

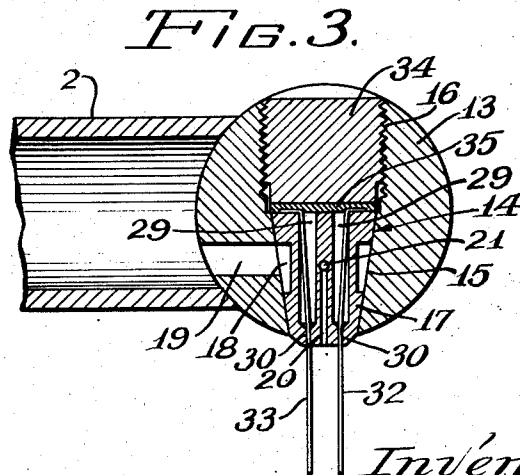
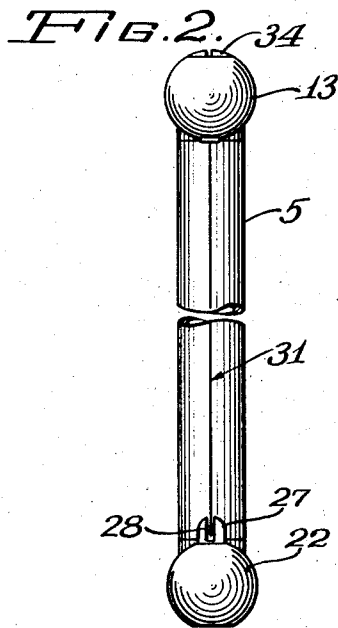
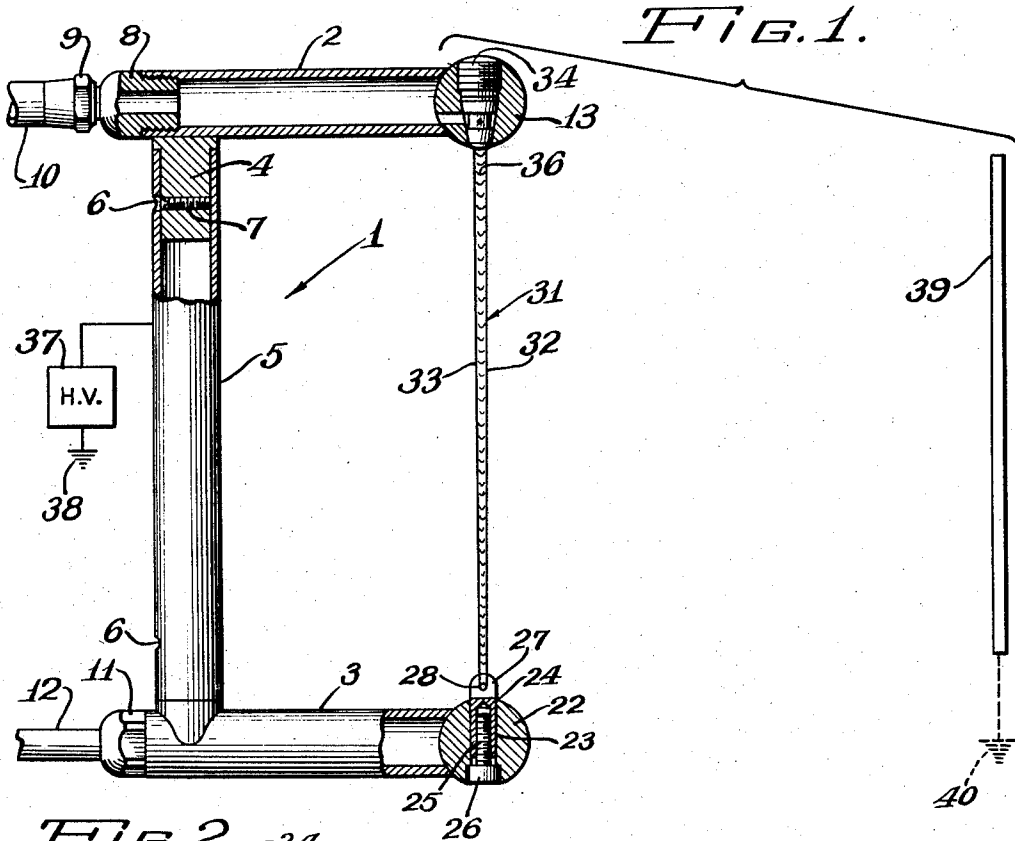
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ELECTROSTATIC COATING DEVICE

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ELECTROSTATIC COATING DEVICE

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This invention relates to improvements in the electrostatic atomization of paint or the like and the transport of the atomized paint by electrostatic means to an article to be coated.

Means and methods of coating articles by what is commonly referred to as "electrostatic spray coating" have heretofore been proposed. However, expedients heretofore proposed have not been entirely satisfactory, for a number of reasons among which may be mentioned, that the voltages found necessary to establish adequately the electrostatic field for atomizing and transporting the atomized material have been excessively high requiring expensive, highly insulated power equipment; with relatively high voltages the danger of arcing is enhanced requiring that the article being coated (usually comprising one of the electrodes) be disposed at a relatively great distance from the electrode of opposite polarity which results in critical control of uniformity of field strength over the entire area of the article to be coated and making uniform coating difficult of attainment.

Many of the difficulties and disadvantages of expedients heretofore proposed may be traced to inadequate and unsatisfactory means and methods of introducing and maintaining a supply of paint or other coating material in the electrostatic field. For instance, one method heretofore proposed contemplates introducing the coating material into the electrostatic field in a partially atomized condition by propelling the material into the field in company with high velocity air, or in introducing and dispersing the coating material into the field by centrifugal dispersing device or the like. In either case, the coating material particles have a component of velocity in the field which is contributed by an agency other than the field itself, said component bearing a varying relationship to the direction of the velocity component caused by the field and, hence, the article to be coated receives coating particles differing in velocity and the atomized mass moving toward the article differs in density. In addition, in many instances the velocity component contributed by the air or centrifugal device may completely overpower or neutralize the velocity component caused by the field in which case many of the particles of coating material completely miss the article and represent waste.

In other cases the material is introduced into the field in non-uniform fashion, that is, in increments which are non-uniform in volume or mass which results in a non-uniform coating since in some instances a predetermined area of the article to be coated receives coating material literally in gobs and other predetermined areas of the article may receive no coating material at all or the coating deposited thereon may be extremely thin or attenuated.

As a feature of the present invention liquid coating material may be introduced into an electric field in a substantially uniform manner both as to quantity per unit of time and as to shape or surface area exposed. In addition, the material moves into the field with a substantially negligible velocity component of its own, but yet

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enters the field and passes through the field in a guided manner, maintaining a substantially fixed spacial relationship to the article to be coated.

As an additional feature of the present invention articles may be uniformly and quickly coated by electrostatic means employing voltages materially lower than those heretofore deemed necessary.

A further feature of the invention resides in the reduction of the danger of arcing and at the same time the object to be coated may be spaced closer to the source of coating material resulting in a more effective use of propulsion of the electrostatic field and diminishing the possibility of the paint drying before it reaches the article to be coated.

Other objects and advantages of the present invention will be apparent from the accompanying drawings and following detailed description.

In the drawings,

Fig. 1 is an elevational view, partially diagrammatic and partially in section, illustrating a device embodying the concepts of the present invention.

Fig. 2 is a front elevational view of the coating device shown in Fig. 1.

Fig. 3 is an enlarged detailed sectional view of the upper wire-supporting portion of the coating device.

Referring in detail to the drawings, 1 indicates a substantially U-shaped frame which is constructed of an electrically conductive material such as metal. The frame 1 may be mounted upon a suitable support (not shown) and is insulated from said support. As will be hereinafter more fully described, the frame 1 constitutes one electrode of a pair between which an electric field is established and preferably comprises the high potential side of the circuit. Of course, if the frame comprises the low potential side of the system, it can be grounded and, hence, the other electrode, that is, the article being coated, being the high potential electrode, will be insulated from ground.

The frame 1 comprises a pair of spaced transverse tubular members 2 and 3, the upper and lower transverse member respectively. A cylindrical plug 4 is rigidly secured to the lower portion of the member 2 and a similar plug (not shown) is rigidly secured to the lower member 3. A connecting vertical tubular member 5 engages the upper and lower plugs in a telescopic fashion, the member 5 functioning as a spacing member between the tubular members 2 and 3. Adjacent the opposite ends of the member 5 said member is provided with apertures 6 into which set screws 7 may be threadedly positioned transversely through the plugs, the set screws functioning to secure the members 2, 3 and 5 as a rigid structure. It will be noted that the set screws 7 are confined within the tube 5, that is, they do not project exteriorly of said tube. It has been found to be preferable that the structure comprising the frame 1 have no sharp points or projecting edges or surfaces, for if such is the case, the field intensity increases to a detrimental degree adjacent such points, projections or the like and has a disadvantageous effect upon the coating operation performed by the device.

A threaded plug 8 engages with one end of the transverse tubular member 2 and connects with a fitting 9, the fitting 9 being carried at the end of a hose 10. The hose 10 at its end is connected to a source of paint or coating material under pressure (not shown) and such hose is preferably constructed of rubber or other insulating material. It is through the hose 10 that the coating device is supplied with its coating material.

A similar plug 11 is threadedly engaged with the lower transverse member 3, said plug being connected to a support 12 whereby the device 1 may be supported in desired position. As has been hereinbefore described,

if the device 1 comprises the highly potential electrode it will be insulated from its support.

A spherical ball 13 is carried at the outer end of the upper transverse tubular member 2, said ball being provided with a recess 14. The lower portion of the recess 14 is conical as indicated at 15 in Fig. 3 and the upper portion of said recess is provided with internal threads 16. A conical block 17 is adapted to be positioned in the lower portion of the recess 14, said block being provided with an annular groove 18. The spherical ball 13 is provided with a bore 19 which opens at one end into the interior of the transverse tubular member 2 and at its opposite end connects into the annular recess 18. The conical block 17 is also provided with a tubular bore 20 which is of relatively small diameter, said bore connecting at its upper end with a transverse bore 21. The transverse bore 21 opens at its opposite ends into recess 18.

The arrangement is such that paint or coating material introduced into the tubular member 2 through the hose 10 enters the bore 19 wherein its transferred to the annular recess 18 and thence to the bores 21 and 20. Hence, bore 20 constitutes the discharge bore which permits the introduction of the paint or coating material into the electrostatic field.

At the outer end of the lower tubular member 3 a spherical ball 22 is positioned. The ball 22 is provided with a bore 23 in which an internally threaded sleeve 24 is positioned. A screw 25 engages with the sleeve 24, head 26 of said screw being countersunk within the ball 22. The upper end of the sleeve 24 carries a lug 27 upon which a pin 28 is mounted.

The conical block 17 is provided with a pair of parallel bores 29, each of which opens into a relatively restricted bore 30, the bores 30 being spaced on each side of the discharge bore 20. In employing the present device a paint carrying member 31 is positioned between balls 13 and 22, said paint carrying member comprising essentially a pair of spaced wires 32 and 33. For convenience, the spaced wires 32 and 33 may comprise a single length of wire, the ends of which extend through the spaced bores 30 and into the parallel bores 29 in the conical block 17. The end portions of the wires are bent over the upper portion of the conical block 17 and are confined therein by a threaded plug 34 which carries at its lower surface a resilient member 35 which functions to anchor the ends of the wire upon the top of the conical block 17. The wire comprising the spaced strands 32 and 33 may be looped, intermediate its length, over pin 28 and by the proper manipulation of screw 25, said strands may be drawn taut.

It will be noted that the two strands 32 and 33 which project through the spaced bores 30 are disposed on opposite sides of the paint discharge bore 20. The arrangement is such, that when paint issues from the discharge bore 20 it flows downwardly along the wire strands 32 and 33, the viscosity of the paint or coating material causing said material to extend in a bridging fashion between the strands 32 and 33 as indicated diagrammatically at 36 in Fig. 1. It will also be noted that the strands 32 and 33 converge from bores 30 to the anchor pin 28 and hence said strands are spaced a greater degree at their upper portions than at their lower portions. The purpose of this arrangement will be hereinafter more fully described.

As has been hereinbefore described the device 1 preferably comprises the high potential electrode and hence said device may be connected to a conventional high voltage power supply 37, one side of which is grounded as shown diagrammatically at 38 in Fig. 1. The article to be coated is indicated diagrammatically at 39 in Fig. 1 and is spaced from and substantially parallel with the strands 32 and 33. The article 39, in the operation of the device, is also grounded as indicated diagrammatically at 40 in Fig. 1. Of course, if the article coated comprises the high potential electrode of the system, said

article would be connected to the power supply and the frame 1 would then be grounded.

Inasmuch as the device 1, including the transverse arms 2 and 3, vertical arm 5, the spheres 13 and 22 and the strands 32 and 33 are constructed of metal, said device when connected to the high voltage power source 37 is brought to a relatively high potential. It has been found that the potentials employed are preferably in the neighborhood of 25,000 to 30,000 volts although the voltage may be anywhere within the range between about 15,000 and 40,000 or higher. Hence, an electrostatic field is established between the device 1, particularly the strands 32 and 33, and the article 39 which is to be coated. The electrostatic field so established tends to atomize the paint or coating material carried on and between the filaments or strands 32 and 33 and tends to transfer said material as an almost invisible mist to the grounded article 39 thereby uniformly coating said article.

The pressure upon the paint or coating material discharged from the nozzle 20 is not sufficiently high to impart material velocity to the stream issuing from said nozzle and hence, the material thus discharged moves relatively slowly down the filaments 32 and 33, the surface tension of the coating material causing the material to flow downwardly along the surface of the filaments and also causing the material to bridge the filaments and form a web 36 between the filaments.

It will be noted that the strands or filaments 32 or 33 are spaced a greater distance from each other adjacent the sphere 13 than they are adjacent the sphere 22. It is desirable when utilizing the device that the entire length of the filaments carry paint or coating material. As the operation of the device proceeds, the paint or coating material is transferred from the filaments to the article 39 as the material moves downwardly along said filaments. Hence, the quantity of material carried by the filaments is progressively depleted as the lower end of the filaments is approached. Accordingly, it is desirable that a greater quantity of paint be carried by the upper increments of the filaments than is carried by the lower increments thereof and by spacing the filaments at a greater distance adjacent their upper ends this increased quantity of paint or coating material may be carried. Thus, the coating of the article 39 will be uniform from the top to the bottom of said article.

The spacing of the filaments 32 and 33 will depend in part upon the viscosity of the paint or coating material used since it is desirable that the web 36 be formed along the entire length of the filament. If the filaments are spaced too far from each other, said web cannot be formed or the formation thereof will be irregular throughout the length of the filaments. In other words, the filaments are preferably spaced a distance from each other no greater than that at which the web 36 ceases to be formed.

It has been found that for a predetermined spacing of the filaments and a predetermined field strength, if the rate of discharge of paint or coating material from the nozzle 20 is too great, the upper portions of the filaments will carry an excessively large volume of coating material which will be propelled toward the article 39 in a partially atomized condition resulting in a nonuniform coating upon the article. If, on the other hand, the rate of discharge of the paint or coating material from the nozzle 20 is too low, the desired web 36 may not be formed or all of the coating material will be propelled from the filaments to the article 39 before the coating material has traveled downwardly upon the filaments a desired distance. That is, the lower portion of the filaments may be entirely bare of paint or coating material.

If desired, a single filament may be employed instead of the spaced filaments 32 and 33 in which case the nozzle 20 will discharge coating material directly upon the upper end portion of the single filament and said material will move relatively slowly down the filament. Of course,

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the quantity of coating material delivered when one filament is employed is usually less than where two or more filaments are used. Where relatively heavy coatings are desired two or more filaments may be employed, being arranged in a desired spaced relationship to each other such that webs, similar to web 36, will be formed between adjacent filaments as the coating material descends the length of the filaments.

In one specific form of the present invention two filaments comprising steel wire of .014 inch in diameter were employed as the filaments 32 and 33. The frame 1 was connected to the high potential side of the current source 37 and the article 39 was grounded. The voltage employed was in the neighborhood of 25,000 volts, direct current. An industrial lacquer having a viscosity of 18 to 22 Zahn and a surface tension of 27 dynes per square centimeter was used as the coating material and the rate of discharge from the orifice 20 was 10 cubic centimeters per minute. The filaments 32 and 33 were 14 inches in length from ball 13 to ball 22 and were spaced $\frac{1}{8}$ inch apart at the top and $\frac{3}{32}$ inch apart at the bottom. It was found that the coating material bridged the wires 32 and 33 and said web extended downwardly along the entire length of the wires. The article coated comprises a square sheet of metal of about 400 square inches area and a coating of about .002 inch in thickness was deposited uniformly thereon in about 15 seconds after the electric field was established, coating material being charged upon the wires to establish an available mass of coating material throughout substantially the entire length of the wires before the field was established.

It is to be understood, of course, that the above example has been set forth merely for purposes of illustration and is not intended to be a limitation on the scope of the invention. In general, however, the voltage upon the system will preferably be in the neighborhood of 25,000 volts as opposed to voltages as high as 100,000 volts heretofore deemed necessary for electrostatic spraying. Although, in the example hereinbefore set forth, the article 39 was positioned about 10 inches from the filaments 32 and 33, said distance could be as small as 4 inches, a distances heretofore deemed impractical because of the danger of arcing.

When employing the present invention the flow of paint or coating material is preferably discontinued before the electric field is shut off and it has been found that the continued maintenance of the field removes substantially all of the residual coating material carried by the wires 32 and 33 thereby accomplishing, in essence, a self cleaning operation.

The source of current employed is preferably rectified direct current. Although this current is preferably filtered, no vibration of the wires 32 and 33 will take place if the wires are tensioned properly. By the manipulation of the screw 25, the filaments may be brought to a desired degree of tension and hence vibration thereof will not take place.

The device 1 is so constructed that physical features thereof may be changed by the substitution of readily available parts. For instance, if it is desired to shorten or lengthen the length of the wires 32 and 33 a separate tubular member may be positioned between the transverse members 2 and 3 in place of the tubular member 5. To make this replacement it is merely necessary to disengage the member 5 from the blocks 4 and substitute a longitudinal or shorter vertical tubular member. In addition, if a greater or lesser quantity of coating material is to be charged to the wires 32 and 33 a block 17 having a different diameter bore 20 may be readily inserted in the sphere 13.

The diameter of the filaments 32 and 33 has been found to be of importance in the atomization process since the field intensity adjacent said wires is an inversion function of their diameter. For instance, with a larger size wire a higher voltage would be necessary to develop the

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same field intensity for the purposes of atomization than would be required with a smaller diameter of wire.

If desired, a plurality of devices 1 may be employed as a coating bank past which the article to be coated may be carried upon a conventional conveyor such as is commonly used in the spray coating art. If a bank of devices 1 is employed the devices may be disposed in a horizontal row past which the article may move or if a relatively large article is to be coated the adjacent devices 1 comprising the bank may be staggered so as to completely embrace the surface of the article being coated.

It is apparent that the present invention contemplates an electrostatic spray coating device which is simple in construction and operation; employs relatively low voltages heretofore deemed unsatisfactory, and yet will perform a coating operation of such excellence as is substantially impossible of attainment by electrostatic coating devices heretofore proposed.

I claim as my invention:

1. A device for electrostatic spraying an article with coating material comprising a frame, a pair of vertically spaced portions on said frame, a pair of substantially vertically disposed wires tensioned between said vertically spaced frame portions, said wires being spaced from each other a relatively small distance and both being spaced from an article to be coated a relatively great distance, the plane including the axes of said wires being disposed transversely to the general plane of the surface of the article to be coated and the axes of said wires being substantially parallel to the general plane of the article being coated, means for depositing a flowable coating material upon the upper end portion of said wires to cause said material to flow downwardly along said wires and distribute itself upon the surface of said wires, said coating material bridging said wires in the form of a surface tensioned maintained film, a source of voltage one side of which is connected to said wires to charge said wires at the same potential and at a predetermined polarity and the other side of which is connected to the article to be coated to charge the same at an opposite polarity from the charge on said wires to establish an electric field between said wires and the article to be coated whereby the coating material carried on and between said wires is atomized and propelled in atomized condition into coating contact with the article to be coated.

2. A device for electrostatic spraying an article with coating material comprising a frame, a pair of vertically spaced portions on said frame, a pair of wires tensioned between said vertically spaced frame portions, said wires being spaced from each other a relatively small distance and being closer together at their lower portions than at their upper portions, both of said wires being spaced from the article to be coated a relatively great distance, the plane including the axes of said wires being disposed transversely to the general plane of the surface of the article to be coated and the length of said wires being substantially parallel to the general plane of the article being coated, means for depositing a flowable coating material upon said wires to distribute said coating material upon the surface of said wires, said coating material bridging said wires in the form of a surface tensioned maintained film, a source of voltage one side of which is connected to said wires to charge said wires at the same potential and at a predetermined polarity and the other side of which is connected to the article to be coated to charge the same at an opposite polarity from the charge on said wires to establish an electric field between said wires and the article to be coated whereby the coating material carried on and between said wires is atomized and propelled in atomized condition into coating contact with the article to be coated.

3. A device for electrostatic spraying an article with coating material comprising a frame, a plurality of wires tensioned between spaced portions of said frame, said

wires being spaced laterally from each other a predetermined distance, said plurality of wires being spaced laterally a greater predetermined distance from an article to be coated and with their lengths substantially parallel to said article, means for depositing a flowable coating material upon said wires to distribute said coating material upon the surfaces of said wires and bridging said wires with a film of coating material, a source of voltage one side of which is connected to said wires to charge said wires at a predetermined polarity and the other side of which is connected to the article to be sprayed to charge the same at an opposite polarity from the charge on said wires to establish an electric field between said wires and the article to be coated whereby the coating material carried by said wires is atomized and propelled in atomized condition into impinging contact with the article to be coated.

4. A device for electrostatic spraying an article with coating material comprising a frame, a plurality of wires tensioned between vertically spaced portions of said frame, said wires being spaced laterally a relatively great distance from an article to be coated and with their lengths substantially parallel to said article, said wires being laterally spaced a relatively small distance from each other, means for feeding a flowable coating material upon said wires at corresponding ends thereof, to dis-

tribute said coating material upon the surface of said wires, said adjacent wires being so spaced that coating material bridges adjacent wires in the form of a surface tension maintained web, a source of voltage one side of which is connected to said wires to charge said wires at the same potential and at a predetermined polarity and the other side of which is connected to the article to be sprayed to charge the same at an opposite polarity from the charge on said wires to establish an electric field between said wires and the article to be coated whereby the coating material carried on and between said wires is atomized and propelled in atomized condition into coating contact with the article to be coated.

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