HYDROSTATIC ATOMIZING APPARATUS

Inventor: Richard O. Probst, Indianapolis, Ind.

Assignee: Ransburg Electro-Coating Corp., Indianapolis, Ind.

Filed: Apr. 12, 1963

Appl. No.: 272,615

U.S. Cl. .................................................. 239/15, 118/626
Int. Cl. .................................................. B05b 5/02
Field of Search ....................................... 239/3, 15; 118/624-632; 317/3

References Cited

UNITED STATES PATENTS
2,302,289 11/1942 Cook ................................................. 239/3
2,710,773 6/1955 Sedlacik ......................................... 239/15
2,766,064 10/1956 Schweitzer ..................................... 239/15
2,802,446 8/1957 Utterback ....................................... 239/15
2,926,106 2/1960 Gauthier ........................................ 239/3
2,989,241 6/1961 Badger .......................................... 239/15

ABSTRACT

An apparatus for atomizing liquid coating material and electrostatically depositing the material on a surface to be coated comprising an elongated body of insulating material having two passages therethrough, one passage for liquid coating material and the other passage containing resistor means connected with a source of high electrical potential. An electrode is connected with said resistor means for electrostatically charging atomized particles of said coating material.

29 Claims, 9 Drawing Figures
HYDROSTATIC ATOMIZING APPARATUS

This invention is concerned with a hydrostatic spray coating apparatus and more particularly with a hand gun for hydrostatically atomizing and electrostatically depositing coating material on an article to be coated.

Prior commercial apparatus for atomizing and electrostatically depositing coating material commonly utilizes either electrostatic or air atomization. In coating certain types of articles, where a high coating material delivery rate is desired or to penetrate into a recess, for example, it is desirable to atomize the coating material hydrostatically, as by projecting the coating material through a small orifice under high pressure. The interaction of the stream of coating material with air causes a break-up of atomization of the coating material into small particles which may be charged electrostatically. Hydrostatic atomization provides a fog-like spray in which the particles do not have the persisting high velocity possessed by particles atomized by air, nor the wide spray pattern of centrifugal atomization. The efficiency of deposition of the coating material on articles, and the quality of the coating may be improved by imparting an electrostatic charge to the spray particles.

A suitable commercial apparatus for hydrostatic atomization and electrostatic charging of coating materials should incorporate safety features to prevent a discharge or spark and possible fire or explosion if the spacing between the article being coated (which is normally grounded) and the charged gun becomes too small, and to prevent injury to the operator where the apparatus is used as a hand held gun. For use as a hand gun, the apparatus should be of small size, convenient to handle and well balanced. It is also desirable that the gun be economical to manufacture and simple in construction to facilitate cleaning, servicing and repair. The novel features of the apparatus disclosed and claimed herein contribute to the fulfillment of these objectives.

The apparatus includes a nozzle defining an orifice through which the coating material under high pressure is directed, to be atomized into fine particles through interaction with air surrounding the nozzle. Electrode means are operably associated with the nozzle and connected with a source of high voltage to establish an electrostatic field in the vicinity of the region of formation of the spray particles, imparting a charge to the particles and affecting their deposition on the article to be coated. A valve controls the flow of paint to the orifice. The circuit from the source of high voltage includes one or more resistors which limit the current flow and provide a safety factor by reducing the electrode voltage if the current increases. The high voltage circuit between the resistor and electrode and electrode means further have a small physical area and appropriate configuration to limit the effective electrical capacity of the system and the energy which may be stored therein and discharged rapidly therefrom.

An electrode system with a low "effective capacity" is a system which has such low true capacitance, such poor conductivity of the material over which it is formed or such shape (particularly as to "sharpness" or "bluntness" of its configuration) that, in an electrostatic coating system of the character with which I am here concerned, the energy contributed to a disruptive discharge between such electrode system and an opposed "blunt" electrode, by the electricity stored in the electrode system is insufficient to render such discharge objectionable.

One feature of the invention is the provision of an apparatus with an elongated body and two passages therethrough, one for the coating material and the other for the high voltage circuit, including resistor means. A first closure closes one of the passages and a second closure closes the other. A further feature is that the closure for the passage with the resistor means includes a conductor connected with the resistor for connection with the charging electrode means, and that the closure for the other passage includes a nozzle with a discharge orifice for the coating material.

Another feature is that the two passages through the body of the apparatus are spaced apart a sufficient distance to prevent internal arcing or other discharge from the high voltage circuit. At the forward end of the apparatus, the voltage in the high voltage circuit is reduced and the spacing between the high voltage circuit in the coating passage is reduced to minimize the bulk of the gun.

Yet a further feature is that the passage for the coating material through the body of the gun is substantially straight to avoid unnecessary wear on the walls of the passage. At the forward end of the gun, where the passage spacing is reduced, the body is provided with an offset or eccentric configuration to have a circular cross-section about the coating material passage.

A further feature is that a valve seat of hard, abrasion resistant material is mounted on a carrier at the front of the body and a valve member is movable longitudinally in the body, into and out of seating engagement with the valve seat. More particularly, the valve seat is a generally cylindrical member with an orifice therethrough and a chamfered valve surface, and the valve member is a ball mounted at the end of an elongated actuator rod extending through the coating material passage.

Still another feature of the invention is that the valve actuating mechanism operates a switch controlling the high voltage applied to the charging electrode so that the gun is only charged when the valve is open and coating material can flow.

Further features and advantages of the invention will readily be apparent from the following specification and from the drawings, in which:

FIG. 1 is a diagrammatic illustration of a system embodying the invention;
FIG. 2 is an elevation of a hand gun embodying the invention;
FIG. 3 is a vertical section taken longitudinally through the gun of FIG. 2 as shown by a line 3—3 of FIG. 6;
FIG. 4 is an enlarged fragmentary section of the nozzle portion of the gun of FIG. 3;
FIG. 5 is an exploded view of the forward end of the gun;
FIG. 6 is a vertical transverse section through the gun generally along the line 6—6 of FIG. 2;
FIG. 7 is a vertical transverse section through the gun generally along the line 7—7 of FIG. 2;
FIG. 8 is an enlarged fragmentary section of a modified nozzle structure; and
FIG. 9 is an enlarged fragmentary section of another modified nozzle structure.
The embodiment of the invention illustrated herein is a gun adapted to be held in the hand of an operator, and some of the features are particularly suited for such use. It is to be understood, however, that the apparatus could be mounted on a suitable structure, either fixed or movable, and actuated from a remote location.

Turning now to the drawings, and particularly to FIG. 1, a coating system is illustrated utilizing an apparatus embodying the invention. Articles 10 are carried by hangers 11 from a conveyor 12, preferably at ground potential. The hydrostatic spray coating apparatus indicated generally at 13 is illustrated as a hand gun having a body 14, a handle portion 15 and trigger 16. A hose 17 connects the gun with a suitable source of coating material under high pressure, as paint pump 18. Power supply 20, which is connected with spray apparatus 13 through a cable 21, provides the unidirectional high voltage which establishes an electrostatic field between the spray apparatus and the articles 10. Particles of coating material are charged in the field and are electrostatically deposited on the articles. Trigger 16 controls the discharge of coating material from the gun 13, and, in a preferred embodiment of the apparatus, controls also the application of high voltage from power supply 20.

The pressure of the coating material supplied from pump 18 depends to some extent on the physical characteristics of the coating material, the nature of the discharge orifice and the like. For example, with present coating materials, pressures may range from 400 to 3,000 pounds per square inch. In a typical system, the pressure may be of the order of 800 to 1,000 pounds per square inch.

The voltage of power supply 20 must be sufficient to establish a voltage gradient adequate to impart to the atomized particles an electrostatic charge, and to establish a field from the coating apparatus to the articles which will affect the deposition on the articles of a substantial portion of the particles which would not otherwise be so deposited. In a typical installation, an average field gradient of the order of at least 3 kilovolts and preferably of the order of 5-10 kilovolts per inch has been found satisfactory. A total voltage from the power supply of the order of at least 40 to 50 kilovolts, and preferably of the order of about 60 kilovolts is suitable in most hand apparatus. A higher voltage, as of the order of 90 kilovolts, may be used with mechanically supported guns.

The body 14 of the gun, FIG. 2, has a rear portion 22 preferably of a suitable conductive material, as aluminum, and a forward or barrel portion 23 preferably molded of an insulating plastic material, as Delrin, an acetal resin sold by E. I. DuPont. Conductive handle 15 is secured to and depends from the rear of body portion 22 forming an angle of the order of 90° therewith, and is grounded, as will appear, to ground the operator. Trigger 16 is pivoted at 24 to body portion 22. Hose 17 for the liquid coating material is connected through a swivel fitting 25 with a boss 26 which extends downwardly from body portion 22 and houses a filter. The hose connection is in front of and generally parallel with handle 15. High voltage cable 21 enters the gun through the base of handle 15.

The coating material is discharged from an orifice at the forward end of barrel 23, is atomized, and atomized particles are charged in the field extending from electrode 27 to the metallic portions at the rear of the gun and to the articles being coated. The spacing between electrode 27 and body portion 22 is approximately 7/4 inches, establishing the field gradient in the vicinity of the discharge from the orifice.

Referring more particularly to the FIGS. 3 and 4, body portion 22 has a passage 28 extending longitudinally through its upper portion and a passage 29 extending longitudinally through its lower portion. Barrel 23, which has an oval crosssection (FIG. 6), is similarly provided with an upper passage 30 and a lower passage 31. Barrel 23 has a flange 23a (FIGS. 2 and 6) at the rear thereof, seated against the body portion 22 and secured thereto as by bolts 34. The upper passages 28 and 30 and the lower passages 29 and 31, and the two body portions 22 and 23 are aligned. A closure or valve housing 35 secured to the forward end of barrel 23 by a threaded retaining ring or nut 36 closes the forward end of passage 30. A second closure or nozzle carrier 37 mounted on valve housing 35 by a threaded cap 38 closes the forward end of passage 31.

One piece handle 15 is secured to the rear of body portion 22 by screws 40. A bushing 41 is threaded into the enlarged rear portion 31a of passage 31 and extends through passage 29 in body portion 22. Coating material from hose 17 flows through swivel joint 25 and filter housing 26 into the bore 41a of bushing 41 and to passage 31. A cylindrical valve seat 42 is carried in the bore 42 through valve housing 35, in communication with passage 31. Nozzle 44 carried by nozzle housing 37 has an orifice 44a communicating with the bore 43 of the valve housing which forms a portion of passage 31.

The rear face of valve seat 42 is chamfered at 42a to seal with a ball valve member 45 carried at the forward end of a valve rod 46 which extends through the length of passage 31. A valve holder 46a is threaded to the end of valve rod 46 and has a recess 46b in which ball 45 is seated. The ball is cemented into the recess by a suitable solvent resistant adhesive, as an epoxy resin, and the periphery 46c of the mounting member is swaged around the ball.

It has been found that swinging alone is often insufficient to secure the ball valve member to the holder, as the high pressure coating material is forced into the space between the ball and the holder. When the ball is seated, the force of the coating material tends to keep the ball seated, and as the valve rod is retracted, the ball valve member may pull from the recess rather than lifting from the valve seat. The adhesive holds the ball valve member in place and prevents paint from getting behind the ball to hold it shut.

A valve rod extension 47 is brazed to a screw 48 threaded into the rear of rod 46, extending rearwardly of the gun through packing washers 50 and connected with valve actuator 51. The actuator is urged forwardly of the gun by a spring 52, seating ball valve 45 against the sealing surface 42a of the valve seat. Actuator 51 is loosely engaged with a pin 53 carried by the trigger 16. Movement of the trigger rearwardly toward handle 15 retracts the valve rod against the action of spring 52, opening the valve and allowing a flow of coating material through passage 31 to nozzle 44 from which it is discharged.

High voltage cable 21 enters the gun through the base of handle 15 and is anchored in place by a fitting 54. The cable includes a grounded conductive outer covering 21a electrically connected with the handle 15,
grounding the conductive portions of the gun. An inner conductor 21b, connected with the high voltage terminal of power supply 20, is surrounded by a body 21c of dielectric material. The dielectric body 21c and high voltage conductor 21b extend through handle 15 and into sleeve 55 which extends through aligned passages 28 and 30. A conductive button 56 is connected with high voltage conductor 21b and contacts the rear terminal of resistor 57 in the rear portion of upper passage 30 of barrel 23.

Dielectric sleeve 55 is shrunk around resistor 57 to have close intimate contact therewith. This provides effective heat transfer from the resistor to the sleeve through which the heat is dissipated into the body of the gun. The space in passage 30 outside sleeve 55 is packed with a high dielectric silicone grease 30b to eliminate air pockets which would provide a relatively low impedance discharge path, and which would impair heat transfer.

Bushing 41 and sleeve 55 serve to align the two body portions. Bushing 41 is threaded into barrel 23. The force of the coating material acts against packing washers 50 held by nut 50a and does not tend to separate the two portions of the gun. Retainer screws 34 need be strong enough only to hold the parts together, and not to withstand the force of the coating material.

At the forward end of barrel 23 there is a step in passage 30, with the forward portion 30a thereof being offset toward passage 31. A second resistor 58 is located in passage portion 30a and is connected with the forward end of resistor 57 through a spring 59. The forward end of passage 30a is closed by a sealing plug 62 which has a conductor wire 63 extending therethrough. A loop 63a of conductor wire is in contact with the forward end of resistor 58. A conductor 64 extends through valve housing 35 and terminates at the rear thereof in a recess 65 filled with a conductive cement which is in contact with the forward end of conductor 63. The forward end of conductor 64 is located in a recess 66 filled with a conductive cement and in physical contact with nozzle 44 which is of an abrasion resistant conductive material. Charging and field establishing electrode 27 comprises a length of wire having a loop portion 27a seated in a recess 37a of the nozzle housing and held in place by nozzle 44.

The coating material which is discharged under high pressure through the orifice 44a of nozzle 44 preferably issues therefrom as a thin film. With a narrow elongated orifice 44a, as shown in the drawing, the film of coating material is flat and fan-like, with diverging edges, and substantially in a single plane. A nozzle with a circular rather than an elongated orifice and having a spinner insert, may be used to provide a hollow, diverging conical film.

At the forward end of the film there is a zone or area of break-up in which the desired fine particles are formed. The electrode 27 is desirably located outside the film, to avoid disturbing the film and the particle formation. The forward end of electrode 27 is preferably located adjacent or slightly to the rear of the zone of break-up. The field, which extends from the electrode both to the grounded body portion 22 and to the articles being coated, has a gradient in the vicinity of the particle formation such that a charge is imparted to the particles. The field extending from the electrode to the articles causes the charged particles to be attracted to the articles so that a substantial portion of the particles which otherwise would have fallen to the floor or gone past the articles, are deposited on the articles.

As a safety feature, it is desirable that the high voltage be connected with the gun and the exposed electrode 27 only when coating material is being discharged. Accordingly, means are provided for controlling the high voltage in accordance with the position of valve 45. Valve actuator 51 has a switch operating portion 51a which extends rearwardly into the interior of handle 15. A voltage control switch 68 is operated by actuator portion 51a when the trigger is retracted and valve 45 opened. Switch 68 is connected through wires 68a, a part of cable 21, with a suitable circuit for operating the high voltage power supply. For example (FIG. 1), the switch may be connected in series with the coil of a relay 69 connected across the leads 70, 71, connected with a suitable source of power, not shown. Contacts 69a and 69b of the relay are closed when the relay is energized, connecting the leads 70, 71 with the power supply circuitry (not shown in detail).

Limiting factors on the transverse size of the gun are the spacing required between the high voltage circuit and portions of the structure with which an objectionable discharge might occur, and the physical strength of the body required to withstand the pressure of the coating material. By objectionable discharge is meant either excessive leakage current or a transient spark discharge. The dielectric cable body 21b provides adequate insulation for high voltage conductor 21c even though it extends through the grounded conductive handle 15, and is in close proximity thereto. The conductive button 56 at the forward end of the high voltage cable is isolated from conductive gun body portion 22 and bushing 41 by sleeve 55 which has a higher dielectric constant than body portion 23.

The spacing between passages 28 and 29, and between passages 30 and 31, aligned therewith, at the forward end of conductive body portion 22 and the rear end of barrel portion 23 is determined by the physical strength of the parts, and particularly by the web 23a of the plastic barrel between passages 30 and 31, where bushing 41 is threaded into the barrel. Passage 30 is straight, aligned with passage 28 and parallel with passage 31, to facilitate assembly of the high voltage cable and resistor 57, which cannot be bent on insertion. The spacing between resistor passage 30 and coating material passage 31 is maintained throughout the major portion of barrel 23. However, the current flow through the high voltage circuit is sufficient to reduce the voltage at the forward end of resistor 57 and the spacing between the high voltage circuit and coating material passage 31 may be reduced without danger of arcing from the high voltage circuit to other structure, as the nozzle or valve.

At the forward end 57a of resistor 57 is silver coated for good contact with connector spring 59. The forward end 58a of resistor 58 is preferably coated with a graphite material which, while conductive for connection with conductor 63, has an appreciable resistance to minimize the effective capacity of the system.

The close spacing of resistor passage portion 30a and coating material passage 31 makes it possible to reduce the diameter of the forward end of the gun. It is desirable, however, that the forward gun structure be circular in cross-section and symmetrical about the forward end of the coating material passage 31. This permits the use of threaded retainer nut 36 and nozzle cap 38, and
symmetrical valve and nozzle housings 35 and 37. In addition to the downward step in passage 30, a slight upward step is provided in coating material passage 31. The coating material passage 31 is preferably substantially straight throughout the body of the gun, to facilitate the design and operation of the valve and to eliminate sharp corners which would increase the flow resistance and would be subject to wear, particularly with coating materials containing abrasive particles.

The slight step 31b in the coating material passage permits valve stem 46 to lie against the upper surface of the passage, leaving the lower portion of the passage free for flow of coating material. The compact cross-section of the lower portion of the flow passage has less flow resistance than would an annular flow passage of equivalent area, if the valve stem were centered in the passage. In addition, the valve stem is stabilized and guided by contact with the passage wall. Valve 45 and the valve holder are centered in the passage portion ahead of step 31b so that the flow of coating material through the valve is uniform and not concentrated in one zone. An extension of the axis of the valve seat coincides with the axis of valve rod 47 and the valve actuator 51.

Valve housing 35 is positioned on the forward end of barrel 23, closing the end of resistor passage portion 30a. A pin 75 extends into an opening 76 in the valve housing insuring alignment of conductor 64 with conductor 63, in the high voltage circuit.

Nozzle housing 37 has a boss 77 extending rearwardly therefrom to locate the nozzle on the valve housing. Boss 77 may be selectively located in one of a plurality of recesses, as 78, on the forward portion of the valve housing. In the embodiment of the invention illustrated herein, the aperture or orifice 44a of nozzle 44 is an elongated slot (FIG. 4). The recesses 78 on the nozzle housing are preferably located with a spacing of 90°, so that orifice 44a may be oriented either vertically or horizontally.

The valve seat 42 is of a wear resistant material, as stainless steel or tungsten carbide. The inner diameter of valve seat 42 is slightly less than the inner diameter of passage 43 through the valve housing. It is necessary to replace the valve seat, a tool may be inserted from the left end of the valve housing to force the valve seat out.

Valve rod 46 has sufficient flexibility to permit ball valve member 45 to seat properly on the chamfered sealing surface 42a of the valve seat. With the valve closed, the area of the valve supporting structure exposed to the pressurized coating material tends to hold the valve seated. This pressure is developed primarily on the right hand or rear face of screw 48. The central portion of the ball valve member 45 is not exposed to the coating material and has no force acting against it tending to open the valve. A relatively high initial force is required on the trigger 16 to lift ball valve 45 from its seat. As soon as coating material enters the space between the ball and seat 43, the force tending to open the valve is increased by the fluid force with the result that valve opens rapidly. This eliminates any initial dribble of coating material which might occur if the valve were held partially open or opened slowly.

The high pressure hose line for coating material ends in a fitting 80 secured to adapter fitting 81 connected with the inner or rotary member 82 of the swivel coupling (FIG. 7). Outer member 83 of the swivel coupling is threaded into the filter housing 26 and is seated against a spring 84. Inner member 82 turns on a bearing, 85, preferably of low friction plastic, and is sealed with outer member 83 by an O-ring 86. A portion 87 of the bore of inner swivel coupling member 82 has a tool receiving configuration, as a hexagonal cross-section, so that the inner member may be held securely while fitting 81 is attached thereto. Retainer nut 88 holds inner member 82 in place and has a bore similarly configured for receiving a tool to tighten it in place.

The filter 90, which may be a sleeve of wire mesh material, is mounted on a base 92 held in place by spring 84 and having a passage 92a through which the coating material flows into an annular chamber 93 around the valve stem bushing 41. Ports 94 through the bushing provide for the flow of coating material into bore 41a and passage 31.

With the high pressures under which the coating material is handled in a hydrostatic apparatus, leakage is a particularly troublesome problem. It is essential that the coating material be excluded from the resistor passage, that leakage from the gun itself be avoided and that solvent used in cleaning be kept from handle 15 and switch 68.

Bushing 41 is threaded into the gun body 23 and this joint is sealed with an O-ring 96 (FIG. 3). An O-ring 97, located immediately adjacent the ring 96, provides a seal between bushing 41 and bore 29 through gun body portion 22. A further sealing ring 99 is provided around valve stem bushing 41, rearwardly of the paint inlet passage.

At the forward end of the barrel, valve housing 35 is sealed with barrel extension 23b by a sealing ring 102. Any coating material which escapes past this seal is trapped in an annular groove 103 from which it is drained through passage 104.

Nozzle 44 is seated against and sealed with a resilient washer 105 received in a recess in the forward face of valve holder 35.

The interior of handle 15 is sealed by a ring 107 received in a channel in the rear face of body member 22. O-ring 108 provides a seal with the high voltage cable fitting 54, at the base of the handle. O-ring 109 seals with valve actuator 51.

Closure 62, at the forward end of resistor passage 30a is sealed with the walls of the passage by means of an O-ring 106.

The gun may readily be cleaned by removing retainer nut 36 releasing the valve housing and the nozzle housing which is carried thereon.

If it is desired to change the nozzle, as to utilize a nozzle with a different spray configuration, it is necessary merely to remove nozzle cap 38, lift off nozzle housing 37 and replace it with a housing carrying the desired nozzle.

A modified high voltage circuit in the nozzle portion of the gun is illustrated in FIG. 8. Parts which have already been identified by reference numeral are indicated by the same reference numeral and will not be described in detail again. Sealing plug 62 has a conductor 110 therethrough with a loop portion 110a in contact with the face or terminal of resistor 58. The forward 110b of conductor 110 is coiled for resilience and contacts a body of conducting cement filling recess 111 in the rear face of valve holder 35. A wire 112 extends through the valve holder and has a coiled spring portion 112a in recess 113 at the forward end of the
holder. Nozzle housing 114 has a conductive coating 115 over the rear surface thereof which is contacted by the resilient end 112a of conductor 112. Coating 115 is applied after nozzle 44 is inserted in the holder and makes a good electrical contact with the nozzle body. Charging electrode 116 is press-fit in a hole in the nozzle housing and has a portion 116a which extends along and in contact with the edge of the nozzle. This construction eliminates difficulty encountered with the construction of FIG. 4 where coating material became lodged in the groove ahead of nozzle 44 and around the looped portion 27a of electrode 27.

A further modified high voltage circuit is shown in FIG. 9. Again, elements of the construction which have been described above and identified by reference numeral are assigned the same numeral and will not be described in detail again. Sealing plug 120 is of a semi-conductive plastic material, as a plastic impregnated with graphite particles. A central point 121 formed in the plug extends into conductive cement filling the cavity 122 in the rear face of valve housing 35. Conductor 123 extends forwardly through valve housing 35 from cavity 122 to a recess in the forward surface in which nozzle sealing washer 124 is seated. Nozzle washer 124 is of a conductive resilient plastic material and interconnects the end 123c of conductor 123 with nozzle 44. Electrode 116 is press-fit in the nozzle holder 114 and contacts the side of nozzle 44, as in FIG. 8.

While I have shown and described a preferred embodiment of my invention, it is to be understood that it is capable of many modifications. Changes, therefore, in the construction and arrangement may be made without departing from the spirit and scope of my invention as disclosed in the appended claims.

I claim:

1. Apparatus for hydrostatic atomization and electrostatic deposition of coating material on a surface to be coated, comprising: an elongated body of insulating material having two passages therethrough, terminating adjacent the forward end thereof; means connecting one of said passages with a supply of liquid coating material under sufficient pressure to effect discharge of said material through an orifice for hydrostatic atomization; means for controlling the flow of coating material through said one passage; circuit means in the other of said passages, connectable with a source of high potential; first closure means mounted on said body, closing one of said passages; second closure means mounted on said body and closing the other of said passages, the one of said closure means closing said resistor passage including circuit means connected with said resistor means, and the other of said closure means including a surface defining said orifice in communication with said first passage, there being a conductive charging electrode operably associated with the discharge from said orifice and connected through said circuit means with said high voltage source for electrostatically charging atomized particles of coating material discharged from said orifice.

2. Apparatus for hydrostatic atomization and electrostatic deposition of coating material on a surface to be coated, comprising: an elongated body of insulating material having two passages therethrough, terminating at the forward end thereof; means connecting one of said passages with a supply of liquid coating material under sufficient pressure to effect discharge of said material through an orifice for hydrostatic atomization of the material; means for controlling the flow of coating material through said one passage; resistor means in the other of said passages, connectable with a source of high potential; first closure means mounted on said body, closing one of said passages; second closure means mounted on said body and closing the other of said passages, the one of said closure means closing said resistor passage including circuit means connected with said resistor means, and the other of said closure means including a surface defining said orifice in communication with said first passage, there being a conductive charging electrode operably associated with the discharge from said orifice and connected through said circuit means with said high voltage source for electrostatically charging atomized particles of coating material discharged from said orifice.

3. Apparatus for hydrostatic atomization and electrostatic deposition of coating material on a surface to be coated, comprising: an elongated body of insulating material having two passages therethrough, terminating at the forward end thereof; means connecting one of said passages with a supply of liquid coating material under sufficient pressure to effect discharge of said material through an orifice for hydrostatic atomization of the material; means for controlling the flow of coating material through said one passage; resistor means in the other of said passages, connectable with a source of high potential; first closure means mounted on said body closing the other of said passages and retaining said resistor means therein, said first closure means including a conductor connected with said resistor means; and second closure means mounted on said first closure means and including a nozzle having said orifice therein and positioned in communication with said coating material passage, there being a conductive charging electrode mounted on said second closure and extending outwardly therefrom, adjacent said orifice, and connected through said conductor with said resistor means and the source of high voltage for electrostatically charging atomized particles of coating material discharged from said orifice.

4. The apparatus of claim 3 wherein said first closure member has formed therein a flow passage in communication with said coating material passage and includes a valve seat forming part of said flow control means.

5. The apparatus of claim 3 wherein said second closure has a recess with a conductive nozzle insert therein, with said electrode having a portion held in said recess by said nozzle insert, and said nozzle is in the circuit between said electrode and said conductor.

6. The apparatus of claim 3 wherein said second closure has a conductive rear surface in contact with said conductor, and said electrode and nozzle are connected with said surface.

7. The apparatus of claim 3 wherein said nozzle seats against a conductive sealing washer carried by said first closure and connected with said conductor, and said electrode has a portion in contact with said nozzle.

8. A hand gun for hydrostatic atomization and electrostatic deposition of coating material on a surface to be coated, comprising: an elongated body of insulating material having two spaced passages extending longitudinally therethrough and terminating at the forward end thereof, a handle extending from said body at a rear portion thereof; means connecting one of said passages with a supply of liquid coating material under sufficient pressure to effect discharge of said material
through an orifice for hydrostatic atomization; resistor means in the other of said passages, connectable with a source of high potential; a first closure member mounted on said body closing the other of said passages and retaining the resistor means therein; said first closure member having an orifice in alignment with said one passage; a conductor extending through said first closure member and connecting with the forward terminal of said resistor means; a retaining ring securing said first closure member to said body; a valve seat in the orifice of said first closure member, said valve seat having a flow passage therethrough; a valve member in said one passage and engageable with said valve seat to close said one passage; a valve stem extending rearwardly through said one passage; spring means urging said valve stem forwardly to seal said valve member; a valve operating trigger pivotally mounted on said body adjacent said handle and connected with said valve stem, for manual actuation of said valve; a second closure member mounted on said first closure member and including a nozzle having said orifice therein and positioned in communication with the flow passage of said valve seat; a retaining ring securing said second closure member to said first closure member; and a conductive charging electrode mounted on said nozzle and extending outwardly therefrom, adjacent the orifice therein, said charging electrode being connected through said conductor in the first closure member with said resistor means and the source of high voltage for electrostatically charging atomized particles of coating material discharged from said orifice.

9. A handgun for hydrostatic atomization and electrostatic deposition of coating material on a surface to be coated, comprising: an elongated body of insulating material having two passages therethrough, terminating adjacent the forward end thereof; a handle at the rear of said body; means connecting one of said passages with a supply of liquid coating material under sufficient pressure to effect discharge of said material through an orifice for hydrostatic atomization; a liquid coating material inlet housing of conductive material forming an extension of said one passage, at the rear thereof and adjacent said handle; resistor means in said other passage; a high voltage cable connectable with a source of high voltage, extending through said handle into said other passage, and connecting with a rear terminal of said resistor means; a nozzle having said orifice in communication with said one passage; and an electrode operably associated with said orifice and connected with said resistor means for electrostatically charging atomized particles of coating material discharged from said orifice.

10. The handgun of claim 9 wherein a valve is provided adjacent the forward end of said coating material passage, and the spacing between the forward end of the resistor passage and the forward end of the coating material passage is substantially less than the spacing between the rear ends of said passages.

11. The handgun of claim 10 wherein a step is formed in said resistor passage, and said resistor means is in two sections, said step being less than the diameter of said resistor sections, the ends of said resistors overlapping.

12. Apparatus for hydrostatic atomization and electrostatic deposition of coating material on a surface to be coated, comprising: an elongated body of insulating material having two passages therethrough, terminating at the forward end thereof, means connecting one of said passages with a supply of liquid coating material under sufficient pressure to effect discharge of said material through an orifice for hydrostatic atomization, the passages being spaced from the longitudinal axis of the body, with at least the forward portion of the body being offset from the remainder thereof and having a generally circular cross-section about said coating material passage; means for controlling the flow of coating material through said one passage; circuit means in the other of said passages, connectable with a source of high potential; a nozzle having said orifice in communication with said one passage; and an electrode operably associated with said orifice and connected with said circuit means for electrostatically charging atomized particles of coating material discharged from said orifice.

13. Apparatus for hydrostatic atomization and electrostatic deposition of coating material on a surface to be coated, comprising: an elongated body of insulating material, said body having a generally oval cross-section, with two passages extending longitudinally therethrough and offset from the axis of the body, said passages terminating at the forward end of the body; means connecting one of said passages with a supply of liquid coating material under sufficient pressure to effect discharge of said material through an orifice for hydrostatic atomization, the forward portion of the body being offset from the remainder thereof and having a generally circular cross-section about said coating material passage; means for controlling the flow of coating material through said one passage; resistor means in the other of said passages, connectable with a source of high potential; a nozzle having said orifice in communication with said one passage; and an electrode operably associated with said orifice and connected with said resistor means for electrostatically charging particles of coating material discharged through said orifice.

14. The apparatus of claim 12 wherein said nozzle is mounted in a circular carrier held in position on said body by a threaded retainer collar.

15. Apparatus for hydrostatic atomization and electrostatic deposition of coating material on a surface to be coated, comprising: an elongated body portion of insulating material having two passages therethrough terminating adjacent the forward end thereof; a body portion of conductive material joined with said body of insulating material and having two passages therethrough in alignment with the passages of the body of insulating material; a tubular member extending into a passage in each of said body portions, aligning said body portions; means connecting one of the passages of said body portions with a supply of liquid coating material under sufficient pressure to effect discharge of the material through an orifice for hydrostatic atomization; high voltage circuit means extending through the other passage of said body portions; a nozzle having said orifice in communication with said one passage of the insulating body; and an electrode operably associated with said orifice and connected with said high voltage circuit means for electrostatically charging atomized particles of coating material discharged from said orifice.

16. The apparatus of claim 15 wherein said tubular member is a sleeve of high dielectric material around said high voltage circuit means and extending through
the corresponding passages of the two body portions, said passages being straight and in substantial axial alignment.

17. The apparatus of claim 15 wherein said tubular member is a bushing mounted in the end of the coating material passage of said body of insulating material and extending into the corresponding passage in said conductive body portion.

18. A hand gun for hydrostatic atomization and electrostatic deposition of coating material on a surface to be coated, comprising: a body portion of insulating material having two passages therethrough, terminating adjacent the forward end thereof; a conductive body portion connected with the rear of said insulating body portion, including a handle, said conductive body portion having two passages extending at least a portion of the way therethrough and aligned with the two passages of said insulating body portion; means for aligning said two body portions, including a sleeve of dielectric insulating material extending through one pair of aligned passages of said two body portions; means connecting the other of said passages with a supply of liquid coating material under sufficient pressure to effect discharge of said material through an orifice for hydrostatic atomization; a high voltage cable connectable with a source of high voltage extending through said handle into the sleeve in said pair of passages; a resistor in said sleeve, connected with said cable; a nozzle having said orifice in communication with said other passage; and an electrode operably associated with said orifice and connected with said resistor for electrostatically charging atomized particles of coating material discharged from said orifice.

19. Apparatus for hydrostatic atomization and electrostatic deposition of coating material on a surface to be coated, comprising: an elongated body portion of insulating material having a passage therethrough, terminating adjacent the forward end thereof; a second body portion connected with the rear of said first body portion and having a passage therethrough in alignment with the passage of said first body portion; a bushing carried in the passage of the first body portion and extending into the passage of the second body portion, said bushing having a flow passage therethrough; means connecting the flow passage of said bushing with a supply of liquid coating material under sufficient pressure to effect discharge of said material through an orifice for hydrostatic atomization; and a nozzle having said orifice, at the forward end of said body member and in communication with said passage.

20. The apparatus of claim 19 wherein a valve is located in the passage of the first body portion, actuated by a trigger carried on said second body portion and including a valve rod extending forwardly through the coating material passage and rearwardly through a packing gland carried by said bushing.

21. Apparatus for hydrostatic atomization and electrostatic deposition of coating material on a surface to be coated, comprising: an elongated body of insulating material having a passage therethrough, terminating adjacent the forward end thereof; a bushing at the rear of said body; means connecting said passage with a supply of liquid coating material under sufficient pressure to effect discharge of said material through an orifice for hydrostatic atomization; means forming a valve seat in said passage having a flow opening therethrough, said flow opening having a chamfered surface; a carrier mounted on said actuator and having a recess in the end thereof; and a ball valve member received in said recess and secured therein by cement, said ball member being movable into seated engagement with said chamfered surface, said valve actuator being movable to move the ball from said seat; high voltage supply means; a nozzle having an orifice in communication with said coating material passage; a conductive charging electrode operably associated with said orifice; and circuit means connecting said charging electrode with said high voltage supply for electrostatically charging atomized particles of coating material discharged from said orifice.

22. In apparatus for atomizing liquid coating material and electrostatically depositing the material on a surface to be coated: an elongated body of insulating material having a passage therethrough; a source of high voltage; resistance means in said passage and connected with said high voltage source; a sleeve of high dielectric material intimately surrounding said resistance means; a paste dielectric material filling the spaces in said passage surrounding said sleeve; and an electrode connected with said resistance means for electrostatically charging atomized particles of said coating material.

23. Apparatus for hydrostatic atomization and electrostatic deposition of coating material on a surface to be coated, comprising: an elongated body of insulating material having a passage therethrough, terminating adjacent the forward end thereof; means connecting said passage with a supply of liquid coating material under sufficient pressure to effect discharge of said material through an orifice for hydrostatic atomization; means for controlling the flow of coating material through said passage; resistor means connectable with a source of high potential; a nozzle having said orifice in communication with said coating material passage, with cooperating surfaces on said nozzle and gun body establishing a plurality of predetermined positions of the nozzle on the body; a conductive charging electrode operably associated with said orifice; and circuit means connecting said electrode through said resistance means with said high voltage source for electrostatically charging particles of atomized coating material discharged from said orifice.

24. The apparatus of claim 23 wherein said nozzle has an elongated orifice, and is mounted in a carrier removably secured to said body, there being keying surfaces on said carrier and body establishing two positions of the nozzle relative to the body, with the orifice displaced substantially 90° between the two positions, and said electrode is mounted on said carrier to retain a fixed position with relation to said orifice.

25. Apparatus for hydrostatic atomization and electrostatic deposition of coating material on a surface to be coated, comprising: an elongated body of insulating material having a passage therethrough, terminating adjacent the forward end thereof; means connecting said passage with a supply of liquid coating material under sufficient pressure to effect discharge of said material through an orifice for hydrostatic atomization; valve means at a forward point in said passage, for controlling the flow of coating material through said passage; a valve actuator rod extending forwardly from said valve; circuit means connectable with the source of high potential; a nozzle having said orifice in communication with said one passage; a conductive charg-
ing electrode operably associated with said orifice and connected through said circuit means with said source of high voltage; and a switch actuated by said valve actuator rod to control said high voltage with operation of said valve.

26. The apparatus of claim 25 for use as a hand gun having a handle at the rear of said body and a trigger adjacent said handle and between said valve and switch, and said valve actuator rod has a portion extending rearwardly from said trigger for actuating said switch.

27. The hand gun of claim 26 in which said switch is mounted in said handle, and said handle is sealed with said body.

28. Apparatus for hydrostatic atomization and electrostatic deposition of coating material on a surface to be coated, comprising: an elongated body of insulating material having two passages therethrough, terminating adjacent the forward end thereof; means connecting one of said passages with a supply of liquid coating material under sufficient pressure to effect discharge of said material through an orifice for hydrostatic atomization; means for controlling the flow of coating material through said one passage; circuit means in the other of said passages, connectable with a source of high potential; first means mounted on said body, closing the other of said passages; second means mounted on said body and extending across said one passage and including a surface defining the orifice in communication with said one passage; a conductive charging electrode operably associated with the discharge from said orifice; and further circuit means connecting said electrode through the circuit means in said other passage with said high potential source for electrostatically charging atomized particles of coating material discharged from said orifice.

29. Apparatus for hydrostatic atomization and electrostatic deposition of coating material on a surface to be coated, comprising: an elongated body of insulating material, said body having two passages extending longitudinally therethrough and offset from the axis of the body, said passages terminating at the forward end of the body, means connecting one of said passages with a supply of liquid coating material under sufficient pressure to effect discharge of said material through an orifice for hydrostatic atomization, the forward portion of the body being offset from the remainder thereof and having a generally circular cross-section about said coating material passage; means for controlling the flow of coating material through said one passage; resistor means in the other of said passages, connectable with a source of high potential; a nozzle having said orifice in communication with said one passage; and an electrode operably associated with said orifice and connected with said resistor means for electrostatically charging particles of coating material discharged through said orifice.

* * * * *
UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,815,820  Dated June 11, 1974

Inventor(s) Richard O. Probst

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 13, line 67, after "surface;" insert -- a valve actuator --; Column 14, line 2, "received" should read -- swaged --.

Signed and sealed this 3rd day of December 1974.

(SEAL)
Attest:
McCoy M. Gibson Jr.
Attesting Officer

C. Marshall Dann
Commissioner of Patents