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Shaffer

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[54] ELECTROSTATIC SPRAY COATING APPARATUS

[75] Inventor: **Patrick D. Shaffer,** Prospect Heights, Ill.

[73] Assignee: **Binks Manufacturing Company,** Franklin Park, Ill.

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

[51] **Int. Cl.** **B05b 5/00**

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

[56] **References Cited**

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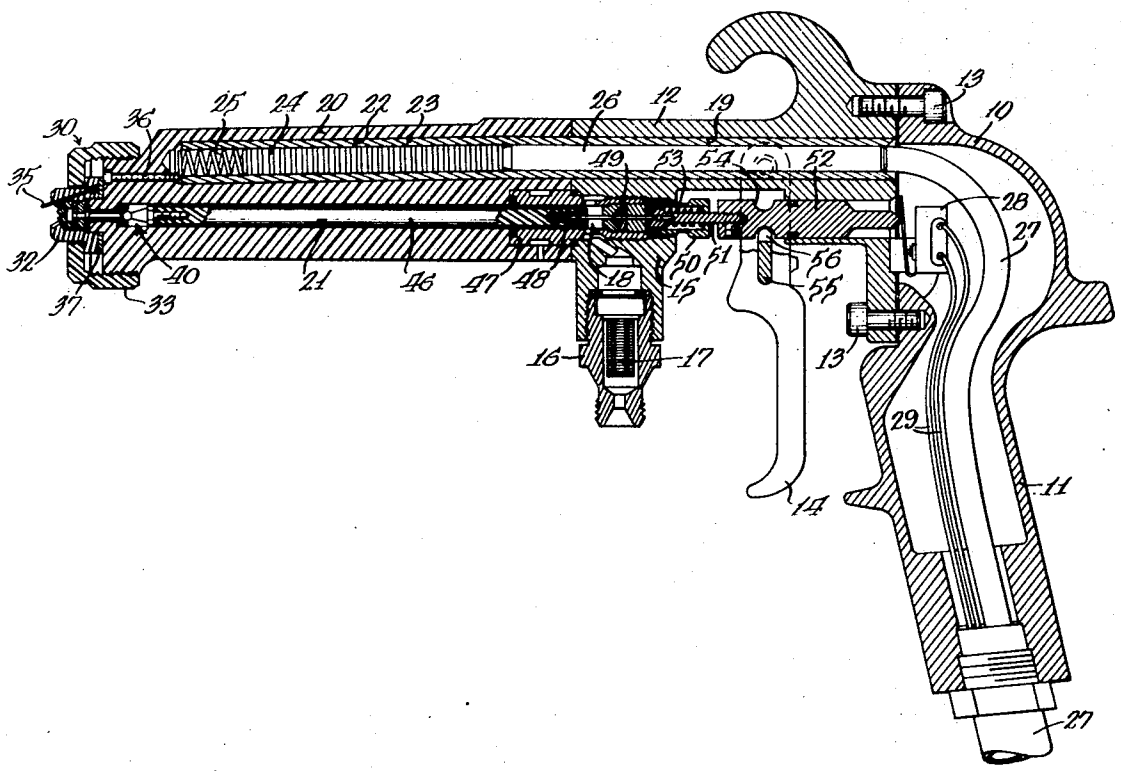
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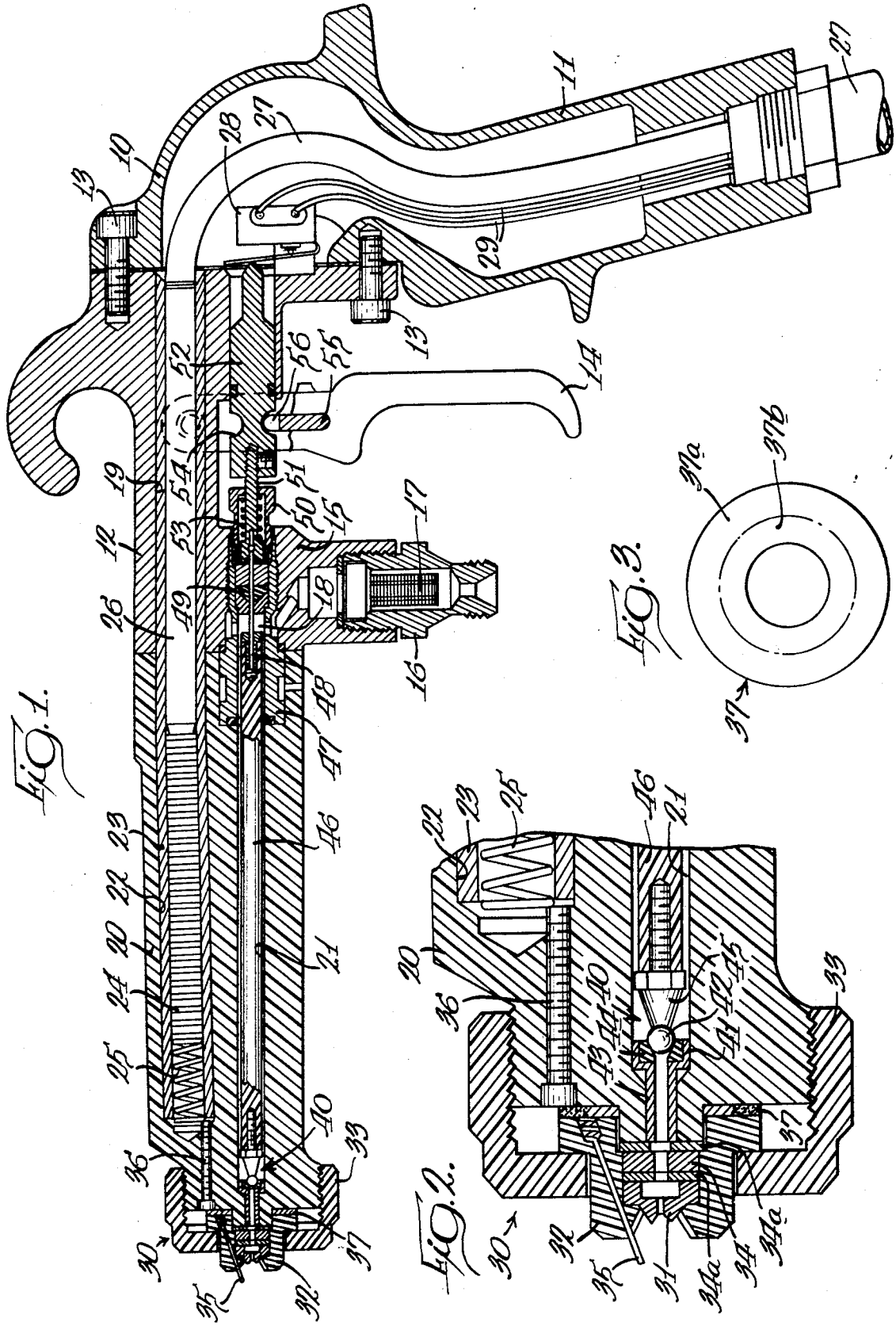
Primary Examiner—M. Henson Wood, Jr.
Assistant Examiner—Michael Mar
Attorney—Lee J. Gary, Thomas R. Juettner and Charles F. Pigott, Jr., et al.

[57] **ABSTRACT**

Electrostatic spray coating apparatus including means for mechanically atomizing coating materials and means for electrostatically charging and depositing the atomized material onto articles, characterized by the features, individually and collectively, of improved means including an improved charging electrode for the efficient and effective charging of the material, and enhanced overall construction for greater service life, more reliable and safe operation, and economy.

8 Claims, 3 Drawing Figures




FIG. 1.
FIG. 2.
FIG. 3.

ELECTROSTATIC SPRAY COATING APPARATUS

BACKGROUND OF THE INVENTION

Manual and automatic spray guns for mechanical atomization and electrostatic deposition of coating materials such as paint, lacquer, varnish and the like are known from such previously issued U.S. Pats. Nos. as 2,805,642; 3,048,498; 3,169,882; 3,169,883; 3,251,551; 3,253,782; 3,268,171; 3,583,632; etc. In general, the material is atomized from a nozzle either by forcing the material through an appropriately shaped nozzle under adequate hydraulic pressure (hydraulic or "airless" atomization) or by impinging streams of air on a stream of the material (air atomization) as shown for example in U.S. Pat. No. 3,583,632 issued to Duane Krohn and me. Atomization may also be effected by centrifugal force and by electrostatic forces. As the material is atomized, an electrostatic charge is imparted to the coating material which causes the charged particles of atomized material to be attracted to work pieces or articles which are purposely grounded, whereby to cause most of the material to be deposited on the work.

SUMMARY OF THE INVENTION

A primary object of this invention is to provide improved means for electrostatically charging the coating material, especially to insure effective charging of each particle in a hydraulically atomized spray to enhance its attraction to the grounded work.

Another object is to provide optimum safety in use and operation of airless electrostatic spray guns.

A further object is to provide an improved airless spray gun of great reliability and serviceability.

Other objects and advantages will become apparent from the drawings and the following description, which are given for the purpose of acquainting those skilled in the art with the manner of making and using my invention, and especially with the best mode presently contemplated by me of carrying out the invention.

THE DRAWINGS

FIG. 1 is a vertical longitudinal section of a manually operated, hydraulic atomizing, hand spray gun embodying the invention;

FIG. 2 is a vertical section of the nozzle portion of the gun taken on an enlarged scale; and

FIG. 3 is a front view of one of the charging elements used in the gun.

DESCRIPTION

The hydraulic or "airless" hand gun of the invention is comprised of an electrically conductive handle portion **10**, an insulating barrel portion **20**, and a nozzle assembly **30** which is electrically insulating to the extent feasible in an airless gun.

The handle **10** is of conventional configuration, the same being formed of metal or other electrically conductive material and including a hollow hand grip **11**, a forwardly projecting main or body portion **12** to which the hand grip is bolted at **13**, and a pivotally mounted trigger **14**. The main or body portion **12** is provided forwardly of the trigger with a depending fluid or material inlet section **15**, which may appropriately be equipped with a depending hose fitting **16** and a filter or strainer **17** for the supply of coating material to the gun. The inlet section **15** is provided with a first longitudinal passage or port **18** for the coating material to be sprayed and the body portion **12** is provided with a second longitudinal passage or port **19** for reception of electrostatic charging components.

The barrel **20** is formed of insulating material capable of withstanding the high pressures normally employed in hydraulic or airless spraying, i.e., in the order of up to about 2,000 p.s.i. The barrel has a pair of longitudinal bores **21** and **22** therein aligned respectively with and constituting continuations of the bores **18** and **19**. The bores **19** and **22** are lined with a continuous sleeve **23** of insulating material, preferably material having both high physical strength and high dielectric strength. The sleeve receives therein, with close tolerance, a resistor **24** having conductive caps at its opposite ends. The purpose and function of the resistor are described in detail in U.S. Pat. No. 3,048,498, and also U.S. Pat. No. 3,169,883. The bore **22** is dead ended adjacent the forward end of the barrel **20**, the sleeve **23** extends to the end of the bore and a compression spring **25** is confined between the end of the bore and the inner conductive end of the resistor. Rearwardly of the resistor, the sleeve **23** is adapted for reception of a conductive probe **26** provided on the end of a high voltage power supply cable **27** which is extended through the hollow hand grip **11** to the rearward end of the sleeve. Details of the probe are shown in U.S. Pat. No. 3,583,632.

A microswitch **28** is mounted within the hand grip **11** for actuation by the trigger **14** for controlling the supply of high voltage to the gun. Low voltage control leads **29** extend from the switch to the cable **27** and extend back through the cable to the high voltage source for performing a control function at the source, whereby high voltage is supplied to the gun only when the gun trigger is depressed.

The nozzle assembly **30** comprises a carbide or other wear-resistant spray tip **31** of conventional construction, an electrically insulating plastic holder **32** for the tip and a cap or collar **33** of electrically insulating plastic material for detachably mounting the holder on the forward end of the barrel **20** with the tip **31** aligned with the material bore or passage **21**. The cap **33** is conventional, having screw threads therein for detachable coupling to a complementary external thread provided at the forward end of the barrel **20**. If desired, a preorifice insert **34** may be used with the tip **31** as described in U.S. Pat. No. 3,000,576; and the tip is sealed to the barrel **20** by washers **34***a*.

Mounted within and projecting through the tip holder **32** is a charging needle **35** which extends from the rear face of the holder downwardly and forwardly into contact with the spray tip **31** and then forwardly from the holder and tip into a position proximate to the spray pattern of atomized particles emanating from the spray tip when the gun is in operation. The particular relation of the charging needle to the spray orifice and spray pattern is described in detail in U.S. Pat. No. 3,169,883.

The charging needle **35** contacts the spray tip **31** in the illustrated embodiment because the tip is formed of tungsten carbide which is electrically conductive. If electrically insulating materials are developed from which airless spray tips can be made, it will not be necessary for the needle to contact the tip. However, when the tip is conductive, contacting the needle with the tip provides a safety feature in that it eliminates a gap

therebetween within which an extraneous and undesirable electrical charge could develop, especially when spraying conductive coating materials.

To conduct the electrostatic charging current from the power cable **27** and safety resistor **24** to the needle **35**, a conductive screw **36** is extended through the barrel **20** from the forward face of the barrel into contacting engagement with the resistor biasing spring **25**.

Heretofore, in spray guns of the general character, it has been conventional to contact the needle **35** directly with the screw or conductor **36**, with the consequent disadvantage that the spray tip and holder could have only a single rotational disposition relative to the gun body or barrel. When spraying with a tip producing a fan-shaped spray pattern, the fan pattern could appear only in the same vertical plane as the gun barrel and hand grip, which imposed limitations on the operator in use of the gun pursuant to the wide variety of techniques conventionally employed in the spray painting industry. Also, in assembly of tips and holders, the tip always had to have a precise rotational disposition relative to the needle.

These disadvantages of the prior art are overcome pursuant to this invention by the provision of an electrically conductive washer **37** between the holder **32** and the forward face of the barrel **20**, whereby the needle can contact the washer at any rotationally offset position relative to the screw **36** and still be in electrical contact with said screw. Thus, the spray tip and holder can be set at any desired rotational disposition relative to the gun body or barrel without diminution or loss of electrostatic charging power.

The novel washer **37** is shown in FIG. **3** in its preferred form as being a unitary annular body comprised of an outer annular band or ring **37a** of electrically conductive (preferably silver impregnated) polytetraflouroethylene and an inner annular band or ring **37*b*** of regular or insulating polytetraflouroethylene. By forming the washer of the two bands or rings, the capacitive effect thereof in the circuit is greatly diminished. By forming the same from polytetraflouroethylene, the washer also provides a supplemental seal between the nozzle and the gun body.

For controlling the flow of coating material to the spray nozzle, the barrel **20** is provided at the forward end of the bore or passage **21** with a control valve **40** comprising a valve seat member **41** and a valve ball **42**. The valve seat comprises a tubular stainless steel body or carrier **43** inserted in a reduced section at the forward end of the bore **21** and a tungsten carbide seat insert **44** provided with a conical seating surface and inserted in a counter-bore in the rearward end of the carrier **43**. The ball **42**, which engages the conical surface of the seat insert **44** to close off the port through the seat and the carrier, is mounted on the forward end of an extension **45** which is screw threaded into the forward end of an elongate valve stem or rod **46** so as to be detachable therefrom to accommodate replacement of the ball.

The valve stem or rod **46** is formed of insulating material and extends rearwardly from the valve **40** to a sealing gland **47** mounted in a counter-bore in the rearward end of the bore or passage **21**. The rod **46** is there joined with a metallic valve stem wire **48** which extends through another packing assembly or gland **49** mounted within the inlet section **15** and including an adjusting nut or screw **50** threaded into the rearward end of the passage **18**. Rearwardly of the gland **49**, the wire is joined to a short metallic extension **51** which is detachably connected to a metallic plunger **52** that is reciprocably mounted within a bore in the rearward part of the body portion **12** of the gun. At its rearward end, the plunger **52** has a reduced extension adapted to actuate the blade of the control switch **28**.

A compression spring **53** disposed between the nut or screw **50** and a shoulder on the extension **51** normally biases the valve stem components forwardly so as to seat the valve ball **42** on its seat **44**, thereby to close the material passage **18–21**, and to cause the switch **28** to be in open circuit position.

Intermediate its ends, the valve stem plunger **52** is provided with an annular depression or groove **54** adapted for reception therein of a transverse block or slide **55** carried by the trigger **14** and extending immediately below the plunger. The block **55** has a cutout **56** in its upper surface medially of its ends and the block is slidably mounted on the trigger for transverse movement to selectively move the cutout **56** into and out of alignment with the plunger **52**. When the cutout is aligned with the plunger, as shown in FIG. **1**, the block or slide will not be engaged in the groove in the plunger and thus actuation of the trigger will not produce any movement of the plunger or the remainder of the valve stem. This provides a safety feature for protection of the operator when he is changing nozzles or otherwise is not actively engaged in a spray painting operation.

When it is desired to effect spray painting, the operator merely shifts the slide **55** sideways to move the slide into engagement in the groove **54**. Then, when the trigger **14** is depressed or moved rearwardly, the plunger **52** and the remainder of the valve stem are moved rearwardly to open the valve **40** and to close the control switch **28**. Thereupon, coating material is fed at high pressure through the inlet fitting **16**, the filter **17** and the passages **18** and **21**, past the valve **40** and through the spray tip **31** and atomized into a mist of finely divided particles. As the finely divided particles emanate from the spray tip **31**, a high voltage electrostatic charge is efficiently and effectively imparted to them by the tip and the needle **35**, whereby the particles will be attracted to and deposited on a grounded article to be coated.

As will be appreciated, the electrostatic coating material charging components of this gun consist of the tip **31** and the charging needle **35**. If desired, the needle **35** could be omitted so long as the tip **31** is electrically conductive and has good electrical connection with the power supply terminal **36**. Alternatively, if the tip were made non-conductive and/or not used with conductive paint, the needle alone could perform the charging function. However, in the present state of the art, I prefer to employ the combination of the two. The two members are directly coupled to the high tension conductor **27** and are otherwise widely insulated from the remaining metal components of the gun. Paint entering and passing through the gun contacts the tip **31** and is atomized in the presence of the charging needle **35**, whereby essentially all of the discrete particles of the spray are efficiently and effectively charged to high electrostatic potential for efficient deposition on a grounded article of work.

At the same time, the operator is afforded optimum safety by virtue of electrical grounding of all components with which he may come in contact. Specifically,

the gun handle **10** and body portion **12**, and the grounding shield on the power supply cable **27** (which is connected to the hand grip **11**) are commonly grounded. Also, the material to be sprayed is grounded at the main body **12**. The gun operator is thus grounded through the gun handle where he does not and cannot become a capacitative influence in the electrostatic system.

In this manner, we have provided an extremely useful and highly efficient airless electrostatic hand spray gun of great safety, long service life, light weight, convenient handling and aesthetically pleasing design.

The same and/or comparable features can also be embodied in automatic spray guns. For example, the trigger and hand grip could be replaced by an automatic operating mechanism for the valve stem and control switch in much the same manner as disclosed in U.S. Pat. No. 3,583,632, and as will be apparent to those reasonably skilled in the art.

Thus, the objects and advantages of the invention have been shown to be achieved in a convenient, economical and practical manner.

While I have shown and described what I regard to be the preferred embodiment of my invention, it is to be appreciated that various changes, rearrangements and modifications may be made therein without departing from the scope of the invention, as defined by the appended claims.

I claim:

1. In electrostatic spray apparatus having a body including a material passage terminating in an outlet orifice at an end face of the body, nozzle means on said end face of said body communicating with said orifice, electrically conductive means in said nozzle means for imparting an electrostatic charge to the material emanating from said nozzle means, and means for conducting an electrostatic charge to the electrically conductive means in said nozzle means, the improvement comprising conducting means having a terminal spaced from said outlet orifice at said end face of said body, electrically conductive means in said nozzle means having a terminal at the end face of said nozzle means juxtaposed to said body end face, and means disposed between said end faces having an electrically conductive area spanning said terminals for electrically connecting said terminals to one another despite relative offset of said terminals, the means disposed between said end faces comprising a washer having a unitary body formed of concentric rings of conductive and nonconductive material.

2. In electrostatic spray apparatus having a body including a material passage terminating in an outlet orifice at an end face of the body, nozzle means on said end face of said body communicating with said orifice, electrically conductive means in said nozzle means for imparting an electrostatic charge to the material emanating from said nozzle means, and means for conducting an electrostatic charge to the electrically conductive means in said nozzle means, the improvement comprising conducting means having a terminal spaced from said outlet orifice at said end face of said body, electrically conductive means in said nozzle means having a terminal at the end face of said nozzle means juxtaposed to said body end face and a needle projecting from said nozzle terminal through said nozzle means to a position forwardly thereof and proximate to the material emanating from the nozzle means, and means disposed between said end faces having an electrically conductive area spanning said terminals for electrically connecting said terminals to one another despite relative offset of said terminals.

3. In the apparatus of claim **2**, said nozzle means including an electrically conductive spray tip in electrically conductive contact with said needle.

4. In electrostatic spray apparatus having an electrically insulating body including a material passage terminating in an outlet orifice at an end face of the body, nozzle means rotatably mounted on said end face of said body concentric to and in communication with said orifice, electrically conductive means in said nozzle means for imparting an electrostatic charge to the material emanating from said nozzle means, and means for conducting an electrostatic charge to the electrically conductive means in said nozzle means, the improvement comprising conducting means having a terminal spaced radially from said outlet orifice at said end face of said body, electrically conductive means in said nozzle means comprising a terminal at the end face of said nozzle means juxtaposed to said body end face and disposed at approximately the same radial spacing from said outlet orifice and a needle projecting from said terminal on said nozzle means through said nozzle means to a position forwardly thereof and proximate to the material emanating from said nozzle means, and a washer disposed between said end faces having an annular electrically conductive area encircling said orifice at the same radial spacing from said orifice as said terminals for electrically connecting said terminals to one another irrespective of the rotational offset of said terminals.

5. In the apparatus of claim **4**, said nozzle means including an electrically conductive spray tip in electrically conductive contact with said needle.

6. Electrostatic spray apparatus comprising an electrically conductive operator section, an elongate electrically insulating barrel projecting forwardly from said section and having a material passage therein terminating in an outlet orifice, a nozzle assembly detachably mounted on the forward end of the barrel in communication with said orifice, said nozzle assembly being in the main electrically insulating and including therein electrically conductive means for imparting an electrostatic charge to the material emanating from said nozzle assembly, means for carrying a high electrostatic charge to said electrically conductive means including a conductor receiving passage extending through said operator section and said barrel generally parallel to said passage and including means for grounding said operator section, a valve in said passage at said orifice for opening and closing said orifice, a valve stem extending rearwardly through said passage from said valve to said operator section, said valve stem being electrically insulating between said valve and said operator section and being electrically conductive at said operator section, a control switch in said operator section connected with said electrostatic charge carrying means and having an actuator in the path of movement of said valve stem, and means for moving said valve stem rearwardly to open said valve and close said switch and for moving said valve stem forwardly to close said valve and open said switch.

7. Apparatus as set forth in claim **6**, said means for moving said valve stem comprising a trigger and a bar slidably mounted on said trigger having means for se-

lective engagement with and disengagement from said valve stem, the latter means when disengaged from the valve stem preventing actuation of both said valve and said switch.

8. Apparatus as set forth in claim 6, said valve comprising a valve ball detachably mounted on said valve stem and a valve seat removably inserted in said outlet orifice, said seat comprising a tubular carrier and a cylindrical insert of wear resistant material on which the ball seats.

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