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Gauthier et al.

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[54] **APPARATUS FOR COATING WITH ELECTROSTATICALLY CHARGED PARTICULATE MATERIALS**

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[52] **U.S. Cl.** **317/3,** 117/93.4, 239/15

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

[58] **Field of Search** 118/621, 627, 629, 118/7; 117/17, 93.4; 239/15, 3; 317/3

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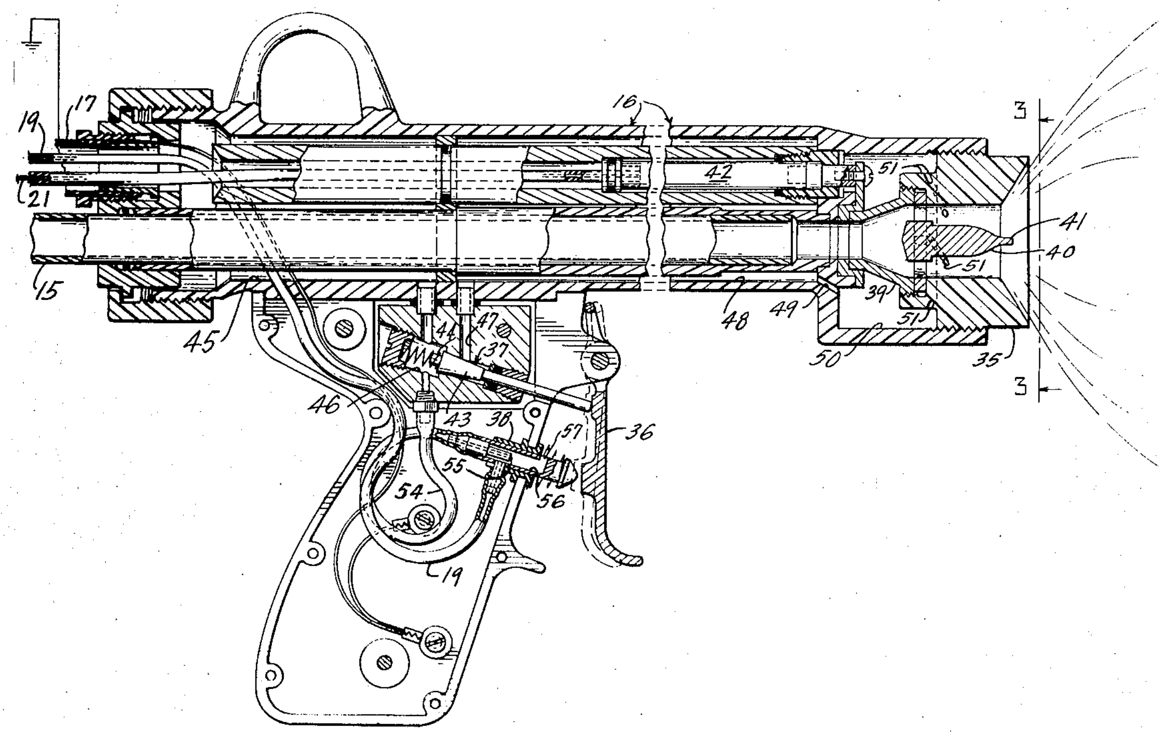
[57] **ABSTRACT**

An improved control device for apparatus for coating articles with an electrostatically charged material in discrete form. The apparatus includes a nozzle having an inlet and a discharge outlet for the particulate material, an electrode for electrostatically charging the particulate material and at least one passage for directing a stream of vortex gas to impart a vortical motion to the particulate material discharged from the nozzle. A trigger on the apparatus operates first and second gas valves. The first valve controls a stream of gas to the vortex gas passages in the nozzle for controlling the pattern of the sprayed material and the second valve operates a pneumatic control to cause a high voltage to be applied to the electrode in the nozzle and to cause a pump to deliver to the nozzle inlet a stream of gas having the particulate material dispersed therein. In a preferred form, the trigger opens the first valve before the second valve and closes the second valve before the first valve. Provision is made for easily cleaning residual material from the pump, the nozzle and an interconnecting tube when changing the material to be sprayed.

8 Claims, 4 Drawing Figures



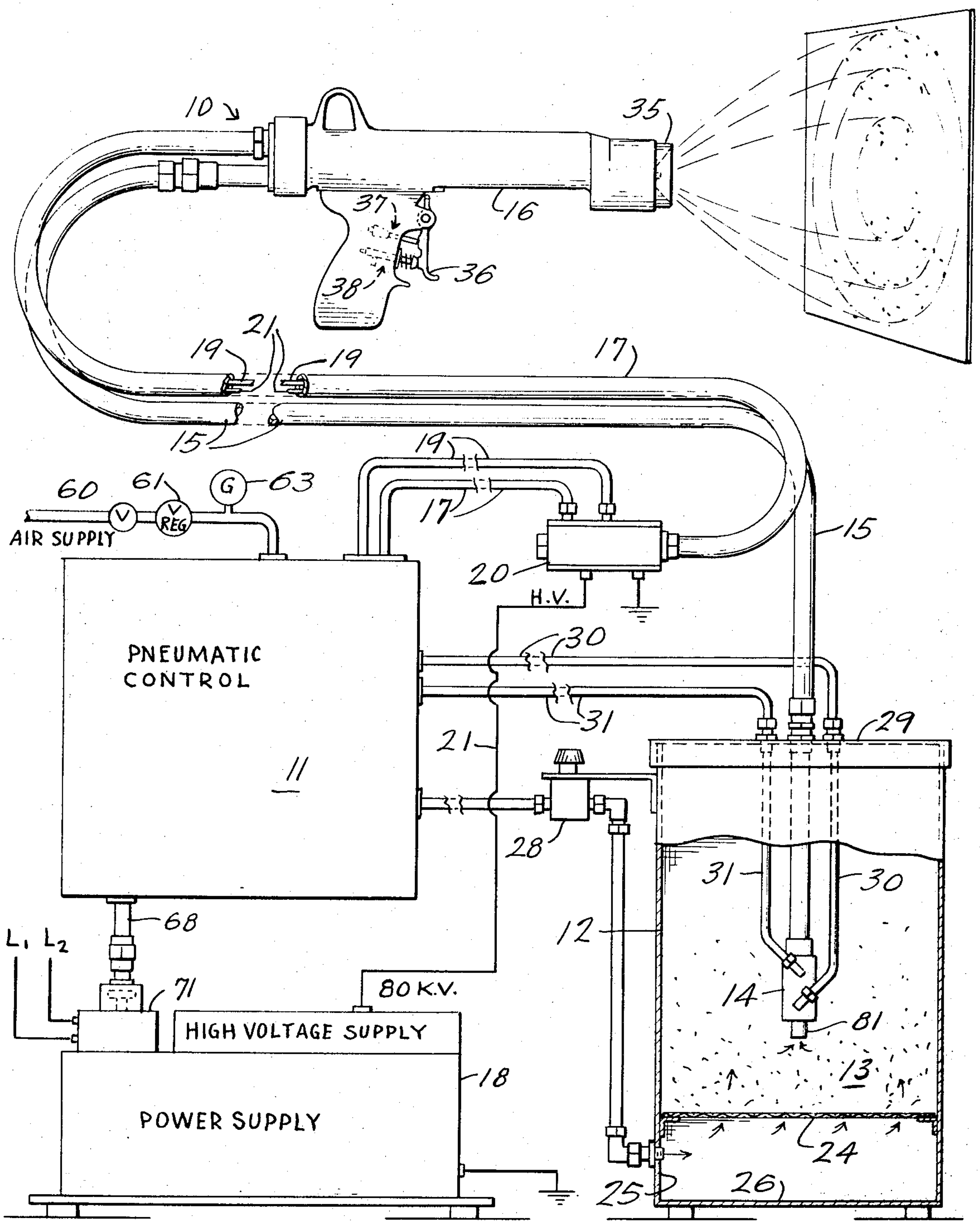


FIG-1-

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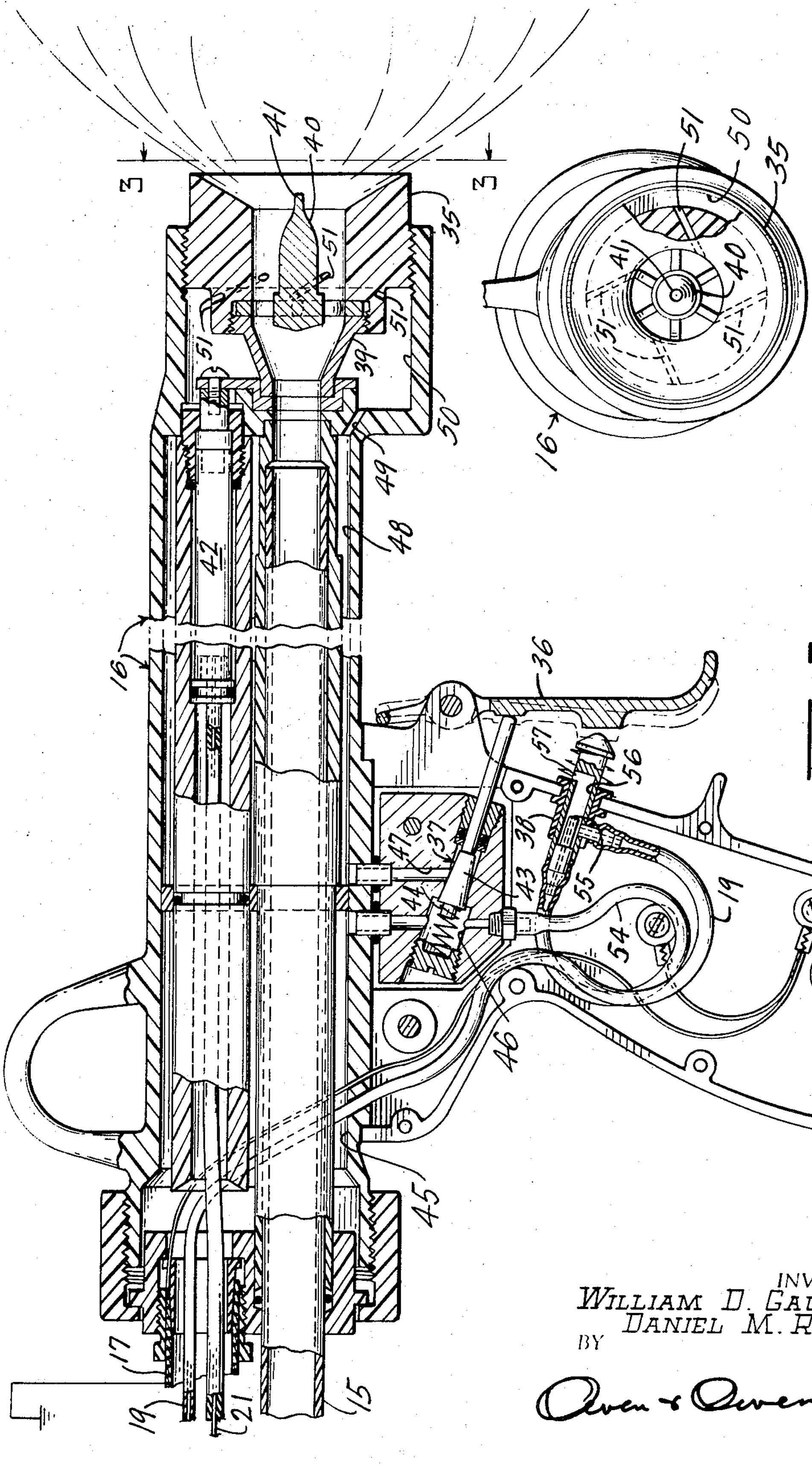

FIG-2-

FIG-3-

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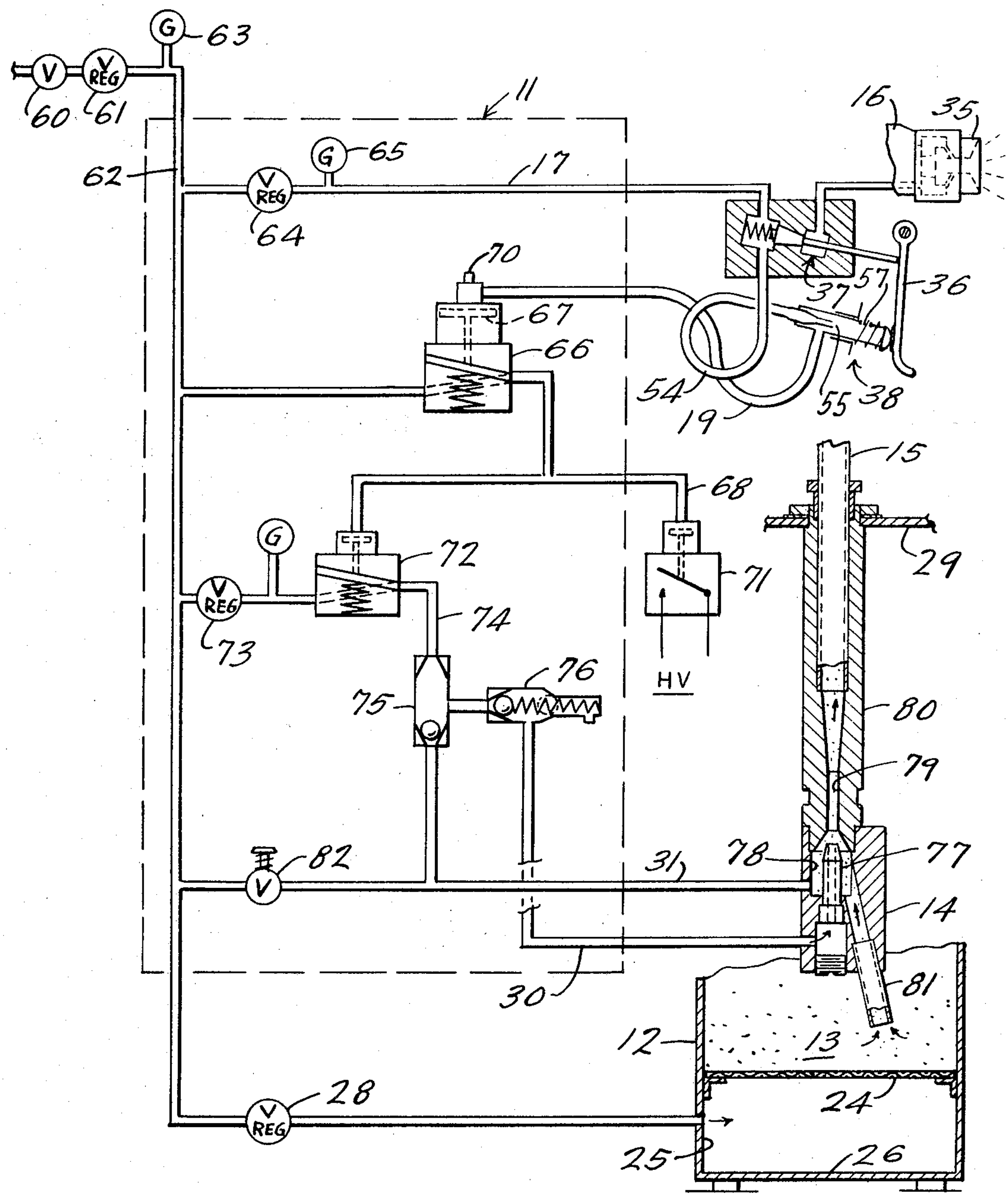

FIG-4-

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APPARATUS FOR COATING WITH ELECTROSTATICALLY CHARGED PARTICULATE MATERIALS

BACKGROUND OF THE INVENTION

This invention relates to apparatus for dispersing an electrostatically charged material in discrete particulate form, such as powders and the like, and more particularly to an improved control device for such apparatus.

Various types of apparatus are used for coating articles with electrostatically charged particulate materials, such as powders, flockings, and the like. The apparatus is typically in the form of a gun having a nozzle for dispersing the particulate material and simultaneously for electrostatically charging the material as it is dispersed. A trigger on the gun closes an electric switch to cause delivery to the nozzle of a stream of gas having the particulate material dispersed therein and to apply a high voltage to an electrode within the nozzle. The trigger also opens a valve to deliver a stream of vortex gas to the nozzle for imparting a vortical motion to the discharged material.

The use of a trigger actuated electric switch within the gun has not been entirely satisfactory. Since the gun is designed for use with powders and other particulate materials, the electric switch should be of an explosion proof type and of an intrinsically safe electrical design. Furthermore, a low voltage is applied to the switch and a very high voltage is applied to the material charging electrode adjacent the gun nozzle. Having two electrical power circuits connected to the gun increases the hazard of electric shock to spray gun operators.

The prior art powder coating systems have an additional disadvantage in that they are frequently difficult to purge or clean when coating with successively different materials or different colored material. Considerable labor expense is wasted, for example, each time a color or material change is made.

SUMMARY OF THE INVENTION

According to the present invention, an improved, pneumatically-operated control device is provided for apparatus for coating with electrostatically charged particulate materials. The apparatus, which may be in the form of a gun, includes a nozzle for dispersing the material and having an electrode for electrostatically charging the material and passages for vortex gas for imparting a vortical motion to the dispersed material. A trigger operates two control valves. A first of the control valves delivers a controlled stream of vortex gas to the nozzle. The volume of the vortex gas is controlled by the trigger to control the size of the pattern of the dispersed material. The second one of the valves, when actuated, applies gas pressure on a tube for actuating a first control valve in the control device. When the first control valve is opened by gas pressure from the second trigger actuated valve, gas pressure simultaneously closes a switch for causing a high voltage to be applied to the charging electrode in or adjacent to the nozzle and opens a second valve for delivering a regulated stream of gas to a material pump for the particulate material.

In the preferred embodiment of the invention, powder or a similar coating material is initially stored in a container having a porous bottom. Fluidizing gas is forced through the porous bottom of the container to place the powder in a fluidized state. The material pump includes a vertically oriented inlet for drawing fluidized material from the container and a tube connecting the powder pump to the charging and dispersing nozzle. The pump inlet is positioned above the powder level in the container when fluidizing gas is not supplied to the container. A manual valve on the control panel is also provided for supplying a stream of purge gas to the powder pump. The purge gas blows any residual material from the powder pump back into the container and also blows such material forwardly from the tubing and the nozzle. The vertical orientation of the pump inlet and of chambers within the pump cause the powder to naturally fall back into the containers during purging. The material pump is preferably mounted on a removable cover for the material storage container such that, after residual material is purged from the pump, the tubing and the nozzle, the pump may be positioned on a different container storing a different particulate material or a particulate material having a different color. Thus, the particulate material being discharged is easily changed to a different material composition or a different colored material.

Accordingly, it is a preferred embodiment of the invention to provide an improved control for apparatus for coating with electrostatically charged discrete particulate material.

Another object of the invention is to provide improved apparatus for coating with electrostatically charged discrete particulate material in which a characteristic of the material being sprayed may be readily changed.

Other objects and advantages of the invention will become apparent from the following detailed description, reference being made to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic diagram of apparatus according to the present invention for spraying electrostatically charged particulate materials;

FIG. 2 is a plan view in section of a depositor gun for dispersing and charging the particulate material;

FIG. 3 is a cross-sectional view taken along line 3—3 of FIG. 2; and

FIG. 4 is a flow diagram showing a pneumatic control according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Turning now to FIG. 1, apparatus is shown for coating with electrostatically charged particulate materials and incorporating a pneumatic control device 11 embodying the principles of the present invention. The apparatus includes a container 12 for holding and fluidizing a supply of particulate or powdered material 13. During operation, a material pump 14 delivers a stream of gas with the particulate material 13 dispersed therein through a tube 15 to a gun 16 which electrostatically charges and disperses the particulate material. A second tube 17 is connected to the gun 16 for supplying high voltage to an electrode 40 (hereinafter described) at the front of the gun from a power supply 18 and compressed gas from the pneumatic control 11 for causing the particulate material to have a vortical motion as it is dispersed from the gun 16. A return tube 19 is located within the second tube 17 for returning from the gun 16 to the pneumatic control 11 a small controlled portion of the gas supplied through the tube 17. A coupler 20 is provided for feeding a high voltage wire 21 from the power supply 18 and the return tube 19 into the tube 17 without loss of gas pressure from the tube 17.

The material container 12 includes a porous gas dispersing bottom 24 which defines the upper wall of a plenum chamber 25 over the bottom 26 of the container 12. The material 13 is introduced above the porous bottom 24. During operation of the apparatus, compressed gas is supplied from the pneumatic control 11 through a pressure regulator 28 to the plenum chamber 25. The compressed gas passes upwardly through the porous bottom 24 to place the powder material 13 in a fluidized state. The material pump 14 is mounted to depend from a removable top 29 for the container 12. The pump 14 is a Venturi type pump operated by compressed gas which is supplied from the pneumatic control 11 through a tube 30. The pneumatic control 11 also selectively supplies compressed gas through a tube 31 for purging residual material from the pump 14, the tube 15 and the gun 16 as hereinafter described. After the system is purged, the container top 29 and the pump 14 may be placed on a different container holding either a different particulate material or a particulate material of a different color. This arrangement permits easy and fast color change.

Referring now to FIGS. 2 and 3, the gun 16, of a type useable with the present invention, is shown in detail. The gun 16 basically comprises a barrel of insulating material terminating in a replaceable nozzle 35, a trigger 36 and first and second valves 37 and 38, respectively, which are controlled by the trigger 36. The fluidized material 13 is delivered through the tube 15 to the nozzle 35. The material delivered to the nozzle 35 passes through a metallic sleeve 39 and past a charging electrode 40, which terminates in a pointed end 41, as it is discharged from the nozzle 35. The high voltage wire 21 from the power supply 18 passes through the tube 17 and is connected through a current limiting resistor 42 to the metallic sleeve 39 which is in turn electrically connected to the charging electrode 40. As particulate material flows past the charging electrode 40, it is charged by the high voltage from the power supply 18, which may be on the order of sixty to eighty kilovolts.

As the trigger 36 is squeezed to operate the gun 16, a valve member 43 in the first control valve 37 is moved against a spring 44 to allow a controlled amount of compressed gas to flow from the tube 17 through a chamber 45 and a chamber 46 within the gun 16 to a passage 47. The passage 47 is connected through passages 48 and 49 to a chamber 50. A plurality of passages 51 in the nozzle 35 direct air from the chamber 50 against the particulate material as it is discharged from the nozzle 35 to cause the particulate material to have a vortical motion. The size of the pattern of the particulate material dispersed from the nozzle 35 is controlled by controlling, with the degree of movement of the trigger 36, the quantity of vortex gas supplied to the nozzle 35 through control of the valve 37. The more vortex gas that flows against the powder stream, the more the dispersion of the powder and the larger the pattern. By cutting back on the vortex gas, the operator can coat with a small circular pattern against small surfaces and, because of the increased forward velocity of the particles, can achieve increased penetration of recessed areas of the work.

The valve 37 is preferably designed to open part way prior to activating the valve 38. Thus when the valve 37 is opened only part way, only a flow of vortex gas is emitted from the nozzle 35. The flow of vortex gas may be useful, for example, for dusting an article either prior to coating with electrostatically charged particulate material or after coating when too much particulate material has been deposited on the article.

As shown in FIG. 4, gas supplied from the tube 17 to the chamber 46 adjacent the valve 37 is also supplied through a tube 54 to the valve 38. The valve 38 includes a small restriction 55 connecting the tube 54 to a chamber 56 and a port or vent 57 connecting the chamber 56 to the atmosphere. The restriction 55 is similar to a Venturi in that a pressure drop occurs across the in 55 in proportion to gas flow. As long as the trigger 36 is in a released position, a small quantity of gas flows through the restriction 55 and the vent 57 to the atmosphere, resulting in only a low gas pressure within the chamber 56. When the trigger 36 is moved a predetermined distance and after the valve 37 is opened by a predetermined amount, the vent 57 is closed to increase the gas pressure in the chamber 56 and to apply the increased pressure to the pneumatic control 11 through the return tube 19, thereby activating the material pump 14 and the high voltage power supply 18. The increased pressure is maintained on the return tube 19 even though the trigger 36 is moved further to increase the flow of vortex gas through the valve 37.

As the trigger 36 is released, the vent 57 in the valve 38 is preferably opened to reduce the gas pressure on the return tube 19 prior to completely closing the valve 37. This assures that vortex gas will be supplied to the gun 16 until the flow of particulate material to the gun has ceased. In a preferred form, the restriction 55 is shaped to define an aspirator. When the vent 57 is opened, gas flowing through the restriction 55 aspirates gas from the return tube 19 to decrease the response time required to de-activate the pump 14 and the power supply 18. The pneumatic control 11 may also be adapted to delay de-activating the power supply 18 until after the pump 14 is shut off and no additional material is discharged from the gun 16.

Turning again to FIG. 4, the pneumatic control 11 is shown in detail. Pressurized gas from a conventional plant source (not shown) is applied through a manual valve 60 and a main pressure regulator 61 to a gas supply line 62. The pressure on the line 62 may be indicated on a gauge 63. Gas at the regulated pressure flows from the line 62 through a second pressure regulating valve 28 to the plenum chamber 25 in the container 12 and through another pressure regulator 64 to the line 17 connected to the gun 16. A gauge 65 is provided for indicating the gas pressure applied to the gun 16 on the line 17.

The return tube 19 is connected from the control valve 38 in the gun 16 to a valve 66. When the gas pressure in the tube 19 reaches a predetermined level, a plunger 67 is moved to open the valve 66, thereby connecting the gas line 62 to a line 68. The valve 66 is shown diagrammatically in its simplest form and may in some instances have auxiliary porting, such as an orifice 70, to increase its sensitivity. The orifice 70 is selected to improve response time characteristics of the system and it also serves to protect the actuating portion of the valve 66 from excessive pressure which might otherwise be developed from the line 19.

The output line 68 from the valve 66 is connected in parallel to a pressure responsive switch 71 and to a pressure responsive valve 72. When actuation of the trigger 36 causes the valve 66 to open and apply gas pressure from the line 62 to the line 68, the gas pressure on the line 68 closes the switch 71 to turn on the power supply 17, thereby applying high voltage over the line 21 to the electrode 40 in the nozzle 35. The pressure on the line 68 also opens the valve 72 to allow gas to flow from the line 62 through a pressure regulator 73 to a line 74. The line 74 is connected through a shuttle valve 75 and a "quick dump" valve 76 to the line 30 which supplies operating gas to the material pump 14. The pump 14 includes a nozzle 77 located within a vertical chamber 78 and connected to the gas supply line 30. The nozzle 77 is directed towards a restricted diameter opening 79 in a vertical tube 80. The nozzle 77 has a smaller diameter than the restricted diameter opening 79. As gas leaves the nozzle 77 it expands within the tube 80 and passes through the tube 15 to the gun 16. Expanding gas causes a pressure drop within the chamber 78 to draw the fluidized material 13 from the container 12 up a substantially vertical intake tube 81 into the chamber 78. From the chamber 78, the fluidized material mixes and flows with air from the nozzle 77 through the tube 80 into the tube 15. When the trigger 36 is released to terminate spraying, the quick dump valve 76 opens to bleed the tube 30 to the atmosphere. This assures that the flow of material to the gun 16 will cease immediately.

A manual valve 82 is provided on the pneumatic control 11 for purging residual material from the pump 14, the tube 15 and the gun 16. By opening the manual valve 82, gas flows from the line 62 through the line 31 to the chamber 78 in the pump 14. Pressurized gas in the chamber 78 blows residual material from the chamber 78 and the intake tube 81 back to the container 12. The vertical orientation of the tube 80, the chamber 78 and the intake tube 81 causes the material to naturally fall from the pump 14 into the container 12, to facilitate purging. Pressure from the line 31 also passes through the valves 75 and 76 to the line 30 to force air through the nozzle 77, thereby cleaning the nozzle 77 and directing gas from the chamber 78 into the tube 80, the tube 15 and the nozzle 35. It is readily apparent that through manual actuation of the valve 82, the pump 14, the tube 15 and the gun 16 are rapidly cleaned of residual material, allowing the pump 14 and the lip 29 to be placed on a different container 12.

It will be appreciated that various changes may be made, particularly in the design of the gun 16, without departing from the spirit and the scope of the claimed invention.

What we claim is:

1. In apparatus for dispersing electrostatically charged material in discrete particulate form, said apparatus including a nozzle having an inlet and a discharge outlet for the particulate material, an electrode for electrostatically charging the particulate material and at least one passage for directing a stream of gas to alter the shape of the pattern of particulate material discharged from said nozzle, an improved control comprising, in combination, a source of compressed gas, first control valve means for delivering and controlling a stream of compressed gas from said source to said at least one passage in said nozzle, a second valve means connected to said gas source, means responsive to actuation of said second valve means for applying a high voltage to said electrode in said nozzle, means responsive to actuation of said second valve means for delivering to said nozzle inlet a stream of gas having the particulate material dispersed therein, and means for jointly controlling said first valve means and actuating said second valve means.

2. In apparatus for dispersing an electrostatically charged material in discrete particulate form, an improved control, as set forth in claim 1, wherein said means for delivering to said nozzle inlet a stream of gas having the particulate material dispersed therein includes a reservoir for holding a supply of the particulate material, a pump responsive to actuation of said second valve means for delivering a stream of gas having the particulate material dispersed therein, means connecting said pump to said nozzle inlet, and means for fluidizing particulate material held in said reservoir.

3. In apparatus for dispersing an electrostatically charged material in discrete particulate form, an improved control, as set forth in claim 2, and including means for purging particulate material from said nozzle, said connecting means and said pump.

4. In apparatus for dispersing an electrostatically charged material in discrete particulate form, an improved control, as set forth in claim 3, wherein said purging means comprises valve means for selectively delivering compressed gas from said source to said pump for blowing particulate material from said nozzle, said connecting means and said pump.

5. In apparatus for dispersing an electrostatically charged material in discrete particulate form, an improved control, as set forth in claim 4, wherein said pump has a vertical orientation, whereby, when said second valve means is unactuated, material falls from said pump into said container to facilitate purging material from said pump.

6. In apparatus for dispersing an electrostatically charged material in discrete particulate form, an improved control, as set forth in claim 1, wherein said jointly controlling means adjustably controls said first control valve means continuously between closed and opened positions to vary the flow of gas to said at least one passage in said nozzle and thereby to vary the pattern of particulate material dispersed from said nozzle.

7. In apparatus for dispersing an electrostatically charged material in discrete particulate form, an improved control, as set forth in claim 1, wherein said second valve means includes a chamber connected to said gas source, means for venting said chamber to the atmosphere, restriction means for limiting gas flow from said source to said chamber whereby the gas pressure in said chamber is normally below the gas pressure from said source, and wherein said means for actuating said second valve means closes said vent to increase the gas pressure in said chamber, each of said means responsive to actuation of said second valve means being responsive to an increase in gas pressure in said chamber.

8. In apparatus for dispersing an electrostatically charged material in discrete particulate form, an improved control, as set forth in claim 1, wherein said means for controlling said first valve means and actuating said second valve means at least partially opens said first valve means prior to actuating said second valve means.

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