

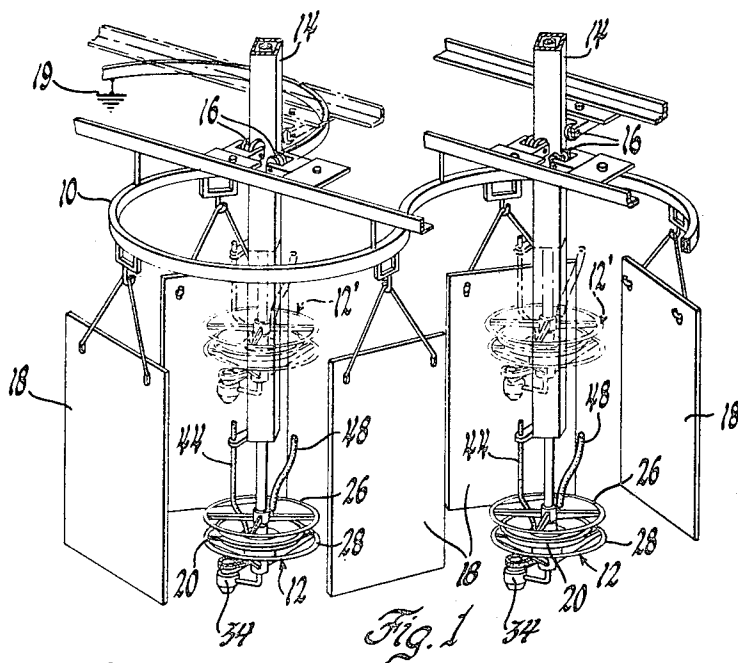
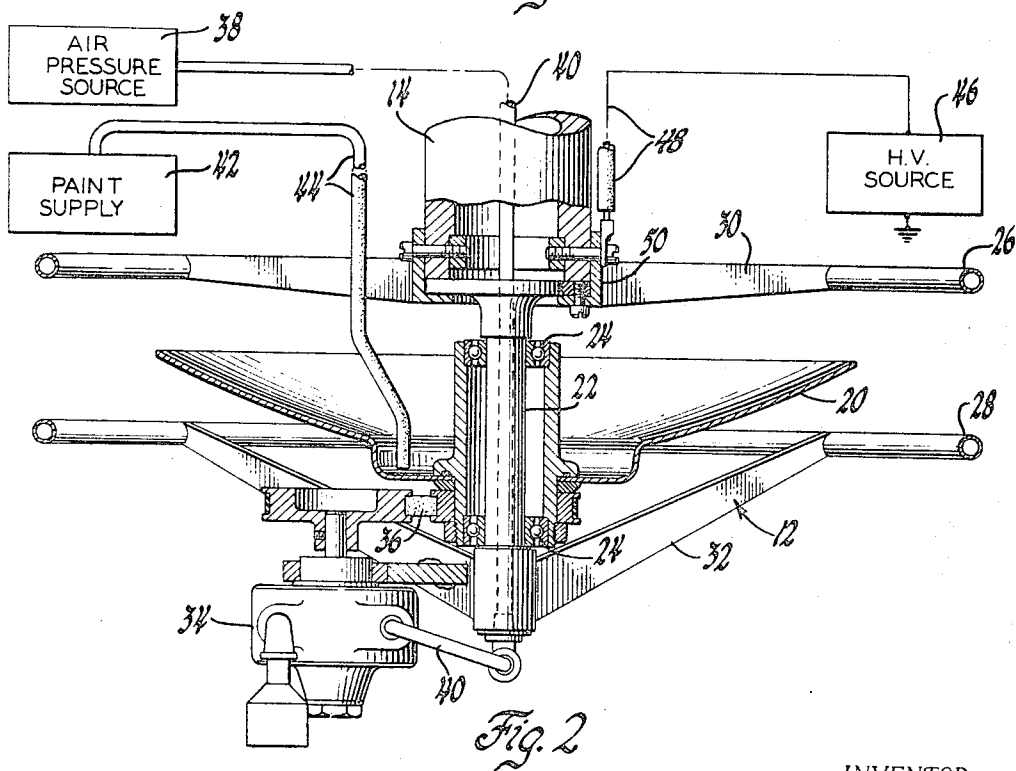
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APPARATUS FOR ELECTROSTATIC SPRAY COATING

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1

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APPARATUS FOR ELECTROSTATIC SPRAY COATING

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ABSTRACT OF THE DISCLOSURE

A centrifugal paint atomizing device is surrounded by a shielding device and voltage is applied to the assembly in such a manner that the electrical field intensity at the edge of the atomizing device is sufficient to effect charging of the paint but insufficient to effect electrostatic atomization of the paint.

This invention relates to a method and apparatus of electrostatic spray coating and, more particularly, to such a method and apparatus wherein atomization of coating material is effected solely by mechanical means and wherein deposition of the coating material is effected, at least in part, by electrostatic forces.

It is well known to mechanically atomize liquid coating material in an electrostatic field having an intensity capable of electrostatic atomization of the coating material; for example, a spinning disc has been used to atomize coating material where the coating material is applied to the disc near its axis of rotation and the material is atomized from the edge of the disc and where the disc forms one terminus of an intense, high voltage electrostatic field and the article or articles to be coated forms the other terminus of the field. With this arrangement the effect of the electrostatic field is to electrically charge the coating material at the disc and then assist in depositing the atomized material onto the article. Where the disc is rotated slowly, the electrostatic field will, in addition, effect electrostatic atomization of the coating material at the periphery of the disc. At high speeds of disc rotation, the coating material is atomized mechanically; that is, independently of the effects of the electrostatic field. However, in either case the atomized particles are very fine and, indeed, are too fine for some applications. Such an arrangement lacks sufficient flexibility to enable the operator of the apparatus to obtain the range of particle sizes desired for certain applications, particularly where coarse particles are desirable or where a relatively large spread in particle size is desired.

A further disadvantage of the arrangement just described is that corona discharge occurs at the relatively sharp edge of the disc which forms one terminus of the intense electrostatic field. This discharge in the presence of the combustible solvent vapors from the coating material gives rise to a fire hazard since the discharge produces an area of air ionization which can start an arc. In addition, the corona discharge draws an undesirably large current from the electrical power supply. While the current drain may amount only to a few milliamperes and therefore appear to be very small when compared with the magnitude of current utilized in ordinary home lighting circuits, for example, such current drain may still be undesirably large in an electrostatic spray coating system for two reasons. First, the smaller the current at the high voltages usually employed, the less risk there is of serious injury to operating personnel who may accidentally come in contact with the high voltage equipment. Second, the high voltage power supplies which are used in electrostatic coating systems usually have quite a low current

2

capacity, so that if the current drain from each atomizing head is minimized, several heads can be operated from a single power supply.

It is therefore an object of this invention to provide a method and apparatus for electrostatic coating wherein an intense, high voltage electrostatic field is available for depositing the atomized material, but wherein there is no corona discharge and no possibility of electrostatic atomization.

Another object of the invention is to provide a method of and apparatus for electrostatic spray coating wherein the paint is charged at the atomizing site to facilitate its electrostatic deposition, and the atomizing device is electrically shielded to prevent electrostatic atomization therefrom.

This invention is carried out by providing a corona free electrostatic field at a mechanical atomizing device which is sufficient to charge the coating material but which is not capable of effecting electrostatic atomization, whereby the desired fineness of atomization may be mechanically controlled independently of the field.

The invention will be made more apparent from the following specification taken in conjunction with the accompanying drawings, wherein:

FIGURE 1 is a perspective view of an apparatus embodying the invention, the reciprocating atomizing device being shown in a lower position in solid lines and in an upper position in broken lines; and

FIGURE 2 is an elevational cross-sectional view of an atomizing head of FIGURE 1.

FIGURE 1 illustrates an overhead sinuous conveyor 10 which defines a series of loops. In the center of each conveyor loop is an atomizing head 12 supported by a reciprocating device 14. The reciprocator 14 is guided by rollers 16 and is driven by any conventional form of reciprocating motor, not shown, so as to continuously move the atomizing head 12 between its lowermost level of travel, as indicated in full lines, and its uppermost level of travel, as indicated by broken lines at 12'. A series of articles 18 carried by the conveyor 10 pass around the atomizing heads 12 in loops defined by the conveyor and are spaced from the atomizing heads. The reciprocators 14 are timed to move in synchronism so that the several atomizing heads 12 always lie in a common horizontal plane. The conveyor 10 and the articles 18 carried thereby are grounded as indicated at 19.

As shown more clearly in FIGURE 2, the atomizing head 12 comprises a saucer-shaped disc 20 rotatably journaled on shaft 22 of the reciprocator by bearings 24, a pair of annular shielding electrodes or rings 26 and 28 supported above and below the disc 20 by means of spiders 30 and 32 fixed to the reciprocator 14 and the reciprocator shaft 22. An air motor 34 mounted on the spiders 32 rotatably drives the disc 20 by means of a belt 36. The air motor 34 is connected to an air pressure source 38 by a hose 40 extending through the hollow reciprocator shaft 22 and reciprocator 14. Paint or other coating material is fed to the interior of the disc 20 from a paint supply 42 by a tube 44 of flexible insulating material such as nylon. A high voltage source or power supply 46 has one terminal grounded and the other terminal, preferably the negative terminal, electrically connected by conductor 48 to a metallic collar 50 on the bottom of reciprocator 14. The section of reciprocator 14 immediately above the collar 50 is composed of electrically insulating material but the reciprocator shaft 22, the spiders 30 and 32, the rings 26 and 28 and the disc 20 are metallic. Accordingly, all the metallic parts of the atomizing head 12 are electrically interconnected and are at the potential of the high voltage source 46. Thus, an electrostatic field is created between the atomizing head 12 and the articles 18, which latter are electrically grounded due to their

connection with the conveyor and associated superstructure.

Principally, the electrostatic field extends between the grounded articles 18 and the shielding rings 26 and 28 so that the field intensity adjacent the shielding rings is great; however, owing to the circular cross-section of the shielding rings 26, 28 of substantial radius, the field intensity at the rings is insufficient to cause corona discharge. A marginal portion of the field between the atomizing head 12 and the articles 18 extends to the edge of the disc 20; however, due to the shielding action of the rings 26 and 28, the intensity of the field at the disc 20 is very low compared to that at the shielding rings. The intensity of the field at the periphery of the disc 20 is so low that it is not capable of effecting electrostatic atomization of the coating material and is not capable of sustaining a corona discharge. On the other hand, the field intensity at the disc 20 is great enough to cause electrical charging of the coating material atomized therefrom.

The dimensions of the shielding rings 26 and 28 relative to the dimensions of the disc 20, and the spacing between the shielding rings are critical. These dimensions must be selected for any given apparatus to meet these criteria: there is no corona discharge from the atomizing head; the field intensity at the edge of the disc 20 is capable of charging the coating material but is not capable of electrostatically atomizing the coating material; and the electrostatic field between the rings 26 and 28 and the grounded article 18 is strong enough to effect electrostatic deposition of the particles of coating material atomized from the disc 20. An example of these design criteria for a specific apparatus are as follows:

	Inches
Diameter of disc 20	17
Shielding rings 26, 28, diameter tubing	1/2
Outside diameter of rings 26, 28	23
Spacing between the rings (measured between the central planes of the rings)	4

The rings 26, 28 are concentric with the axis of rotation of the disc 20 and are spaced equidistantly from the plane of the periphery of disc 20. This atomizing head is operated in conjunction with a conveyor having a loop diameter of five feet. Accordingly, the spacing between the shielding rings 26, 28 and the center of the article 18 is approximately 18 1/2 inches. The atomizing head is maintained at a potential of 100,000 volts. The disc speed is 1450 r.p.m. and the paint flow rate is 24 ounces per minute. A typical coating material used in this installation is a vinyl nonmetallic paint known as Kanasta KF168-3091 reduced with an aromatic hydrocarbon solvent having a flash point of 150° F. such as SC 150 solvent in a proportion of 15 gallons of solvent per 55 gallons of paint.

In the mode of operation just described, there is no corona discharge from the disc 20 due to the low intensity field at the disc and, similarly, there is no corona discharge from the shielding rings 26, 28. One result of this lack of corona is that the current required by the apparatus is a small fraction of that required by a conventional unshielded disc; hence, a less costly and more easily controlled supply may be used. Due to less current being required, a more sensitive arc anticipating device may be used with the equipment being shut off at a much lower current output than would be necessary to sustain an arc. This, of course, reduces the fire hazard of such equipment. Also, there is less danger to operating personnel, and often several atomizing heads may be operated from a single power supply without exceeding its rated current capacity.

Another important feature of this invention is that the shielding rings 26, 28 are mounted in such a manner as to permit laminar air flow at the paint surface on the disc. A disc-like shielding electrode above or below the rotating disc 20 produces turbulent air action disturbing the flow of paint across the disc 20. It is necessary to get

as near laminar air flow as possible at the paint surface on the disc to obtain proper flow and charging of the paint droplets. The rings 26, 28 are disposed well outside the area of the disc 20 and shaped so as to minimize any interference with the natural laminar air flow.

Because the atomization is caused solely by mechanical means, the particle size of the atomized coating material is independent of the intensity of the electrostatic field and, hence, the potential on the atomizing head may be varied to suit the desired character of the depositing field so long as the above-mentioned criteria are met. Hence, the dimensions of the disc and shielding rings may differ from one installation to another according to the size of the conveyor loops, the nature of the articles being coated, the type of coating material being used, and other considerations which may determine the size of atomizing head required. Similarly, in a given apparatus the fineness of the atomized particles may be varied by changing several factors, such as the speed of disc rotation, viscosity and surface tension of the coating material and the rate of supplying coating material to the disc. In this manner, great flexibility in the operation of the painting apparatus is attained due to the size of the particles being independent of the electrical field.

In operation, air pressure is supplied to the air motor 34 to rotate the disc 20 at the desired rate. Electrical potential is applied to the head and coating material is supplied to the central portion of the disc 20. Due to the rotation of the disc, the coating material is uniformly spread over the interior surface of the disc and advances in a thin film to the disc edge where it is atomized solely by centrifugal force. The weak electrostatic field adjacent the disc causes the disc and the coating material to become electrically charged so that the atomized coating material carries an electrical charge as it leaves the periphery of the disc. The atomized material is projected by centrifugal force between and past the shielding rings 26, 28 generally in the plane of the disc edge but the atomized particles are mechanically dispersed in a fan-like pattern as they leave the disc edge. The shielding rings 26, 28, however, being of the same polarity as the charged particles, tend to repel the particles toward the plane of the disc edge thereby squeezing the pattern or reducing the degree of dispersion compared to that which would obtain in the absence of the shielding rings.

As the particles enter the strong electrostatic field established between the rings 26, 28 and the article 18, they become subject to the forces of that field and are deposited on the articles 18 in a manner well known to those skilled in the art of electrostatic coating. However, the vertical width of the spray pattern is relatively small due to the squeezing action of the shielding rings on the charged paint particles. An advantage of this effect is that a smaller amount of overspray occurs at the top and the bottom of the vertical travel of a reciprocating spray head, thereby reducing paint loss at these extreme positions as compared to the case where a wide spray pattern is used. Another advantage of the narrow spray pattern is the reduction of the loss of solvent which occurs in the case of a wide spray pattern where the particles travel through a larger volume of air. Thus, the likelihood that some particles will be deposited on the article in a dry state is minimized.

Because the atomizing heads 12 in adjoining loops of the conveyor 10 are disposed in the same horizontal plane, any charged particles from one head which miss an article 18 and proceed into the adjoining loop will tend to be returned toward the article by the electrostatic field in the adjoining loop. This arrangement, therefore, further improves the deposition efficiency of electrostatic spray coating.

While the invention is described in terms of this preferred embodiment, it is applicable to other types of apparatus including other types of mechanical atomization such as hydraulic atomization, ultra-sonic atomization and the like, although air atomization is not con-

templated to be within the realm of mechanical atomization for purposes of this invention. The principle of the invention that the field intensity required to charge the coating material is lower than that required to electrostatically atomize the material can be applied to non-centrifugal types of atomization to realize the chief advantages of the invention of avoiding the drawbacks of electrostatic atomization and corona discharge to thereby increase the flexibility and usefulness of various coating material atomizing devices.

I claim:

1. Apparatus for electrostatically spray coating an article comprising a centrifugal atomizing disc spaced from the article, the disc having a diameter of the order of 17 inches, means for rotating said atomizing disc, means for feeding liquid coating material at a controlled rate to said atomizing disc for centrifugal atomization therefrom and projection generally along a plane toward said article, a pair of shielding rings arranged concentric with the axis of rotation of the atomizing disc and disposed one on each side of the plane of atomization of the coating material, the rings having a generally circular cross-sectional configuration, the rings being equally spaced on opposite sides of the plane of atomization of the coating material and being spaced apart a distance of the order of 4 inches, said shielding rings each having an outside diameter of the order of 23 inches, and means for establishing between the shielding rings and the article an electrostatic field having its highest intensity at the shielding rings but being of insufficient intensity at said rings to create a corona discharge, and said field having a marginal portion of lesser intensity extending adjacent said atomizing disc, said portion being of sufficient intensity to electrically charge the coating material at the atomizing disc but being of insufficient intensity to effect electrostatic atomization of the material from the atomizing disc.

2. Apparatus for electrostatically spray coating an article comprising a centrifugal atomizing disc spaced from the article, the disc having a diameter of the order of 17 inches, means for rotating said atomizing disc, means for feeding liquid coating material at a controlled rate to said atomizing disc for centrifugal atomization therefrom and projection generally along a plane toward said article, a pair of shielding rings arranged concentric with the axis of rotation of the atomizing disc and disposed one on each side of the plane of atomization of the coating material, the rings having a generally circular cross-sectional configuration with a diameter of the order of one-half inch, the rings being equally spaced on opposite sides of the plane of atomization of the coating material and being spaced apart a distance of the order of 4 inches,

said shielding rings each having an outside diameter of the order of 23 inches, and means for establishing between the shielding rings and the article an electrostatic field having its highest intensity at the shielding rings, and said field having a marginal portion of lesser intensity extending adjacent said atomizing disc, said portion being of sufficient intensity to electrically charge the coating material at the atomizing disc but being of insufficient intensity to effect electrostatic atomization of the material from the atomizing disc.

3. Apparatus for electrostatically spray coating an article comprising a centrifugal atomizing disc spaced from the article, means for rotating said atomizing disc, means for feeding liquid coating material at a controlled rate to said atomizing disc for centrifugal atomization therefrom and projection generally along a plane toward said article, a pair of shielding rings arranged concentric with the axis of rotation of the atomizing disc and equally spaced by about 4 inches one on each side of the plane of atomization of the coating material, said shielding rings each being greater in diameter than the atomizing disc by about 6 inches, and means for establishing between the shielding rings and the article an electrostatic field having its highest intensity at the shielding rings but being of insufficient intensity at said shielding rings to create a corona discharge, and said field having a marginal portion of lesser intensity extending adjacent said atomizing disc, said portion being of sufficient intensity to electrically charge the coating material at the atomizing disc but being of insufficient intensity to effect electrostatic atomization of the material from the atomizing disc.

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