being extended to provide a cusp supporting area.

5. An electrostatic atomizing nozzle in accordance with claim 2 wherein said discharge member comprises a frustum of a cone having a sharp base cooperating with a complementary, conical closure rotatably mounted in respect of each other, one of said conical members being extended to provide a cusp supporting area, said area being less than one tenth the distance from the edge of said discharge member to said field members.

6. In an electrostatic atomizing assembly for the deposition of dispersible material on an article maintained in a substantially field-free space, in combination, a dispersible material control conduit of insulating material having means for supplying low pressure liquid thereto, a discharge head comprising an annular frusto-conical distributor head merging into a sharply pointed perimeter, a nesting closure of insulating material for said head comprising a control cone having a sharply edged base,

which base cooperates with the sharply pointed perimeter of said distributor head, thereby to provide a substantially circularly edged film forming aperture when moving to a spaced position, means for rotating said cone, grounded electrode means carried by said head providing field-forming members, each supported to opposite sides of said head and adjacent thereto and means to connect the liquid to a source for creating electrostatic fields between said head and said members for electrostatically atomizing the liquid film adjacent said edge, the atomized particles being guided to and between said grounded electrode members into a field-free space, the field-forming members being closely spaced to said head, thereby providing a substantially field-free zone about said members in the space between said members and the article to be coated, and switch means selectively electrically to connect the field members and film, selectively to interrupt the atomization by said source whereby interruption of said atomization may be effected independently.

7. An electrostatic atomizing nozzle assembly for use in coating dispersions of dispersible material upon a surface of an article comprising a discharge member of insulating material having means for connecting the same to a supply of said dispersible material and means to discharge the same, said last means comprising a frusto-conical distributor of insulating material, a rotatably mounted closure therefor comprising a control cone of insulating material having peripheral edges separably contacting said distributor to provide a controlled aperture about said distributor and form said material into a continuous film, grounded ring shaped field pieces of surface conducting material surrounding and to each side of said distributor and spaced therefrom, means for creating electrostatic fields adjacent to said distributor and between said distributor and said ring-shaped pieces, said field pieces being each provided with grounding means and being spaced in a position between said discharge head and said article to be coated to provide distribution of atomized material entirely between said rings into a field-free space and means to support the article to be coated maintained faced toward said distributor in said space.

8. An electrostatic atomizing nozzle assembly for use in coating dispersions of dispersible material upon a surface of an article comprising a discharge member of insulating material having means for connecting the same to a supply of said dispersible material and means to discharge the same, said last means comprising a frusto-conical distributor, a rotatably mounted closure therefor comprising a control cone having peripheral edges separably contacting said distributor to provide a controlled aperture about said distributor, ring shaped field pieces of conducting material surrounding and to each side of said distributor and spaced therefrom, means for creating electrostatic fields between said distributor and said ring-shaped pieces, said field pieces being each provided with grounding means and being spaced between said discharge head and said article to be coated to provide distribution of atomized material between said rings into a field-free space where the article to be coated is maintained faced toward said distributor, said control cone being formed of insulating material and has an axial support extended therefrom axially supporting one of said grounded field pieces.

9. An electrostatic atomizing nozzle assembly for use in coating dispersions of dispersible material upon a surface of an article comprising a discharge member of insulating material having means for connecting the same to a supply of said dispersible material and means to discharge the same, said last means comprising a frusto-conical distributor, a rotatably mounted closure therefor comprising a control cone having peripheral edges separably contacting said distributor to provide a controlled aperture about said distributor, ring shaped field

pieces of conducting material surrounding and to each side of said distributor and spaced therefrom, means for creating electrostatic fields between said distributor and said ring-shaped pieces, said field pieces being each provided with grounding means and being spaced between said discharge head and said article to be coated to provide distribution of atomized material between said rings into a field-free space where the article to be coated is maintained faced toward said distributor, said control cone being formed of insulating material, and has an axially positioned support extended therefrom, to which support one of said field pieces is mounted, said support being an insulator and through which the field piece is grounded, leaving the peripheral edges unobstructed.

10. Apparatus for applying atomized liquid coatings to an article comprising a nozzle head of insulated material having, in combination, a liquid receiving conduit axially supporting a rotatable insulated distributor comprising sharp edge cooperating members providing a closure for the conduit to define a sharp edge circumferential film forming aperture about said distributor, the distributor serving to distribute the liquid in a continuous film adjacent the aperture, a grounded field forming member insulated from said aperture and carried by the distributor to one side of said aperture and adjacent thereto and spaced outwardly therefrom, means electrostatically to charge the liquid film flowing to said aperture to provide a divergent electrostatic field between said film at said aperture and said grounded member, with the said aperture as the focal point of the field, electrostatically to atomize the liquid, the resultant stresses of said field guiding the atomized particles to pass said grounded member into a field-free space beyond said grounded member and means to support the article to be coated to receive said coating in said field-free space.

11. Apparatus for applying atomized liquid coatings to articles comprising an insulated nozzle head for a liquid supply conduit having, in combination, a frusto-conical distributor terminating in a sharply edged base cooperating with an axially supported, insulated rotatable control cone forming a closure for said sharp-edge base, thereby to provide a substantially circularly edged continuous film forming aperture, means electrostatically to charge the liquid flowing to said film forming aperture and grounded, spaced field forming electrode members mounted axially closely adjacent said base and on opposite sides of said aperture and carried by said distributor to provide an electrostatic field between said aperture and said grounded electrode members, electrostatically to atomize the liquid and to project the same divergently past said members, the atomized particles being guided between said grounded field forming electrode members to move in a substantially field-free space and means to support the article to receive said coatings in said substantially field-free space.

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