United States Patent

Walberg

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[54] **SPRAY APPARATUS WITH ATOMIZATION DEVICE**

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[52] **U.S. Cl.** **239/15**

[51] **Int. Cl.** **B05b 5/00**, F23d 11/28

[58] **Field of Search** 239/299, 15, 3, 601

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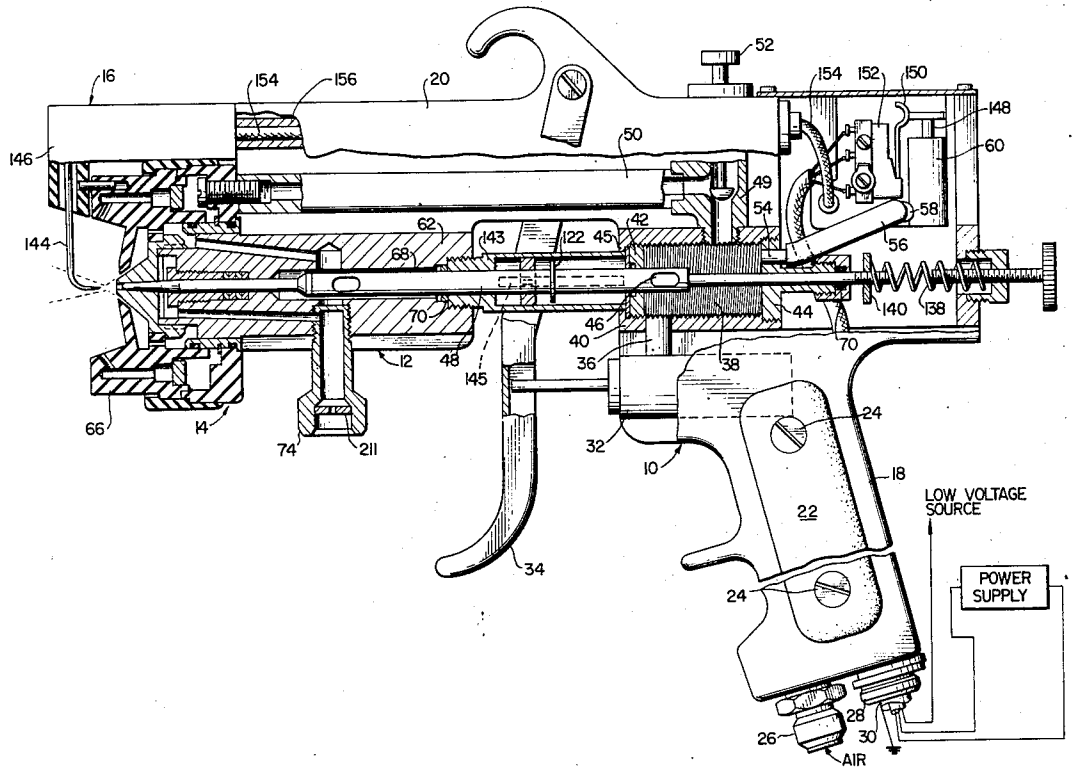
[57] **ABSTRACT**

An improved atomization device for spray apparatus in which the nozzle used for atomization of materials has an exposed surface to atmosphere that is continually wiped by the flow of the material dispensed therefrom which forms finely divided atomized particles. After the exiting material has been atomized into particles they tend to be confined in a region generally in the shape of a cone, the base of which is adjacent the nozzle and extends forward therefrom. The flow of the atomized particles out of the cone-shaped region along their flow path may be termed as turbulent flow. In one exemplary embodiment, an electrical atomization nozzle produces finely divided particles in the presence of an electrical corona discharge having its principal ionization component directed in a rearward direction along the path of the projected coating material particles to be charged. In the aforesaid embodiment, a substantial portion of the coating material particles exiting from the material dispensing nozzle flows along the exposed surface of the nozzle in the presence of the corona discharge in the region adjacent thereto where an associated air stream intercepts the exiting coating material, thereby creating a significant vacuum due to aspirating action in the region adjacent to the nozzle, enabling the coating material to flow across the external surface of the nozzle under the influence of air in circular or turbulent motion, causing the surface of the nozzle to be continuously wiped by the flow of the coating material before it subsequently forms finely divided atomized particles, which may be charged in the presence of the corona discharge.

7 Claims, 3 Drawing Figures



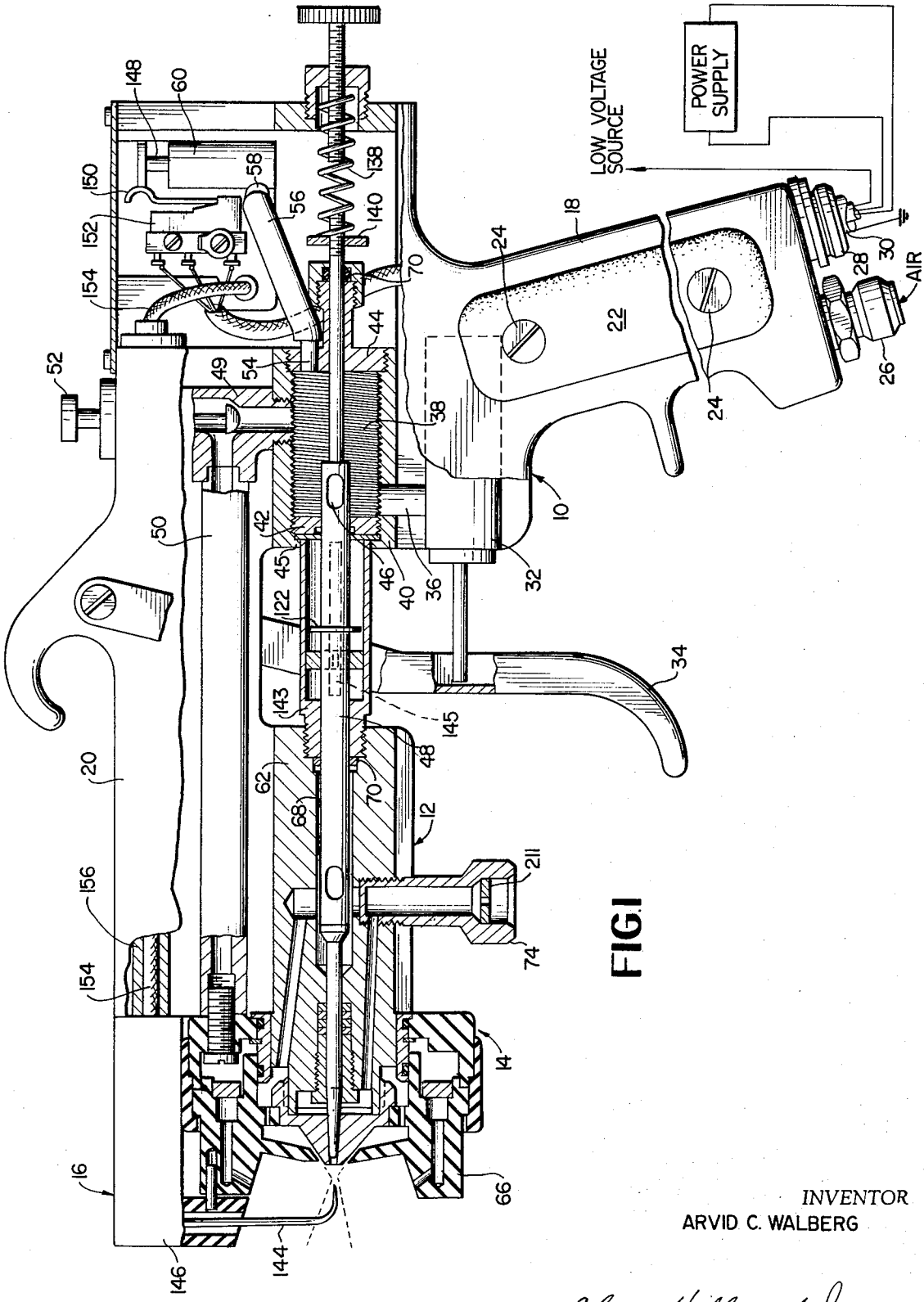


FIG. 1

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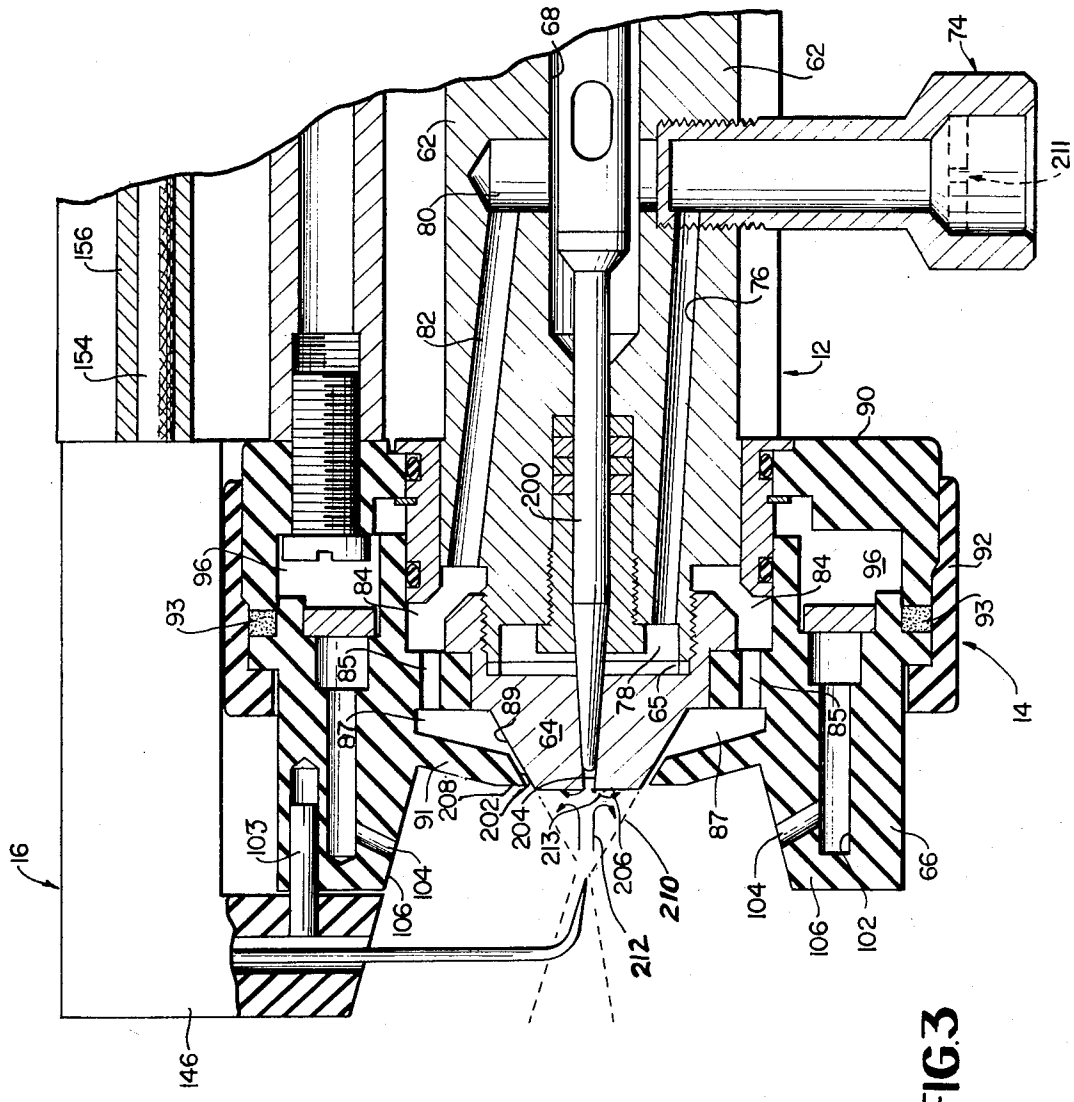

FIG.3

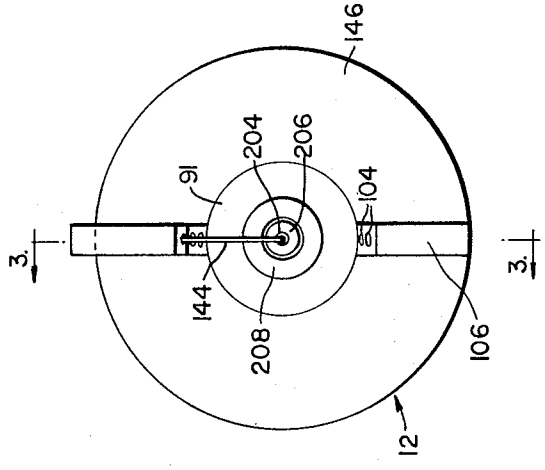

FIG.2

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SPRAY APPARATUS WITH ATOMIZATION DEVICE

BACKGROUND OF THE INVENTION

In the prior art apparatus for discharging atomized material, such as paint or other sprayable or liquid coating materials, have long been known and used. Such apparatus have provided arrangements for discharging a stream of material in atmosphere and jet atomizing the same at or near the point of discharge by means of compressed air, as an example.

In current spray technology, both electrostatic and non-electrostatic, sprayable materials are normally atomized by mechanical or electrostatic techniques. Upon issuing from the spray apparatus, the atomized particles are impelled away from the spray apparatus toward a work piece to be coated by an electric field having field lines maintained between the spray apparatus and the work piece in the case of "conventional electrostatic" techniques or by the attraction of the charged atomized particles towards opposite "image charges" residing on the work piece, which typically is maintained at or near ground potential. In the case of non-electrostatic techniques the atomized particles are impelled to the work piece by associated jet air or high pressure applied to the sprayable material which is delivered to the spray apparatus.

Variations in design of such apparatus have emerged from time to time to satisfy a number of operational requirements for a variety of industries which utilize such apparatus. The ability of any one apparatus to meet all the needs for possible uses in industry has been extremely difficult, if not impossible, owing to the fact that the materials employed may differ and the types of atomization of the required materials for each type of use or application may differ.

For example, conventional electrostatic spray apparatus, such as spray guns for electrostatic coating, have utilized atomization techniques quite extensively. The type of atomization required for various types of materials in electrostatic spray applications generally differs from other types of non-electrostatic uses. In some instances the differences may arise solely from the presence of high potential electrostatic field and corona discharges associated therewith and other cases the difference may arise from the nature of the material to be sprayed or the application. A great deal of money and time has been expended in the investigation and design of various atomization arrangements by numerous producers of spray apparatus. However, no one design has solved all of the needs for such producers, because each apparently has requirements which are unique to its individual needs.

A more recent problem in providing a useful atomization device for electrostatic uses arises from the fact that little is known about the atomization requirements when the charging mechanism occurs in the presences of an electrical corona discharge which is substantially concentrated about the outlet of a nozzle and the components of the corona discharge are in a direction opposite to the flow of the discharged particles.

In co-pending patent application Ser. No. 869,628, filed Oct. 27, 1969, entitled "Electrostatic Spraying Methods and Apparatus," assigned to the same assignee as the present application, there is disclosed an electrostatic spray apparatus utilizing an electrical corona discharge for charging atomized particles of sprayable material adjacent an exiting material orifice, wherein the principal components of the corona discharge are directed rearwardly along paths which are opposite to the flow of the atomized particles.

Under such conditions the atomized particles encounter resistance to their forward motion owing to the electrical effects of the rearwardly directed electric field lines of the corona discharge.

Inasmuch as the exact nature of the charging mechanism under such arrangement is not fully understood, it is believed that the atomized particles are significantly slowed down along their exiting paths and acquire greater charge per particles on the average and thus tend to migrate or return to the region adjacent the exiting nozzle where they are deposited in an undesirable manner.

The deposition or collection of the particles on the nozzle of the spray apparatus will after a rather short span of time significantly cause a reduction in the effectiveness of the corona discharge owing to the fact that the sprayable material may be non-conductive and therefore produce an insulative coating over the conductive elements of the spray apparatus which cooperate with the corona needle to produce the corona discharge. The accumulation of dirt on the nozzle also hinders the atomizing function of the nozzle.

The foregoing and other objectionable features of the prior art are overcome by the present invention.

SUMMARY OF THE INVENTION

The present invention is based upon the discovery, after considerable time consuming and costly investigation, that a spray apparatus having a highly concentrated electrical corona discharge in the region extending from an electrically conductive sprayable material conductive discharge nozzle to a corona needle tip in a direction opposite to the flow of the atomized particles requires an atomizing arrangement different than that heretofore known or fully understood or appreciated in the prior art. More specifically, a spray apparatus embodying the present invention, as an exemplary embodiment, is so constructed as to provide a spray nozzle having a discharge orifice with an external plane surface defined by a circle at right angles to the axis of the orifice and concentric therewith. Such construction provides a plane surface of predetermined surface area over which a substantial portion of the exiting sprayable coating material flows as a thin layer or sheet. The flow of material is substantially uniform and extends to the outer circumferential edge thereof. At the outer circumferential edge of the plane surface, the layer of sprayable material is picked up, atomized, and carried away from the nozzle surface by a projecting annular air stream or air shroud emcompassing the edge of the circular plane surface. The projected air stream exits through a passage having a truncated conical configuration to produce an air jet substantially conical in shape. As the pre-shaped conical jet or blast of air flows continuously past the edge of the nozzle plane surface it is believed that a vacuum within the cone-shaped air blast is created by aspirating action which sets up what may be termed as "circulating air currents." These cir-

culating air currents tend to move toward the nozzle plane surface along paths parallel and adjacent to the axis of the orifice and impinge thereupon and are deflected along the plane surface of the nozzle in the direction of flow of the layer of sprayable material. In so doing, the circulating air currents insure that the exiting sprayable material forms a uniform continuous layer on the plane surface of the nozzle and moves thereacross such that there is a continuous wiping action or flow of the sprayable material across the face of the nozzle. Any spray particles attracted to the nozzle surface are collected in the thin film of coating material, carried to the outer edge of the nozzle plane surface to be re-atomized by the annular jet of compressed air. This prevents the accumulation of atomized particles on the nozzle.

Another notable unobvious feature of the invention makes the atomizing arrangement applicable for both electrostatic and non-electrostatic uses. This feature arises from the "continuous wiping" action of the exiting sprayable material as it flows across the exterior plane surface of the nozzle. The continuous flow of the spray material across the nozzle surface keeps the surface clean and thereby minimizes or eliminates the possibility that the spray material will agglomerate thereon and is subsequently removed therefrom in the form of unatomized "globs" or large droplets. It will be appreciated by those skilled in the art that such globbing is highly objectionable. In the case of paint spraying, with either electrostatic or non-electrostatic, such globbing produces an unacceptable product finishing coating and is costly and uneconomical to the user.

The foregoing advantage of the invention may be said to be attributable to the fact that the atomized particles tend to be confined to a predictable region generally having the shape of a cone, the base of which is at the nozzle face in the form of the thin layer of moving material. The atomized particles are generally confined in a region which extends from the base of cone-shaped region to the apex thereof under the influence of the circulating air currents within the region. The atomized particles flow out of the cone-shaped region about the apex of the region along flow paths which may be termed as turbulent flow. After the particles pass through the region near the apex of the cone-shaped region under turbulent flow conditions they commence to spread out in a round spray pattern being aerodynamically impelled by air under pressure higher than atmospheric pressure.

An additional advantageous feature of the invention makes it possible to more effectively and efficiently electrically charge the sprayable material for continuous operation. This is obtained by the continuous wiping action of the sprayable material across the plane surface of the nozzle to thereby avoid coating build-up on the nozzle face which, in turn, could cause electrical shorting, arcing, breakdown, and the like. In addition, such electrical break-down would substantially reduce the effectiveness of the corona discharge in the ionizing region, or prevent the corona discharge from occurring completely.

Another advantage of the invention is derived by virtue of the fact that the cone-shaped jet air may completely confine the atomized particles within an envelope which is enveloped by the corona discharge field lines extending from the conductive corona needle tip to the surface of the conductive nozzle.

Yet another advantage of the invention arises from the fact that the exiting fluid stream is diverted from its forward path to flow over the face of the fluid tip in a substantially thinner form for ease of atomization. As a consequence of the reduced thickness in the stream of material to be atomized, less compressed air is required to achieve the desired atomization. It has been discovered that with less compressed air being required for atomization the forward velocity of the projected spray is substantially reduced thereby increasing the operating efficiency, since operating efficiency is a function of air pressure used in the system.

BRIEF DESCRIPTION OF THE DRAWINGS

For a clearer understanding of these and other features and advantages of the present invention, as well as the objects thereof, reference may be made to the following detailed description and to the drawings, in which:

FIG. 1 is a side elevational view of an electrostatic spray gun illustrating an embodiment of the invention;

FIG. 2 is a front end view of the spray gun of FIG. 1, taken along the line 2—2 of FIG. 1 and looking in the direction of the arrows; and

FIG. 3 is an expanded detail view of the spray head of the gun of FIG. 1. Taken along the line 3—3 of FIG. 2 and looking in the direction of the arrows.

DESCRIPTION OF A REPRESENTATIVE EMBODIMENT

In FIG. 1, there is shown a representative embodiment of an air-type spray gun constructed according to the invention. The spray gun shown in FIG. 1 is similar to that disclosed in co-pending patent application Ser. No. 869,628 recited herein above, but differs with respect to atomization arrangement. The spray gun includes a body **10**, a spray head **12**, a detachable fan ring and atomizing air assembly **14** and an electrostatic particle charging unit **16** supported on the assembly **14**.

The gun body **10** preferably is formed of light weight, high strength plastic, and conveniently is molded as two separate halves which, when joined together define a pistol-grip type handle **18** and a generally cylindrical housing **20**. Conductive metal plates **22** and screws **24** on both sides of the handle **18** secure the molded plastic halves of the gun body to internal air and electrical conduits (not shown) and in addition, serve as a convenient electrical ground for the operator's hand.

A fitting **26** at the base of the handle **18** connects the internal air conduit to an external supply of air under pressure, while a fitting **28** abbuts to the electrical conduit within the handle a multiple-conductor cable **30** leading to the voltage source and high voltage power supply for energizing the particle charging unit **16**.

A main air supply valve **32** allows the flow of air to the spray head **12** and fan ring and atomizing air assembly **14** when the trigger **34** is actuated and, as shown in FIG. 1, completely shuts off the flow of air to the gun when the trigger is released. Air valves for this purpose are widely known, and any valve of suitable construction may be used.

An air passage **36** connects the main air supply valve **32** with a main air chamber **38** defined by a tubular

member 40, a forward end closure member 42 and a rearward end closure member 44. The tubular member 40 is formed with a circumferential flange 45 of reduced diameter at the forward end. Therefore, the member 40 is threaded internally throughout its length and in a counter-bore at the rearward end so that both of the correspondingly threaded closure members 42 and 44 can be inserted from the rearward end of the member.

Air flowing to the main air chamber 38 is exhausted therefrom along three separate paths. Part of the air, as indicated by the arrows in FIG. 1, enters a bore 46 in the stem 48 of the spray material control valve, the stem 48 traversing the closure members 42 and 44 and chamber 38 to extend forward to the spray head 12. Another part of the air in the main air chamber 38 passes through an adjustable valve 49 threaded to the tubular member 40 and is conducted to the fan ring assembly 14 through an elongated tube 50. The quantity of air flowing to the fan ring assembly 14 is adjusted as desired by manipulation of the operator knob 52 of the valve 49.

Still another portion of the air escapes from the main air chamber 38 by way of a nipple 54 extending through the rearward closure member 44. This air is delivered through a short section of flexible tubing 56 to the inlet port 58 of an air cylinder 60.

Turning now to the spray head 12, as shown in FIG. 3, it consists of a body 62, a combination metallic fluid nozzle and attractor electrode 64 and a front end subassembly 66 of the fan ring and atomizing air assembly 14. The body 62 and the nozzle and attractor electrode 64 are preferably metallic, while the fan ring and atomizing air assembly 14 must preferably be of non-conductive (insulative) material. A central bore 68 in the spray head body 62 is aligned with the tubular member 40 so as to receive the forward portion of the spray material control valve 48 shown in FIG. 1. Sealing gaskets 70 are positioned between the valve stem 48 and the bore 68, closure member 42 and closure member 44 to prevent the leakage of air along the stem.

The material to be sprayed, for example, a paint of appropriate viscosity, is delivered under pressure to the spray head 12 through a spigot 74 and is conveyed through a bore 76 in the body 62 to a chamber 78 behind the combination nozzle and attractor electrode 64. The body 62 and nozzle 64 has a sealing gasket 64 therebetween to prevent leakage of the paint. Flow of paint from the chamber 78 is controlled by the operation of the trigger 34 in a manner more fully set forth hereinbelow.

Air exiting from the bore 46 in the valve stem 48 enters the central bore 68 in the spray head body 62 and there after flows through passage 80 and 82 into an annular air chamber 84 formed between the front surfaces of the body, the rear surfaces of the nozzle 64 and internal rear surfaces of the front end subassembly 66 of the fan air and atomizing air assembly 14. From there, the air passes from the annular air chamber 84 through a plurality of equally spaced apertures 85 to a second annular air chamber 87 between a truncated cone surface 89 of electrical conductive nozzle 64 and a concave-shaped flange circular member 91 which is concentric with truncated-cone surface 89 of nozzle 64. Air exiting from chamber 87 flows between the cone-surface 89 and adjacent ends of flange member 91. The exiting air from chamber 87 serves several functions, namely; first to propel the paint particles away from the spray gun 10; and secondly, and more importantly, to atomize the paint as it flows through an orifice 204 in the nozzle 64, as will be discussed more fully hereinbelow.

Referring now to FIG. 3, the fan ring and atomizing air assembly 14 includes the front end subassembly 66, a cooperating fan ring seat member 90 and annular lock or retainer ring 92, all of which preferably are formed of dielectric material. Subassembly members 66 abuts snugly over the nozzle and attractor electrode member 64 and fan ring seat member 90 abuts snugly against the body 12 and are held together in sealing engagement by retainer ring 92 with spacer 93 there between.

Air reaching the fan ring assembly 14 through the tube 50 (see FIG. 1) is admitted to an annular air reservoir 96. From the reservoir 96, the air passes through passages 102 and orifices 104 in air horns 106 to control the pattern of the spray in a manner that will be discussed more fully hereinbelow.

As previously mentioned, when the trigger 34 is depressed (see FIG. 1), part of the air flowing through the main air chamber 38 is conducted to an air cylinder 60 located at the rear of the gun. Upon entering the cylinder 60, the air causes a piston 148 to move upwardly and engage the spring arm 150 of a microswitch 152, thereby closing the normally open contacts of the switch to connect the input low voltage to the power supply (see FIG. 1).

When the trigger is released, air flow to the cylinder is interrupted by the closing of the main air valve 32. The piston 148, which may be spring loaded or otherwise biased against the lifting force of the air, then returns to the rest position, releasing the spring arm 150 and returning the microswitch 152 to the normally open position. The corona discharge which is generated between corona needle 144 and attractor electrode 64 is accordingly terminated.

For convenience, the electrical wiring leading from the low voltage source to the switch, from the switch to the power supply, and from the power supply to the corona electrode is all contained within the multiple-conductor cable 30 which enters the gun through the fitting 28 in the handle. That portion 154 of the high voltage lead immediately adjacent the electrode 144 (see FIG. 1) is enclosed within an elongated tube 156 that extends forward to the rearward end of the insulator piece 146 and which also serves to support the particle charging unit 16. Additional rigidity is thereby given to the spray gun while allowing the weight of the gun to kept to a minimum.

Ideally, the entire gun, including the nozzle attractor 64, is connected to electrical ground, and a grounded shield conductor may be included in the cable 30 for this purpose (see FIG. 1).

Continuing with the description of FIG. 3, particular attention will be devoted now to a discussion of the atomizing features of the invention.

In practice it has been found that the configuration, shape and size of the combination nozzle and attractor electrode member 64 is essential to the successful

operation of the present invention. In FIG. 3 the downstream end of the nozzle, in particular the truncated cone surface 89 thereof preferably has a taper of about 30 degrees to an axis of the nozzle 64, designated by the center line 200, an adjacent annular surface 202 of the concave-shaped flange member 91 which is disposed parallel to the truncated cone surface 89 of the nozzle 64 and is spaced apart therefrom by a preselected distance, preferably on the order of 0.010 inches to provide the required flow of exiting air for atomization of the material discharged through an orifice 204 and off of a plane circular surface 206 of the nozzle 64. Another requirement of this arrangement is that an annular surface 208 of the concave-shaped flange member 91 is disposed parallel to plane surface 206 but is preferably recessed therefrom by a distance in the range of 0.010 to 0.012 inches.

It has been discovered that it is essential that the two surfaces 206 and 208 should not be in the same plane. More specifically, it must be noted that the plane surface 206 is metallic and the concave-shaped flange member 91 is a dielectric material. It also has been found that the surface 208 should be recessed from plane surface 206 to avoid being coated by the material discharge through the orifice 204 and as it subsequently flows across plane surface 206 where it is blasted away from the circumferential edge of plane surface 206 by air exiting from air chamber 87. At this point it is necessary to indicate that the cross-sectional area of the surface 206 should be sufficiently large enough to accomplish two functions, namely; to support a thin layer of material which flows across such surface and to support the electrical field lines needed to generate a rearwardly direction corona discharge. The size of the attractor surface 206 must be sufficiently large to distribute the lines of force and prevent "back-ionization" or corona discharge at surface 206.

As a further explanation of the operation of the atomizing process, reference is made to the cone-shaped broken line designated 210, and the curved arrows designated 212, located within the region enclosed by broken-lines 210. The broken lines 210 illustrate the general confined region in which the atomized material particles flow as they are impelled from the spray gun 10. The curved arrows 212 illustrate the direction of flow of the circulating air current which is believed to be associated with the present invention and helps to explain why a thin layer of material to be atomized continuously flows in a wiping action across the face of nozzle 64, along surface 206, whereby it is blasted from the edge thereof by exiting air from air chamber 87.

As may be observed from the drawing, broken-lines 210 tend to form a cone-shaped envelope whose base is at the surface 206, and extends towards the tip of the corona discharge needle 144, at a point which approximates the apex of a cone. Thereafter, the atomized particles tend to flow along a path such that particles commence to fan out. Under the influence of air impelled through air passages 104, the atomized particles may be formed into a fan pattern.

As a still further explanation of the operation of the present atomizing arrangement, it is observed that a circulating motion of particles is present within the region defined by broken-lines 210 and it is reasoned that the motions of such particles is attributable to the generation of a vacuum in the region caused by the passage of exiting air from air chamber 87. The exiting air causes an aspirating action at the outer periphery of face 206 causing a vacuum that pulls the fluid and air toward the outer edge of face 206. The recirculating air flow is shown by arrows 212 and the fluid flow is shown by arrows 213. To a limited extent some of the fluid discharged from orifice 204 is discharged straight forward as a solid stream to be atomized by the apex of the cone formed by dotted lines 210.

In this exemplary embodiment, charging of the atomized particles may be explained in a manner similar to that as disclosed in co-pending patent application Ser. No. 869,628 identified more fully hereinabove. However, one significant difference exists, namely, that the external surface area 206 of nozzle 64 is greater than that of the recited co-pending patent application and enables the electric field lines to be concentrated in the region considered more desirable for better electrical performance during the particle charging process. In the co-pending patent application, the entire face of the spray gun in front of the corona discharge needle is conductive and the electrical field lines extend to all areas thereof.

Under the arrangement disclosed in the identified co-pending patent application, it was found that as the particles were charged and commenced to seek escape from the region of the strong electric field lines, which are rearwardly directed, many of them were forced back to the front face of the spray gun to thereby cause undesirable coating. Such coating had two deleterious effects, namely; that of causing agglomeration, which in turn caused arcing and sparking, making the spray gun inoperative in many instances and clogging up the air and paint passages to adversely effect or eliminate atomization or charging of the paint which is discharged.

Thus, the present novel arrangement eliminates such problems by confining the charged material particles and eliminates the conductive surfaces which would contribute to the problem. For example, it has been determined by experimental test and design that the circular plane surface 206 of the nozzle 64 is preferably at least 0.375 inches in diameter, which is on the order of 1,000 per cent larger in area than the surface adjacent to the orifice of the spray gun in the recited co-pending patent applications.

Referring again to FIGS. 1 and 3, there is shown an alternate arrangement of a fluid orifice to control and reduce the velocity of the sprayable material as it enters the spray gun 10. As shown in FIGS. 1 and 3 a disc-like restrictor orifice 211 is placed in the fluid inlet 74. The restrictor 211 cooperates with the orifice opening 204 to regulate and control the flow of material through orifice 204.

It has been found that an orifice diameter of 0.040 inches for orifice 204 can be opened up to 0.070 inches and used with restrictor 211 having an orifice of 0.040 inches to provide an output of material through orifice 204 which is equal to that when the diameter of orifice 204 was 0.040 inches. Thus, by using various sized restrictors 211, the velocity at which material is dispensed through orifice 204 can be effectively controlled.

It will be understood by those skilled in the art, that the abovehdescribed embodiment is intended to be merely exemplary in that it is susceptible to modification and variation without departing from the spirit and scope of the invention. For example, although an electrostatic spray apparatus with strong rearward directed field lines from a corona discharge has been illustrated and described, it will be apparent that the atomizing arrangement features of the present invention may be used independent of the rearward directed corona discharge or any associated electrostatic fields for particle charging. More specifically, the atomizing arrangement of the present invention may be readily utilized in conventional, non-electrostatic spray apparatus, and other application wherever atomization of a sprayable material of any type and purpose is required. All such modification, variation, uses and application, therefore, are intended to be included within the scope and spirit of the invention, as defined in the specification and appended claims.

I claim:

1. In an electrostatic spray system, the combination comprising: a spray head for issuing intersecting streams of material and air to produce an atomized spray of material particles including an electrically conductive centrally disposed material dispensing nozzle having an orifice passage along an axis thereof for discharging the material and a plane concentric surface formed at the external end of the orifice passage at right angle to said axis for receiving said discharging material as a thin sheet of said material, as said material flows to the outer edge of said plane surface, and a non-electrically conductive means in surrounding relation to said centrally disposed nozzle in a generally circular pattern there-around to form a concentric air passage with said nozzle for issuing a moving shroud of air which atomizes said sheet of material as it flows to the outer edge of said circular plane concentric surface; means for supplying air under pressure to the spray head; means for supplying material under pressure to the spray head; means, including an emitter electrode disposed in the path of the particle spray in downstream spaced relation to the spray head, for establishing a rearwardly directed corona discharge terminating at the electrically conductive nozzle of the spray head to charge the coating material particles electrostatically; a high voltage power supply for energizing the emitter electrode; and means for preventing sparking between the emitter electrode and the spray head nozzle, the spark preventing means including switch means disposed within the spray gun and responsive to the flow of shroud air to the spray head for electrically connecting the high voltage power supply to the emitter electrode to establish the corona discharge, whereby air flows from the spray head and over the emitter electrode prior to the initiation of the corona discharge, said flow of air being effective to prevent sparking between the emitter electrode and the spray head in the absence of the particle spray.

2. An electrostatic spray system according to claim 1 further comprising: means defining at least one passage within the spray gun for conducting air to the spray head, the switch means being located in communication with the air passage and being responsive to the flow of air through the passage to connect the high voltage power supply electrically to the emitter electrode.

3. An electrostatic spray system according to claim 2 further comprising: individually operable valves in the spray gun for controlling the flow of coating material and air from the spray head, and operator means associated with the spray gun for sequentially opening the air and coating material valves, the operator means being arranged to open the air valve prior to opening the coating material valve so that the air is delivered to and discharged from the spray head, and the air flow-responsive switch is actuated to energize the emitter electrode, before coating material is issued from the spray head.

4. An electrostatic spray apparatus for spraying a liquid coating material, the combination comprising: a body provided with a passage having an intake for connection to a source of liquid coating material, said passage having an outlet; a nozzle assembly including a nozzle secured to said body at said outlet through which liquid coating material can be discharged into atmosphere, said nozzle having an external plane surface having peripherical edge with an aperture therein forming a discharge orifice for the coating material; means for forming a layer of liquid coating material on said external plane surface of said nozzle upon passage through said discharge orifice of said nozzle; an electrical insulation member encompassing said nozzle and forming a continuous opening surrounding the peripherical edge of the plane surface of said nozzle, through which an air stream is passed, causing said layer of liquid coating material to flow over the external plane surface of said nozzle and for atomizing said layer of coating material into finely divided particles to be discharged from the apparatus; at least one metallic charging electrode secured to said body, said charging electrode having a sharp point, extending rearwardly toward said nozzle and terminating adjacent thereto; and means for imposing a high electrical potential between said charging electrode and said nozzle to generate an electrical corona discharge therebetween in which the principal component is in a rearward direction and terminates at said nozzle in the vicinity of said outlet, whereby the discharged particles from the apparatus acquire an electrical charge along a path, the direction of which is opposite to that of components of the corona discharge.

5. An electrostatic spray gun of the type in which a spray of coating material particles is produced by interacting streams of coating material and air under pressure comprising:

a. a spray head for issuing intersecting streams of material and air to produce an atomized spray of material particles including an electrically conductive centrally disposed material dispensing nozzle having an orifice passage along an axis thereof for discharging the material and a plane concentric surface formed at the external end of the orifice passage at right angle to said axis for receiving said discharging material as a thin sheet of said material, as said material flows to the outer edge of said plane surface, and a non-electrically conductive means in surrounding relation to said centrally disposed nozzle in a generally circular pattern there-around to form a concentric air passage with said nozzle for issuing a moving shroud of air which atomizes said sheet of material as it flows to the outer edge of said circular plane concentric surface,

b. means for supplying air under pressure to the spray head,

c. means for supplying material under pressure to the spray head,

d. means, including an emitter electrode disposed in the path of the particle spray in downstream spaced relation to the spray head, for establishing a rearwardly directed corona discharge terminating at the spray head to charge the coating material particles electrostatically,

e. means for preventing sparking between the emitter electrode and the nozzle of the spray head, the spark-preventing means including switch means responsive to the flow of air to the spray head for energizing the emitter electrode, whereby air flows from the spray head and over the emitter electrode prior to the initiation of the corona discharge, said flow of air being effective to prevent sparking between the emitter electrode and the spray head in the absence of the particle spray, and

f. means defining at least one passage within the gun for conducting air to the spray head, the switch means being located within the gun in communication with the air passage to the spray head.

6. An electrostatic spray gun of the type in which a spray of coating material particles is produced by interacting streams of coating material and air under pressure comprising:

a. a spray head for issuing intersecting streams of material and air to produce an atomized spray of material particles including an electrically conductive centrally disposed material dispensing nozzle having an orifice passage along an axis thereof for discharging the material and a plane concentric surface formed at the external end of the orifice passage at right angle to said axis for receiving said discharging material as a thin sheet of said material, as said material flows to the outer edge of said plane surface, and a non-electrically conductive means in surrounding relation to said centrally disposed nozzle in a generally circular pattern there-around to form a concentric air passage with said nozzle for issuing a moving shroud of air which atomizes said sheet of material as it flows to the outer edge of said circular plane concentric surface,

b. means for supplying air under pressure to the spray head,

c. means for supplying material under pressure to the spray head, and

d. means, including an emitter electrode disposed in the path of the particle spray in downstream spaced relation to the spray head, for establishing a rearwardly directed corona discharge terminating at the spray head to charge the coating material particles electrostatically, said emitter electrode being supported on the spray head assembly and extending transversely into the spray and thereafter curving rearwardly to terminate at a point in front of the spray material orifice, and the said moving shroud of discharge air being inclined with respect to the axis of the spray material orifice to an extent that the air exiting from the spray head converges toward the rearwardly extending portion of the electrode.

7. A spray gun according to claim 6 in which the rearwardly directed corona discharge terminating at the spray head is confined between the electrically conductive centrally disposed fluid nozzle and the rearwardly curved emitter electrode tip and to the plane concentric surface formed at the external end of the orifice passage along the axis thereof.

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