United States Patent

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[72] Inventors **Richard O. Probst; Kenneth E. Pollard, both of Indianapolis, Ind.**

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[73] Assignee **Ransburg Electro-Coating Corp. Indianapolis, Ind.**

[54] **SPRAY GUN FOR APPLYING SOLID PARTICLES**
17 Claims, 2 Drawing Figs.

[52] **U.S. Cl.** **239/15,** 239/143, 239/302, 239/591
[51] **Int. Cl.** **B05b 5/02**
[50] **Field of Search** 239/3, 15, 142, 143, 144, 302, 303, 307, 308, 339, 526, 591, 602

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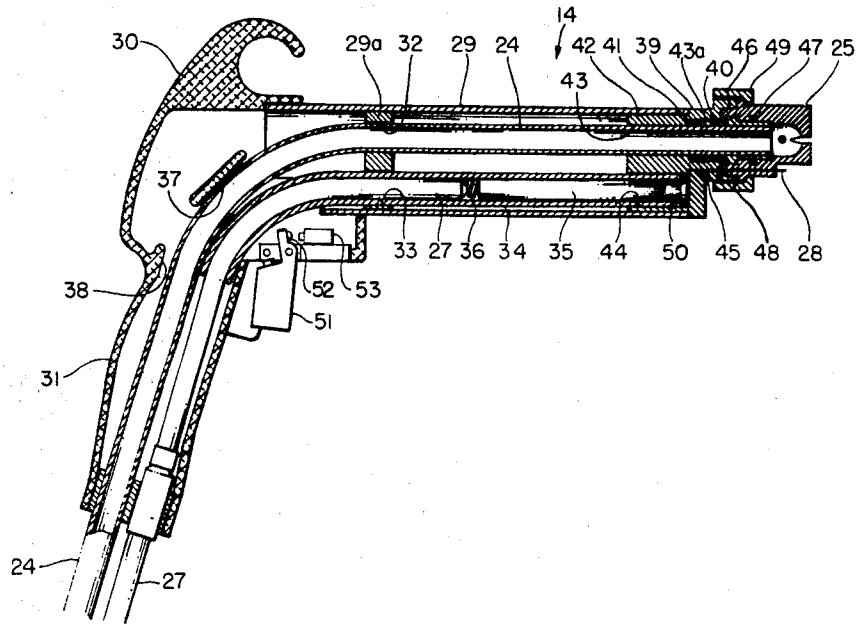
Primary Examiner—M. Henson Wood, Jr.
Assistant Examiner—Michael Y. Mar
Attorneys—Merrill N. Johnson, Harry E. Downer, David H. Badger and Charles W. Hoffmann

ABSTRACT: A spray gun for applying solid particles to an article includes a handle and a barrel member. The passageway for conveying a suspension of solid particles in a carrier gas is an elongated flexible tube which extends from the spray nozzle through a bore in the barrel member, the handle and outwardly from the gun to the source of coating material particles. Such a gun can also include an elongated insulator forming a passageway for high-voltage circuit means within the gun and curved between the grip portion of the handle and another bore in the barrel. A closure means of insulating material at the front of the barrel can include a portion projecting into the barrel to provide electrical insulation for the connection between the high-voltage circuit means and an electrode mounted on the front of the spray gun. The closure means can also provide a means for attaching a spray nozzle at the front of the gun.



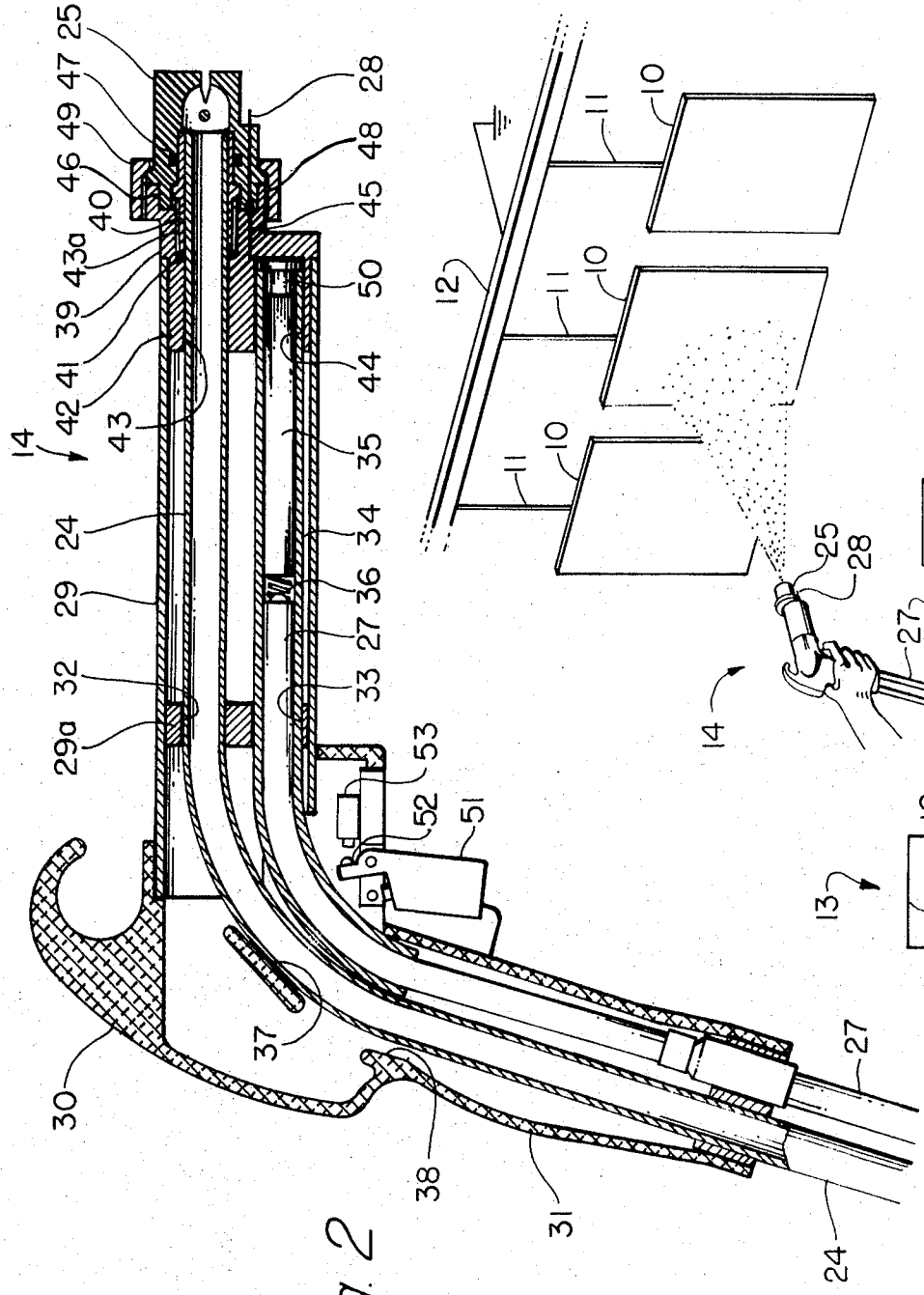


Fig. 1

Fig. 2

INVENTORS

KENNETH E. POLLARD

RICHARD O. PROBST

SPRAY GUN FOR APPLYING SOLID PARTICLES

BACKGROUND OF THE INVENTION

This invention relates to an improved spray gun for applying solid particles and more particularly to such a gun which includes means to electrostatically charge such solid particles for application.

Guns in common use for spraying and electrically charging solid particles have included a barrel member of nonconducting material having passageways for the solid particles of coating material and for the high-voltage circuit components used to charge the solid particles. Some of these early guns have included a metallic handle member depending angularly from the gun adjacent its rear to permit an operator to support and manipulate the gun. In such guns the passageway for solid particles was an integral portion of the gun and extended through the gun along a straight line. The conduit carrying solid particles to the gun was attached to the gun at its rear with a hose fitting. Where such a gun included a grip portion dependent from the gun, the conduit would extend over the hand of the operator and, although flexible, would impose forces on the hand of the operator which were fatiguing and restrained the manipulation of the spray gun.

Other hand guns have been proposed having essentially a straight barrel to be used in a wandlike manner when manipulated by an operator. Fixedly supported guns have been similarly arranged.

One such fixed gun, however, included a tube forming a passageway for solid particles. A deflector for the solid particles was adjustably positioned forwardly of the passageway. Means to adjust the deflector extended along the passageway and rearwardly of the gun. The tube forming the passageway was curved near the rear of the gun to provide a portion to which a conduit for solid particles was attached. The tube was connected to a high-voltage source and was supported on a fixed holder in operation.

FEATURES OF THE INVENTION

This invention provides a spray gun which is more readily manipulated than any disclosed in the prior art. A gun of this invention includes as a passageway an elongated flexible tube from the spray nozzle at the front of the gun to the source of solid particles to be applied. The spray gun includes a handle having a grip portion and a barrel. The elongated flexible tube forming a passageway for solid particles is curved to angle within the grip portion of the handle and a bore in the barrel and terminates adjacent a spray nozzle at the forward end of the gun. In electrostatic spray guns, the barrel member is of nonconducting material and includes, in addition to the bore for the elongated flexible tube, another bore. An elongated insulator is contained in this bore and curves within the grip portion of the device. The elongated insulator forms a passageway for high voltage circuit means within the spray gun. At the front of such an electrostatic gun, closure means is provided having two bores. The closure means includes a portion at its rear which extends into the bore of the barrel. One bore in the closure means accepts the elongated flexible tube, and means is provided to attach a spray nozzle at the front of the gun on the axis of this bore. The other bore is closed at its front end and accepts the elongated insulator. Means to electrically connect the circuit means in the elongated insulator with an electrode at the front of the spray gun is carried within the closure means. The preferred embodiment of such a gun is shown in the attached drawings.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective drawing of a system for electrostatically charging and applying solid particles to articles to be coated including a spray gun embodying this invention.

FIG. 2 is a cross-sectional view through the center of the spray gun of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Many coatings are more advantageously applied in dry powder form than as resins dissolved in a liquid carrier. Such coatings include those formed from pigmented resins of polyethylenes, nylon, polyvinyl chloride and epoxides among others. FIG. 1 illustrates a method of applying such materials to an article using the apparatus of this invention.

Where thermoplastic or thermosetting powder material is to be applied to an article, the article in some instances is raised to a temperature above the fusion temperature of material but below the temperature at which the material is deleteriously affected. The solid particles of material upon being deposited upon the article are fused into a continuous film. In other instances where electrostatic charging is used, heating is sometimes unnecessary and the solid particles which are deposited on the article are retained on the surface of the article as a coating of discrete particles by virtue of their electrostatic charge until they can be fused.

Although articles of many configurations may be coated, the articles **10** are illustrated in FIG. **1** as plates. Articles **10** are hung from conductive supporting members **11** depending from a conveyor **12**, which is maintained at ground potential. The articles **10** are electrically connected to ground potential by electrical contact with the conductive depending members **11** and the grounded conveyor **12**.

Solid particles of the coating material to be applied are placed in a fluidized bed. This fluidized bed is formed in a source of coating material **13** for the spray gun **14**. The source **13** includes a foraminous plate **15** forming the lower surface of the fluidized bed. Compressed air is supplied to an inlet **16** on the source of coating material **13**. The compressed air is connected through a flow control regulator **17** (the details of which are not shown) to a chamber **18** within the source of coating material **13**. Foraminous plate **15** forms the upper surface of chamber **18**. In operation, a flow of compressed air to chamber **18** is controlled by regulator **17**. The air passes from chamber **18** through the foraminous plate **15** producing a fluidized bed of solid coating material particles, indicated as **19**, within the source **13**. An injection pump **20** within the fluidized bed **19** is used to withdraw coating material particles from the bed for delivery to spray gun **14**.

Compressed air from inlet **16** passes through flow control regulator **21** (the details of which are not shown) and solenoid valve **22** (the details of which likewise are not shown). In operation a controlled flow of air passes through regulator **21** and valve **22** into a nozzle within the injection pump **20**. The compressed air passing through the nozzle within pump **20** creates a reduced pressure at an opening **23** of the injection pump. Coating material particles are withdrawn from fluidized bed **19**, entrained in the flow of compressed air and directed into an elongated flexible tube **24**.

Solid particles of coating material are conveyed suspended in the compressed air through the elongated flexible tube into spray gun **14**. Delivery of coating material to spray gun **14** is controlled by the operator of the spray gun by manipulation of a trigger which actuates solenoid valve **22**, as will be explained. When the operator of the spray gun wishes to apply coating material particles to an article to be coated, he merely depresses the trigger of the spray gun. Coating material particles are withdrawn from source **13** in the manner described and delivered through the elongated flexible tube **24** to spray nozzle **25** on the spray gun. Actuation of the trigger also turns on a source of high voltage **26**. Electric charge is conducted through a high-voltage conductor **27** into spray gun **14**. Coating material particles supplied to spray nozzle **25** are formed into a pattern suitable for application of the solid materials to the article to be coated. Solid particles emitted from the spray nozzle **25** are electrostatically charged by an electrode **28** at the front of the gun and connected with the high-voltage conductor **27** within the spray gun **14**. The spray nozzle can be changed when different spray pattern is desired. Using such a

spray gun, the operator can select the pattern most suitable for applying solid particles to the article to be coated and can easily manipulate the spray gun directing a flow of charged solid particles at the article 10 to achieve a uniform coating on the article.

Details of the regulators 17 and 21 to control the flow of compressed air are not shown since such regulators are in common use and their selection can be made readily by one skilled in the art. An example of such a regulator is Kendall Model 30 Air Pressure Regulator, manufactured by Fairchild-Hillor. Details of the solenoid valve 22 are likewise not given. An example of such a valve is Skinner Precision Industries, Inc. Solenoid Valve No. V30B2100.

The structure of spray gun 14 which is the preferred embodiment of this invention, is shown in FIG. 2. The spray gun 14 includes a barrel including a barrel portion 29 attached to a handle 30 including a grip portion 31 depending at an angle below the barrel to provide a spray operator with means to grip and manipulate the spray gun. The barrel member 29 is constructed of nonconducting material and includes two bores 32 and 33. Bores 32 and 33 have a short length at only the rear of barrel member 29 which is largely in the form of a relatively thin-walled tube.

An elongated insulator 34 forms a tubular passageway for circuit means within the gun. The elongated insulator 34 is within bore 33 of the barrel member 29 and is curved into the grip portion 31 of handle 30. It is formed of nonconductive material, has a sufficient wall thickness to withstand high voltages, such as 50,000 to 100,000 volts, which are applied to the gun, and provides a surface which will not act as a path for high voltage. Non conductive materials suitable for this application include for example, Delrin, nylon and polyethylene. Polyethylene is a preferred material for use as the elongated insulator since a wall thickness of about one-eighth inch will provide sufficient insulation against voltages of 50,000 to 100,000 volts and a surface of several inches in length will resist sparking of these voltages over the surface.

The elongated insulator 34 contains the end portion of the high-voltage conductor 27, which is a high-voltage cable of the type commonly in use in electrostatic coating apparatus, and a resistor 35 within the spray gun, preferably adjacent the forward portion of the barrel. The resistor 35 is several inches long and is electrically connected to conductor 27 with a small spring 36. The connection 36 between high-voltage conductor 27 and resistor 35, the point of highest voltage within the spray gun, is thus well insulated from the handle and the forward portion of the gun. The elongated insulator 34 extends several inches rearwardly of this connection and is curved into the grip portion 31 of the handle. Angling the elongated insulator 34 from the barrel into the grip portion of the handle permits a shorter overall gun length. Resistor 35 is a multimegohm resistor having a typical value of 160 megohms.

The passageway for solid particles within the gun is formed by the elongated flexible tube 24. The elongated flexible tube 24 defines the entire passageway for conveying solid particles suspended in compressed air between the source 13 and the spray nozzle 25 at the forward end of spray gun 14. The elongated flexible tube is inserted in the grip portion 31 of handle 30 and into the bore 32 of barrel member 29. The handle 30 contains means within it in the form of surfaces 37 and 38 to support the elongated flexible tube. Assembled within the spray gun, the elongated flexible tube curves between the grip portion 31 of the handle and bore 32 of the barrel.

The spray gun 14 at its forward end includes the closure means 39 including a compression member 40 and an elastic member 41. Closure means 39 includes projecting portion 42 at its rear adapted to enter and be fastened to the forward end of barrel member 29. Two bores 43 and 44 pass through the projecting portion 42 at its rear in alignment with bores 32 and 33 respectively. Elongated flexible tube 24 passes within bore 43 and compression member 40 to the forwardmost portion of closure means 39. Compression member 40 and closure means 39 are threadedly engaged at the forward threaded portion 43*a* of bore 43. As compression member 40 is threaded into closure means 39, elastic member 41 is compressed and grips elongated flexible tube 24 to fasten it within spray gun 14.

Elongated insulator 34 is within bore 44 of closure means 39. Bore 44 is closed at its forward end by closure means 39 which includes means 45, in the form of a small wire, electrically connecting the circuit means within said elongated insulator to a surface in recess 46 at the forward end of closure means 39. The forward end of closure means 39 also includes a threaded portion 48 to provide means on the axis of bore 43 for attaching spray nozzle 25 to spray gun 14. Spray nozzle 25 carries an O-ring 47 in a groove to seal the spray nozzle with compression member 40. The rear surface of spray nozzle 25 carries a portion that projects into recess 46 when mounted on closure means 39. The electrode 28 carried by spray nozzle 25 extends into the projecting portion of the nozzle and is electrically connected with the source of high voltage by contacting electrical connecting means 45 within the recess 46 at the front of closure means 39. Spray nozzle 25 and electrode 28 are attached to the front portion of barrel 29 by a threaded nut of nonconductive material 49 which engages the threaded portion 46 of the closure means 39.

Because of the arrangement of elongated insulator 34, closure means 39 (particularly the projecting portion 42 at its rear end), and barrel 29, the electrical connection between the forward end of resistor 35 and the electrical connecting means 45 of closure means 39 is prevented from sparking to the operator's hand or other such grounded objects approaching the front portion of the barrel of spray gun 14. Elongated insulator 34 passes forwardly through bore 33 into closed bore 44 of the closure member 49. Semiconducting pluglike member 50 extends into the passageway of elongated insulator 34 and contacts resistor 35 thus interconnecting resistor 35 with the electrically connecting means 45 of closure means 39. Portion 42 of closure means 39, projects rearwardly into the barrel 29 a sufficient distance so that a circuitous path is formed over the surfaces of elements 34, 39, and 29 having a sufficient distance to prevent sparking or other electrical leakage between the electrical connection at element 50 and the outside of spray gun 14. Closure means 39 provides sufficient insulation thickness between pluglike member 50 and electrical connecting means 45 and its exterior surface to prevent sparking through the closure means to a grounded object approaching the front of the gun. In like manner the recess 46 at the front of closure means 39 permits the formation of a circuitous path from the connection between electrode 28 and means 45 to the exterior of the spray gun 14 over the surfaces of elements 25, 39, and 48.

In the preferred embodiment, barrel member 29 of the barrel is constructed of electrically nonconductive material. Materials suitable for use in the barrel member include phenolic, epoxy, nylon, Delrin, polyethylene, polypropylene and other such materials. Barrel 29 may be formed by casting, injection molding, or machining of these nonconductive materials. As shown in FIG. 2, the barrel member 29 is formed of a relatively thin-walled phenolic tube having a phenolic insert 29*a* cemented in its rear that has been drilled to provide bores 32 and 33. Closure means 39 of the barrel is likewise preferably formed of electrically nonconductive material. Materials identified as suitable for use for barrel member 29 are also suitable for use for the closure means 39. As noted previously, the projecting portion 42 at the rear of closure means 39 is adapted to enter the barrel member 29. Use of a barrel like that comprised by composite barrel member 29 and closure member 39 removes weight from the forward portion of the gun and permits it to be economically made.

The elongated flexible tube 24 is preferably formed of a nonconducting material such as nylon or polyethylene tubing. As a specific example, a spray gun like that shown in FIG. 2 would use a nylon hose having an inside diameter of three-eighths inch and an outside diameter of one-half inch.

The handle 30 is preferably formed of a metallic material which can be cast such as for example aluminum or zinc. The metallic handle is maintained at ground potential by a braided conductor (not shown) forming the outside part of the cable used as the high-voltage conductor 27. The braided conductor portion of high-voltage conductor 27 is connected to the handle 30 and to a ground connection at the voltage supply. The operator gripping portion 31 of handle 30 will, thus, be maintained at ground potential and prevented from accumulating a static charge which might form a harmful uncontrolled electric discharge.

In operation, the operator depresses trigger 51 mounted on handle 30. As the trigger is depressed, a portion 52 extending into the handle actuates switch 53 contained within the handle 30. Conductors from electrical switch 53 (not shown) run through the grip portion of the handle and are connected to voltage supply 26 (FIG. 1) and solenoid valve 22 (FIG. 1) in such a manner as to turn on the voltage supply and to open the solenoid valve when the trigger is depressed. Air flowing through injection pump 20 thus entrains the solid particles of coating material from the fluidized bed 19 and directs it into the elongated flexible tubing 24 forming the powder material passageway within the gun. The entire passageway from the injection pump to the spray nozzle has a uniform cross section and a smooth wall without any discontinuity. Within the spray gun the elongated flexible tube curves gradually between the grip portion of the handle and the barrel. Thus, the coating material particles flow to the nozzle in a stable suspension. In addition, no solid particles are trapped in the passageway. The operator may easily clean the passageway and in changing from one material to another avoid contamination of the second material with a residue of materials used earlier. The continuous passageway also prevents solid particles from contaminating the interior of the spray gun without resorting to any seal members within the spray gun.

An advantage of this construction exists which is independent of use in an electrostatic gun. Where abrasive solid particles are applied, such particles flowing through a spray gun erode the passageway through which they pass.

This erosion is particularly troublesome if the coating passageway bends as the particles due to their momentum will tend to impinge on the wall at such a bend. This problem was largely avoided where the coating material passageway did not curve into the grip portion of the handle but extended rearwardly from the barrel along a straight line and passed out the rear of the gun over the hand of the operator. Attaching the solid particle conduit in such a manner was unsatisfactory since the tubing through which coating material was delivered to the gun imposed a torquelike force on the spray gun which would fatigue an operator and restrict the manipulability of the gun. As in the preferred embodiment illustrated in FIG. 2, the elongated flexible tubing, or the passageway for coating materials, can enter a spray gun at the base of the grip portion of the handle, a position where it imposes the least possible restriction on the manipulability of the spray gun, and curve into a barrel portion of the gun. In a sense, such a structure includes a self-contained and ready supply of replacement parts. In the event of failure of the coating material passageway because of erosion of its walls by solid particles, the spray nozzle and a compression member, like 40, can be removed from the front end of the gun. The elongated flexible tube which forms the passageway with its walls, can be pushed or pulled forwardly through the spray gun and the portion of the tube containing the failure can be cut from the end and discarded. Replacing the compression member and elastic member at the front of the barrel will fasten the elongated flexible tube to the gun and operation can be continued. This procedure can be repeated until the elongated flexible tube leading from the source of solid particles becomes too short to permit ready manipulation of the spray gun. Such a spray gun can thus be readily repaired many times without the delay of obtaining spare parts.

While we have shown and described the preferred embodiment of our 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 the invention as disclosed in the following claims.

We claim

1. An electrostatic spray gun for charging and depositing powder particles comprising,
   - a handle including a grip portion,
   - a barrel of nonconducting material including two bores,
   - a closure means including a projecting portion at the rear and adapted to enter the forward end of the barrel, and including two bores in alignment with the bores of the barrel,
   - an elongated flexible tube forming a passageway for powder particles from the gun and angled to pass within the grip portion of the handle and one of the bores of the barrel and of the closure means,
   - an elongated insulator forming a passageway for circuit means within the gun and angled to fit within the grip portion of the handle and the other of the bores of the barrel and the closure means,
   - said closure means including at its forward end a compression member on the axis of the elongated flexible tube and threadedly engaging the closure means, and means to grip the elongated flexible tube as the compression member is threadedly engaged.

2. The electrostatic spray gun of claim 1 wherein the elongated flexible tube angled between the barrel and the grip portion of the handle forms a smooth curve.

3. The electrostatic spray gun of claim 1, including a spray nozzle attached to the closure means on the axis of the elongated flexible tube and providing a seal with the compression member.

4. The electrostatic spray gun of claim 1 wherein the compression member is a cylinder around the elongated flexible tube and threaded into the forward end of the bore carrying the elongated flexible tube, and the means to grip the elongated flexible tube is an elastic member located in position to be compressed between the compression member and the closure means as the compression member is threaded into the bore.

5. The electrostatic spray gun of claim 1 wherein the barrel includes a barrel member comprised of a thin-walled tube and an insert providing the two bores.

6. An electrostatic spray gun for charging and depositing powder particles comprising,
   - a handle including a grip portion,
   - a barrel member of nonconducting material including two bores,
   - a closure means including a projecting portion at the rear adapted to enter the forward end of the barrel and including two bores in alignment with the bores of the barrel,
   - an elongated flexible tube forming a passageway for powder particles within the gun and curved to pass within the grip portion of the handle and one of the bores of the barrel and of the closure means,
   - an elongated insulator forming a passageway for circuit means within the gun and gradually curved to fit within the grip portion of the handle and the other of the bores of the barrel and the closure means,
   - said closure means including at its forward end means for attaching a spray nozzle on the axis of the bore for said elongated flexible tube and including means to electrically connect circuit means in the bore of said insulator to a forward surface of the closure means.

7. The electrostatic spray gun of claim 6 including means at the forward end of the closure means to fasten the elongated flexible tube within the spray gun.

8. The electrostatic spray gun of claim 7 wherein the means to fasten the elongated flexible tube includes a cylindrical compression member around the elongated flexible tube and threadedly engaging the closure means.

9. The electrostatic spray gun of claim 8 including a spray nozzle mounted on the compression means, attached to the closure means, and providing a seal between the compression means an the spray nozzle.

10. A gun for spraying solid particles, comprising,

a handle,

a barrel projecting from the handle and including a bore,

spray forming means attached to the forward end of the barrel,

an elongated flexible tube including a passageway for conveying solid particles suspended in gas passing within the handle and the bore of the barrel, the tube curving gradually in the gun,

means to fasten the elongated flexible tube with the gun, the flexible tube adapted to be moved with respect to the gun when the tube is unfastened from the gun,

the passageway of said elongated flexible tube being substantially smooth walled and having a substantially uniform cross section from a source of solid particles to the spray forming means whereby the solid particles flow to the spray forming means in a substantially stable suspension.

11. The gun of claim 10 including a cylindrical compression member around the elongated flexible tube and threadedly engaging the forward end of the barrel, and means compressed as the compression member is threadedly engaged to grip the elongated flexible tube.

12. The gun of claim 11 including a seal member between the cylindrical compression member and the spray forming means.

13. The electrostatic spray gun of claim 6 wherein the elongated flexible tube has a substantially uniform cross section from a source of solid particles to the spray nozzle whereby the solid particles flow to the nozzle is a substantially stable suspension.

14. A spray gun for spraying solid particles comprising a barrel including a bore,

a handle including a portion depending at an angle from the barrel,

a spray nozzle adjacent to the forward end of the barrel,

an elongated flexible tube including a passageway for conveying solid particles suspended in a gas within the portion of the handle depending at an angle from the barrel and within the bore in the barrel, the passageway of the flexible tube curving gradually in the handle to reduce erosion of the passageway at the curve by solid particles flowing thereby and the passageway having a substantially uniform cross section from a source of solid particles to the spray nozzle whereby the solid particles flow to the nozzle in a substantially stable suspension.

15. The spray gun as claimed in claim 14 wherein a closure means is adjacent the forward end of the barrel and attaches the nozzle to the forward end of the barrel, the closure means engaging the elongated flexible tube to locate the tube within the forward end of the barrel.

16. The spray gun as claimed in claim 14, wherein the barrel includes two bores, the second of the bores including an elongated insulator for electrical circuit means, the elongated insulator includes a curved portion in the handle.

17. A spray gun for spraying solid particles comprising a barrel including a bore,

a handle including a portion depending at an angle from the barrel, and

means adapted to be moved with respect to the barrel, the means including a passageway for conveying solid particles suspended in a gas within the portion of the handle depending at an angle from the barrel and within the bore in the barrel, the passageway curving gradually in the handle to reduce erosion of the passageway at the curve by solid particles flowing thereby and the passageway having a substantially uniform cross section from a source of solid particles to a spray nozzle connected to the bore whereby solid particles flow to the nozzle in a substantially stable suspension.

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,617,000 Dated November 2, 1971

Inventor(s) Richard O. Probst et al.

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

Column 3, line 13, "V30B2100" should read -- V530B2100 --. Column 4, line 33, "49" should read -- 39 --. Column 6, line 17, "from" should read -- within --. Column 7, line 4, "an" should read -- and --.

Signed and sealed this 29th day of August 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

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