

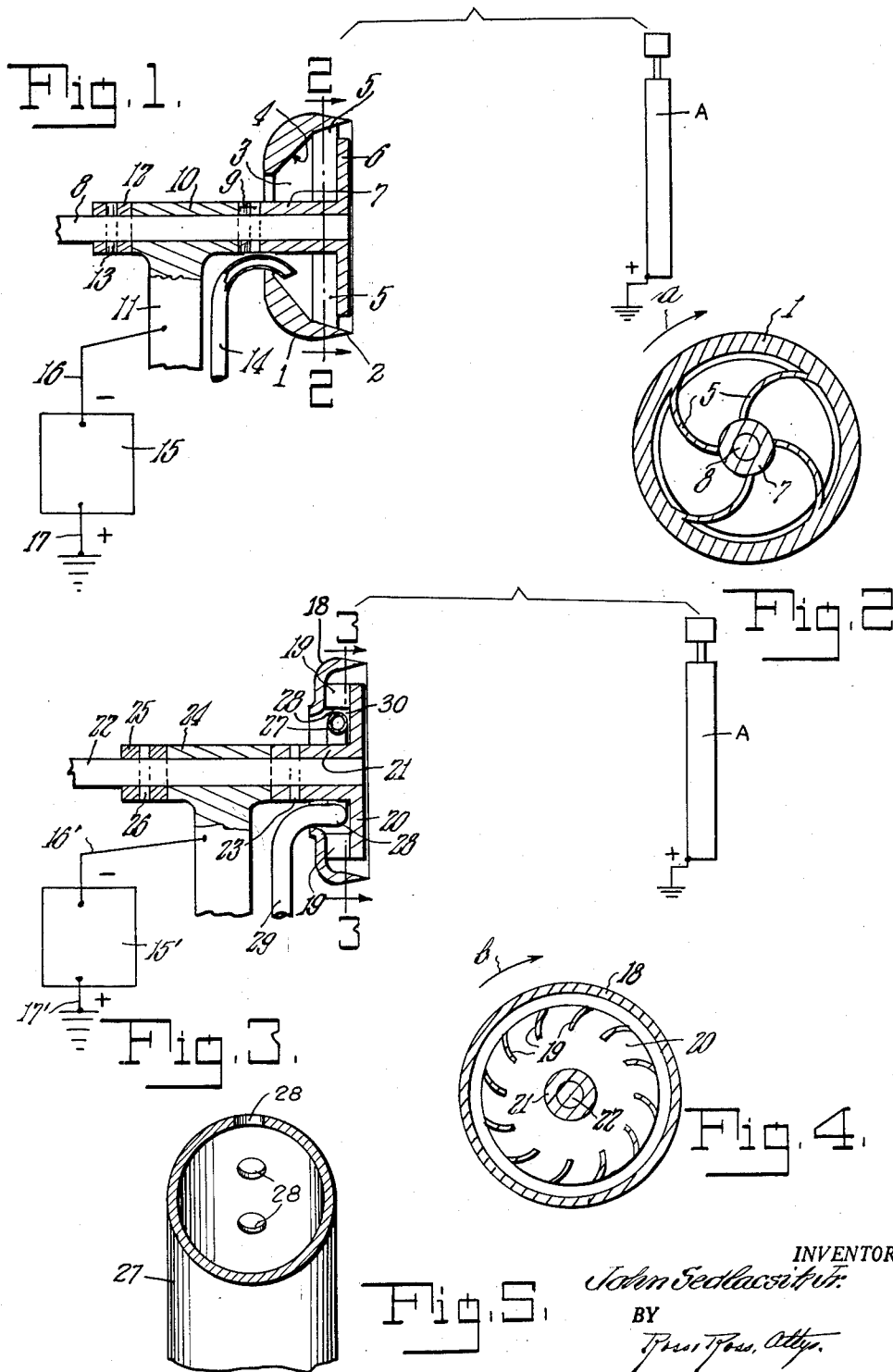
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ELECTROSTATIC ATOMIZING HEAD

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ELECTROSTATIC ATOMIZING HEAD

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2 Claims. (Cl. 239-15)

This invention relates to new and useful improvements in coating, and more particularly, to coating apparatus and coating methods for use in electrostatic coating systems.

Specifically, this invention relates to a method and means for applying an atomized aerated ionically dispersed coating fluid or material to an article to be coated, by electrostatically charging and depositing particles of the atomized material upon the article within a high potential field between the article to be coated and the atomizing head, wherein air is intermingled with the particles being blown toward, and attracted by, the article to be coated.

The atomizing head or shell is provided with a concentric cavity and tapers outwardly to a peripheral edge. Means is employed for supplying fluid coating material into the apex end of the shell whence, due to centrifugal force occasioned by the rotation of the shell, the coating material covers and flows over the annular inner surface of the shell towards the peripheral edge from which it is centrifugally atomized into the form of a mist, atomizing being effected by the discharge of the material over the edge. A high electrical potential for creating a corona discharge is directly connected to the atomizer head but may be coupled electrically by an electrode means in any arrangement, such as by an annular conducting ring adjacent the atomizer, whereby the particles of the pre-atomized material are electrically charged and propelled towards the article to be coated, which articles are of an opposite polarity to that of the charged particles.

In the prior art of electrostatic coating, no direct means is employed to initiate the movement of the mist toward the article to be coated, other than the mutual attraction of oppositely charged elements, that is, the fluid and the article to be coated. This invention incorporates means whereby a stream of ionized air accelerates the spray in a well defined and uniform pattern.

The foregoing and other objects and advantages of the invention will appear more fully hereinafter from a consideration of the detailed description which follows, taken together with the accompanying drawings wherein several embodiments of the invention are illustrated. It is to be expressly understood, however, that the drawings are for the purpose of illustration and description, and are not to be construed as defining the limits of the invention.

In the drawings:

FIG. 1 is an axial section of one form of apparatus embodying this invention;

FIG. 2 is a section at 2-2 of FIG. 1;

FIG. 3 is an axial section of another form of the apparatus embodying this invention;

FIG. 4 is a section at 3-3 of FIG. 3; and

FIG. 5 is a detail transverse fragmentary sectional view of the manifold shown in FIG. 3.

In the following description and claims, various details will be identified by specific names for convenience. The names however, are intended to be as generic in their application as the art will permit.

Referring to the form of the invention, disclosed in FIGS. 1 and 2 of the drawings, the atomizing head essentially consists of a conical electrically conductive shell 1, for receiving coating material and discharging the same therefrom toward an article A to be coated.

The shell is shaped to eliminate all unnecessary points and corners to attain maximum effective corona discharge at its fluid ejection edge 2 at the front of the shell, the edge being preferably, in one form, a knife-edge to concentrate the corona discharge at this edge, when a high electrical potential is applied to the edge, as hereinafter more fully described.

As the material is discharged from the head over the edge 2, it is atomized into a mist with particles thereof being electrically charged at one polarity for attraction toward the article A, which is of an opposite polarity.

The rear of the shell forms an annular chamber 3 having an outwardly tapered surface 4, terminating at the junctions of vanes 5, forming part of shell 1 and hubbed flange 6. The hub portion 7 of flange 6 extends through an opening formed in the rear wall of the shell and is keyed to shaft 8 by pin 9. Shaft 8 is journaled in bearing 10, and its bracket 11 is extended to be fastened to a suitable stand, not shown. A retaining collar 12 is keyed to shaft 8 by pin 13 to keep the whole rotating assembly from axial displacement.

Shaft 8 is suitably coupled to a variable speed motor, not shown, which motor imparts rotation to the shell and its associated members, in the direction shown in FIG. 2 by the arrow a.

Inserted through the space or opening between the inner edge of chamber 3 and hub 7 is a fluid material conduit 14 terminating inside of chamber 3 and through which the coating material or fluid may be injected.

One terminal of the high potential direct current supply 15 is connected to bearing bracket 11 through conductor 16, and the opposite pole terminal is grounded to the conveyor system through conductor 17, the article A to be coated being connected to and carried by the conveyor system and thus grounded as diagrammatically illustrated.

Conduit 14 is connected to a suitable coating fluid supply, with appropriate means to control the flow rate of the fluid into the chamber 3. The flow rate depends upon the viscosity and type of the fluid, and the rate at which it can be efficiently ionized, to obtain optimum operation.

In operation, the shell is rotated preferably at the rate of 3000 to 50,000 r.p.m., or higher, depending upon the physical dimensions of the shell selected for a given area to be covered and the type and specific gravity of the coating fluid and the viscosity thereof. The shell is charged with a high potential voltage of one polarity, and the article to be coated with the opposite polarity, thus creating an intense electrostatic field between them. As the shell, which may be regarded as a discharge electrode, rotates, the fluid, which is injected by any suitable pressure means or pump means through conduit 14 into chamber 3, is picked up by the outwardly tapered surface 4 and is conveyed by centrifugal force against the vanes or accelerators 5, to be accelerated by said accelerators and urged against the inner surface of the shell and forced through the gap between the shell and the outer periphery of flange 6, together with a volume of air expelled also by vanes 5. The effect of centrifugal force flattens the fluid into a smooth thin film and, due to the outward forwardly taper, causes the film to move toward the annular discharge edge 2 and be discharged and centrifugally atomized therefrom tangentially or normal to the axis of the atomizer head, the particles of the material thus atomized being electrically charged in a zone adjacent the annular discharge edge by reason of the corona effect or discharge. The material is thus atomized into a mist or a cloud of finely dispersed similarly charged mutually repelling particles, which are drawn towards the oppositely charged article A, which constitutes a collector

electrode, it being noted that additional impetus is given to the dispersed particles by the out-streaming air emerging from the shell.

The pattern of the comminuted stream partly impelled by the out-rushing air may be controlled by the rate of rotation of the shell, the rate of flow of the coating fluid fed into the opening of the intake end of the shell, the number of accelerators or vanes in the shell, the intensity of the electrostatic field, and the distance between the opposing electrodes. All these may be varied to obtain maximum coverage with the desired uniformity and thickness of coating applied to the article.

Referring to the form of the invention disclosed in FIGS. 3 and 4 of the drawings, the shell 18 conforms to the shape of the shell 1 heretofore described, and is formed, at its coating fluid or material intake end, with an inwardly projecting annular flange perpendicular to the axis, to which the rearward edges of impeller vanes 19 are fastened, to provide an annular space between the radially outer edges of vanes 19 and the inner surface of shell 18. Fastened to the axially forward edges of vanes 19 is a hubbed flange 20, of which hub 21 receives shaft 22, keyed by pin 23. Shaft 22 is journaled in bearing 24 and is held against axial displacement by collar 25, keyed to the shaft by pin 26. Shaft 22 is coupled to and rotated by a suitable motor, not shown. The radially inside edges of vanes 19 terminate inwardly of and out of the confines of the opening at the rear end of the shell, to form an annular space 30 for accommodating an injection manifold 27 supported by and being part of conduit 29. Manifold 27 is in the form of an annular tube provided with a plurality of orifices 28 radially disposed toward the inner edges of impeller vanes 19, as shown in FIG. 5.

One terminal of the high potential direct current supply 15' is connected to member 24 through conductor 16', and the opposite pole terminal is grounded to the conveyor system through conductor 17', the article A being grounded through the system as shown in FIG. 3.

Various devices, which may be in the form of a cone-type atomizer head or a disc-type atomizer head, have been utilized. The diameter of the annular atomizing edge of the discs has been varied from approximately 1" to 30". The form of the impellers may be varied, depending on the ingredients and viscosity liquid coating material applied and the particular results desired. Further, the number of accelerators or vanes in the shell may be positioned for a particular function, since the accelerators may be in the form of vanes and may have one or more functions. For example, the accelerator may be employed to generate a draft of air for causing a flow outwardly or axially of the atomizer head, so that any stagnation or restriction of particle circulation at the center area of the atomizer head will be activated and urged forwardly, generally in the direction of the lines of formation of the electrostatic field, between the atomizer head and the article or object to be coated. The accelerators normally impinge the paint and cause the paint to be rotated at a speed which would be substantially the same as the speed of the peripheral edge or atomizing edge of the atomizer head. However, preferably in the larger diameter of the atomizer head, the accelerators or vanes may be appreciably closer to the atomizer head than the peripheral or discharge edge of the atomizer head. At high rates of speed, the accelerators are vitally important for the purpose of physically moving the paint about the axis, which causes a greater shearing of the particles of paint, so that there is a reduction in the particle size. By utilizing the accelerators in the arrangement indicated, the accelerators will cause the paint to move at substantially the same speed as the peripheral edge of the atomizer. The angle of divergence of the opposed side of the atomizer head, along an axial cross-section thereof, may determine, in great part, the condition of the coating material projected or atomized.

Normally, if the shell is rotated at higher speeds approaching 20,000 to 50,000 r.p.m., then less voltage is required to charge the particles, which facilitate deposition of the charged particles onto the surface of the article to be coated. If a stipple or spattered finish is desired, a lower speed or r.p.m. of the atomizer head is employed, so that there will be less atomization due to the action of the accelerators or vanes, as they operate to move the coating material, when the atomizer head is rotated. If an extremely fine finish is required, the high r.p.m. of the device is utilized. Accelerators employed in the discs at higher speed prevent "slugging" or throwing off of the predominantly larger particles. While the atomizer head is shown to be directly charged as in the present arrangement, it is to be understood that an annular discharge ring, having sharp edges or points, may be used exteriorly of the atomizer head for charging the particles. The atomizer head may be non-metallic or made of partially conducting material, and used in conjunction with a charging element, such as a ring, or the atomizer head may be made of metal or semi-conducting material and charged directly.

The size and physical characteristics of the accelerators or vanes may be such as to create an air flow having appreciable velocity, so that the coating material may be at least partially caught in the air stream of the forwardly projected air particles moved by the air flow, so that there will be greater penetration of the particles into the cavities of the surface irregularities of the article to be coated. Accordingly, the higher the r.p.m., the greater the draft or forward velocity of the air flow to improve the penetration into the surface irregularities of the articles to be coated.

In operation, the shell or discharge electrode is rotated in the direction indicated by the arrow *b* in FIG. 4, in one form of the invention, and the coating fluid is injected through orifices 28 into the intake zone of vanes 19. The injected stream of coating fluid or coating material is broken up, and accelerated to be expelled against the inner wall of the shell 18 and subsequently discharged over the annular discharge edge 31, the result being substantially the same, as described, in reference to FIGS. 1 and 2.

In practicing this invention, there is provided a discharge element or atomizing head having an annular discharge edge, means for feeding a source of liquid coating material to the atomizing head, accelerator means having a multiplicity of different surfaces and disposed in the path of the liquid coating material for contact therewith and adapted to rotate the liquid coating material at a rotational speed similar to the rotational speed of the atomizer head, and preferably having radial dimensions somewhat less than that of the annular discharge edge of the atomizer head to move the paint or coating material outwardly or centrifugally toward the atomizer head for centrifugal atomization therefrom, and thereafter establish an electrostatic field between the atomizer head and the article to be coated for electrostatic deposition of the centrifugally atomized particles. The accelerators may be of any configuration or disposed in any arrangement so that they mechanically cause the coating material to be rotated substantially at the same rotational speed as the atomizer. In operation, after the accelerators bring the coating material up to the rotational speed of the atomizer head, the material is centrifugally thrown outwardly toward the atomizing edge to thin out the material. The thinning out of the material is accomplished by the force of centrifugal action so that the paint may, in many instances, depending on the rotational speed and configuration of the atomizer head, be thrown almost directly radially or outwardly from the atomizer head toward the articles. While one set of accelerators are shown at one axial position, more than one set of accelerators may be used positioned axially of the atomizer head. The accelerator may also be formed of curved blades to create air

turbulence and forward velocity when velocity is required for penetrating purposes to coat cavities, recesses, etc.

While there have been patents issued relying solely on electrostatic force for the atomization, it is particularly pointed out herein that many materials that may be used for coating cannot be coated by a process employing electrostatic atomization. For example, water-base paints ordinarily can not be used in the coating processes where electrostatic atomization is employed. Accordingly, this invention is directed to centrifugal atomization which will atomize coating materials regardless of their formulation. Therefore, it is stressed that the accelerators are quite essential for best results in centrifugal atomization in order to bring the rotational speed of the coating material up to substantially the same rotational speed as the peripheral edge of the atomizer head. The accelerators not only cause the paint to be moved at the same rotational speed as the atomizer head but also cause the paint to be broken up or atomized internally of the atomizer, particularly where the accelerators are spaced radially from the side wall of the atomizer head or where the hub portion or flange, such as 6 and 20, of FIGS. 1 and 3, respectively, cause the paint to be thrown radially outwardly by centrifugal force, against the side wall and causing atomization. While the axial length of the atomizer shell or atomizer head extends an appreciable distance beyond the edge of the hub or flange, such as 6 or 20, there have been utilized many versions where the axial length of the shell beyond the hub or flange is very small such as $\frac{1}{8}$ inch to $\frac{1}{2}$ inch. By making this axial length of the shell very small, the paint film centrifugally attained is exposed to the air for a much shorter period of time than it would be if the axial length of the shell were longer. Therefore, the accelerators actually move the paint rotationally and simultaneously break it up while centrifugal force permits the paint film which forms on the inner surface of the atomizer head to move only a very short axial distance before it is projected centrifugally in atomized form. Accordingly, with the accelerators being closely positioned relative to the atomizing edge, the formulation of the paint becomes far less critical. The plane of the atomizer edge of the atomizer head or shell is preferably between $\frac{1}{8}$ inch and $\frac{1}{2}$ inch axially beyond the plane of the accelerators.

Ordinarily, when high rotational speeds are used, it is not required that the edge of the atomizer head be sharp or knife-like, since the electrostatic force is used only to charge the particles which are centrifugally atomized and mechanically projected from the head perpendicular to the axis of rotation of the atomizer, while the electrostatic field bends the path of travel of the atomized particles generally axially of the atomizer, this general path of travel of the particles may also be controlled by the relative positioning of the articles to the atomizer.

If the voltage is applied to a grid ring or electrode around the atomizer head or conical head, instead of directly to the atomizer head, the article to be coated can be positioned much closer to the head of the centrifugal atomizer, thereby increasing the penetrating characteristics of the accelerated-centrifugal atomizer. A charged electrode or ring positioned rearwardly of the atomizer head, relative to the path of travel of the atomizer material, will also tend to shape or bend the particle paths forming the spray pattern toward the articles to be coated. The closer the charging ring is positioned to the front of the atomizer head or shell, the more the spray pattern is compressed in overall size and greater concentration of the paint particles is obtained in the center of the spray pattern.

The function of the accelerator fundamentally is to move the paint on the interior surface of the atomizer at substantially the same rotational speed of the atomizer head, so that the peripheral speed of the particles, as they are projected, are the same, or substantially the same, as the peripheral speed of the atomizer head. Without the

accelerators, the coating material would not attain the rotational speed of the atomizer head and consequently, the peripheral speed of the atomizer head would be much greater than the peripheral speed of the particles as they are projected. Accordingly, the function of the accelerators is to have the peripheral speed of the atomizer head substantially matching the speed of the particles at the peripheral edge of the atomizer head, since the peripheral speed of the coating material as it forms into moving particles as the particles are projected, determines the size of the particles. Accordingly, the basic function of the invention is to utilize accelerators to have the speed of the particles as they are projected from the atomizer head being substantially the same as the peripheral speed of the atomizer head, thereby utilizing air, accelerated and centrifugal force for atomization. The particle size is controlled by increasing or decreasing the r.p.m. of the atomizer head. The particle size decreases as the r.p.m. of the atomizer head increases, and the particle size increases as the r.p.m. decreases.

It is to be understood that accelerated atomization, air atomization or centrifugal atomization, or a combination thereof will pulverize or break up the coating material into microscopic or suitable size particles. Furthermore, the device is suitable for coating entirely in the absence of an electrostatic field, since the field is used preferably to create wrap-around of the coating material on the articles, and may be used for deposition of the particles when the article to be coated is not aligned to receive the particles as they are centrifugally projected. High rotational speeds are desired since materials such as water-base paints, porcelain enamel, etc. require use of extreme high speeds for fine atomization.

While several embodiments of the invention have been illustrated and described in detail, it is to be expressly understood that the invention is not limited thereto. Various changes may also be made in the design and arrangement of the parts without departing from the spirit and scope of the invention as the same will now be understood by those skilled in the art.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. Apparatus for centrifugal atomization of a liquid coating material having a pneumatically generated forward velocity toward the article to be coated and employing electrostatic force for deposition of the atomized liquid coating material upon the article comprising, a motor driven shallow cup-shaped atomizer head having an annular atomizing edge and having a centrally disposed opening in that end thereof opposite said atomizing edge, a fluid material conduit extending through said opening and terminating immediately inside said cup-shaped head, a hub mounted coaxially and internally of said atomizer head and extending through said opening and having a disc-shaped radially extending flange and spaced centrifugal impeller-type accelerators disposed circumferentially symmetrically thereon for generating an air current internally of said hub to provide a forward velocity of air and of coating material atomized by said atomizer head and to initially break up the liquid coating material and rotate same at a speed similar to the rotational speed of the atomizing edge to increase the shear action of the liquid coating material as it is emitted from the atomizer head to control the atomized particle size, the plane of the front face of the hub flange being disposed a distance of substantially between $\frac{1}{8}$ " to $\frac{1}{2}$ " from the plane of the atomizing edge to control the time interval the liquid coating material travels so that the coating material remains on the surface of the atomizing head a minimum time after being accelerated centrifugally, and means providing an electrostatic field adjacent the peripheral edge of the atomizer to facilitate deposition of the coating material onto the article to be coated.

2. Apparatus for centrifugal atomization of a liquid coating material having a pneumatically generated for-

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ward velocity toward the article to be coated and employing electrostatic force for deposition of the atomized liquid coating material upon the article comprising, a motor driven shallow cup-shaped atomizer head having an annular atomizing edge, a hub mounted coaxially and internally of said atomizer head and having a disc-shaped radially extending flange and spaced centrifugal impeller-type accelerators disposed circumferentially symmetrically thereon for generating an air current internally of said hub to provide a forward velocity of air and of coating material atomized by said atomizer head and to initially break up the liquid coating material and rotate same at a speed similar to the rotational speed of the atomizing edge to increase the shear action of the liquid coating material as it is emitted from the atomizer head to control the atomized particle size, the plane of the front face of the hub flange being disposed a distance of substantially between $\frac{1}{8}$ " to $\frac{1}{2}$ " from the plane of the atomizing edge to control the time interval the liquid

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coating material travels so that the coating material remains on the surface of the atomizing head a minimum time after being accelerated centrifugally, manifold means having a plurality of apertures therein for injecting under pressure a plurality of streams of coating material about the axis of the atomizer head and on an inner surface thereof to be impinged by said accelerators, and means providing an electrostatic field adjacent the peripheral edge of the atomizer to facilitate deposition of the coating material onto the article to be coated.

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