

[54] COLOR CHANGE OF ELECTROSTATIC SPRAY APPARATUS

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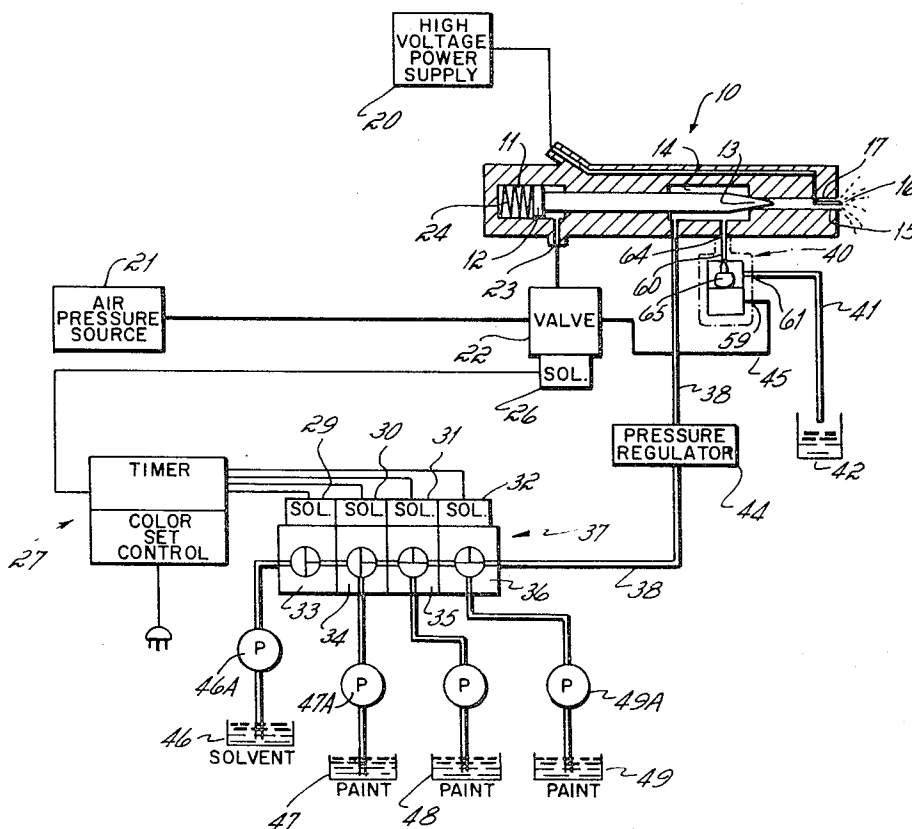
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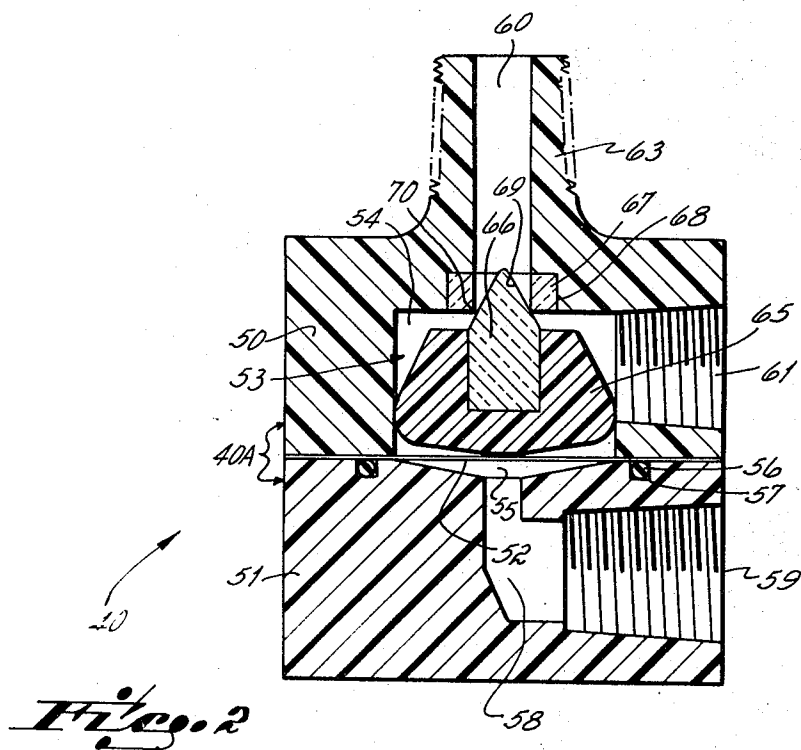
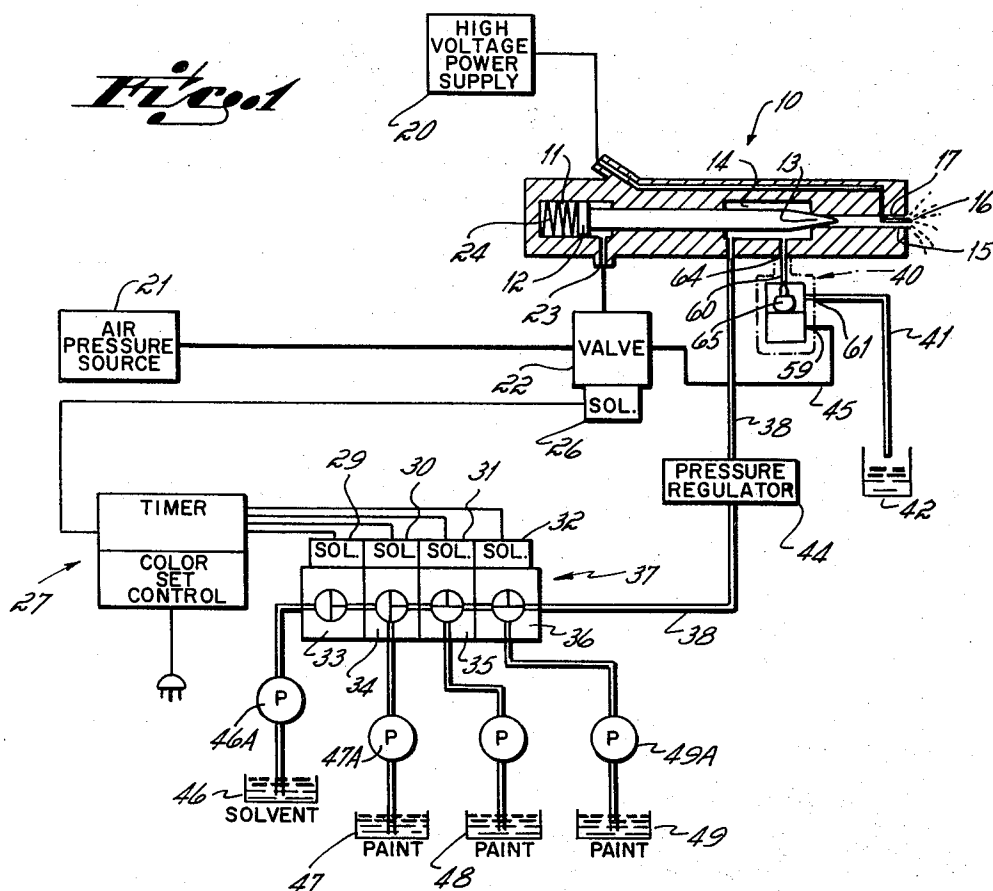
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Primary Examiner—M. Henson Wood, Jr.*Assistant Examiner*—Andres Kashnikow*Attorney, Agent, or Firm*—Wood, Herron & Evans[57] **ABSTRACT**

An electrostatic spray system for spraying multiple colors of material or multiple materials through a single common gun, including apparatus for spraying solvent through the gun between color or material changes. The system includes a dump valve for connecting the spray gun to a waste tank upon a color change so that the old color plus a solvent for purging the system of the old color may be pumped to the waste tank upon a color change. The dump valve is mounted directly upon the spray gun and is made from non-metallic, low capacitance material so that it does not store an electrical potential sufficient to create a dangerous condition in a spray environment and so that it does not leak or bleed excessive electrical potential from the system and thereby destroy its deposition efficiency.

27 Claims, 2 Drawing Figures



COLOR CHANGE OF ELECTROSTATIC SPRAY APPARATUS

The invention of this application relates to a quick-change color system for use with a single spray gun operable to selectively discharge different coating materials, such as paints of different color, or varnishes, waxes, protective coating materials or other surface treating liquids upon a substrate. More particularly, the present invention relates to a quick color change electrostatic spray system in which the paint or other material is sprayed or discharged from the nozzle, is electrostatically charged with an electrical charge of one polarity and deposited upon a substrate or object of the opposite polarity. The present invention is specifically directed to such a quick-change spray system for changing from one color or material to another without the previously used old color or material contaminating the new color or material when it is sprayed.

Throughout the application, we shall refer to the invention as being applicable to a color change system or a system for quickly changing from one color material to another to be sprayed from a common gun. It should be appreciated though that the reference to color change is for convenience only and that the reference is used in a generic sense to encompass and include changes of materials, as for example changes from one wax, varnish, paint or other material to another material.

The increased use of automated painting and coating apparatus such as in assembly lines in automobile plants or for coating a series of objects to be painted or otherwise coated as the objects pass a spray station, and in which these objects typically require the applications of different coatings and colors, have resulted in an increased demand for multiple color paint spray systems. The utility of systems wherein a single apparatus having a single discharge nozzle, or single set of nozzles, as the requirement may be, for spraying the plurality of coating liquids one at a time has resided in the ability of the color change system to change from one color to another quickly and with a minimum waste of paint and solvent. Typically, these systems employ a manifold to which the plurality of coating liquids is connected and through which one of the plurality of coating liquids is selectively connected to the spray gun. When changing from one coating material to another, it is necessary to purge the manifold, the feedline connecting the manifold to the spray gun, and the spray gun itself of the old coating color prior to the injection of a new color. Commonly, the solvent material is injected into the system to force the old color out of the system through a dump valve and to flush the system of the old color. Commonly, the duration of the injection of solvent into the system has either been controlled manually or by an automatic timer circuit. In general, irrespective of which method was employed, a manual or an automatic one, the objective was always to minimize the quantity of paint and solvent required to effect a color change and the time required to make the changeover. Two patents which disclose automatic systems for effecting the color change are U.S. Pat. No. 3,672,570, issued June 27, 1972, and U.S. Pat. No. 3,450,092, issued June 17, 1969.

One of the factors which affects the time period for making a changeover from one color to another is the length of line which must be purged of the old paint by

means of a solvent and then replaced with a new paint. In general, this length of line or conduit is that which extends between the distribution manifold and the spray gun and between the spray gun and the dump valve. In the case of electrostatic spray systems, these lengths of hoses are dictated by safety and spray efficiency conditions which require that the manifold be located a specified minimum distance or "standoff" from the spray gun and that the dump valve similarly be located a specified minimum distance from the electrostatically charged gun. At the present time, these minimum distances are required to prevent leakage of electrical charge or current from the gun back through the paint to and through the manifold to ground, or from the gun through the conduit to the dump valve and subsequently to ground. If the manifold or the dump valve is located too close to the electrostatically charged gun and is grounded, excessive voltage losses occur through leakage to the manifold or dump valve with the result that the system sprays inefficiently, i.e. with less than optimal deposition of the paint onto the objective or substrate. Alternatively, if the manifold and dump valve are ungrounded, a safety hazard can be created if a leaked charge is stored on the manifold or dump valve and is subsequently discharged by contact with some grounded object so as to create a spark in a volatile spray booth atmosphere.

One objective of this invention has been to shorten the length of conduit required to be located between the dump valve and the spray gun so as to minimize the wasted paint required to be purged from the line in the event of a color or spray material change without creating a condition of spray loss of efficiency or of a safety hazard.

Another objective of this invention has been to provide a color change electrostatic spray system in which the dump valve may be physically attached to the spray gun so as to eliminate all conduit between the gun and the dump valve and without creating a safety hazard or an inefficient electrostatic spray system.

These objectives are accomplished and this invention is partially predicated upon the concept of utilizing a dump valve located closely adjacent or attached to the spray gun but one which is incapable of either leaking current to ground through the dump valve or of storing a potentially dangerous electrical charge. To this end the dump valve utilized in the system of this invention is made from electrically non-conductive and very low or practically zero capacitance such that the valve may be mounted directly upon the electrostatic spray gun and thereby eliminates any need of an electrical "standoff" in the paint conduit between the valve and the electrostatically charged gun.

Another objective of this invention has been to provide an improved dump valve which is not subject to clogging and which may be made from very low or for practical purposes zero capacitance materials. In the preferred embodiment the dump valve is made from a plastic housing within which there is a ceramic valve seat and needle valve. The ceramic needle valve is mounted in a plastic piston, the movement of which is controlled by a diaphragm type pneumatic motor.

These and other objectives of this invention will be more readily apparent from the following description of the drawings in which:

FIG. 1 is a diagrammatic illustration of an electrostatic color change spray system incorporating the invention of this application.

FIG. 2 is a cross sectional view through the dump valve employed in the system illustrated in FIG. 1.

Referring to the drawings, there is illustrated diagrammatically a color change system for electrostatically spraying any one of three different paints from a single common spray gun 10. The gun 10 is a conventional electrostatic spray gun of the type which includes a pneumatic cylinder 11 at the rear of the gun having a piston 12 movable therein and operatively connected to a needle 13 of the spray gun. The needle 13 operates as a valve to open or close a central spray material flow passage 14 through which coating material is emitted for atomization as it is ejected from the gun. The gun 10 depicted in the drawing is of the airless spray type, but the invention is equally applicable to spray guns of the type which utilize an atomizing air stream impacting with the liquid stream to effect atomization of the spray particles as they are ejected from the gun.

In order to increase the deposition efficiency of the gun 10, it includes an electrostatic charge-applying needle 16 extending from the discharge orifice 17 of the gun. This needle is supplied with a high voltage electrical charge from a high voltage power supply 20 through a control circuit as is conventional in all electrostatic spray guns.

To control actuation of the needle 13 and consequent emission of spray from the gun, air from an air pressure source 21 is supplied to the gun through a solenoid actuated valve 22. When air pressure is supplied to an inlet port 23 of the gun through the valve 22, it causes the piston 12 to move rearwardly against a spring bias and thereby effects opening movement of the needle 13 relative to its seat. Closure of the valve 22 connects the port 23 to atmosphere and allows the spring 24 of the gun to effect closing movement of the needle 13 relative to its seat.

Actuation of the air flow control valve 22 is controlled by the solenoid 26. This solenoid is in turn controlled by an electrical color set control and timer circuit indicated generally at 27. This timer may be electrical and of the general type illustrated and described in U.S. Pat. No. 3,450,092, or may be pneumatic as illustrated and described in U.S. Pat. No. 3,672,570. For the sake of simplicity, it has been illustrated as an electrical control in the diagrammatic illustration of FIG. 1.

This same timer and color set control 27 also controls solenoids 29, 30, 31, and 32, each one of which controls opening and closing of a liquid flow control valve 33, 34, 35, and 36 respectively. These four valves are all located within a common manifold 37, from which paint or solvent is supplied through a pressure regulator to the paint flow passage 14 of the gun via a conduit 38. Paint or solvent may be dumped from the paint or spray material flow passage 14 of the gun through a dump valve 40 and discharge conduit 41, which conduit empties into a waste tank or reservoir 42. The dump valve 40 is pneumatically actuated, as explained more fully hereinafter, and is connected to the valve 22 via a pneumatic line 45. The dump valve 40 is normally closed, i.e., so long as the valve 22 is open and air pressure is supplied to the dump valve 40 through the connecting line 45, the dump valve 40 is maintained in a closed position.

The solvent flow control valve 33 is operable to control the flow of solvent from a solvent supply tank 46 through the valve 33 and the conduit 38 to the gun 10. Similarly, the valves 34, 35, and 36 are operative to control the flow of paint from three different paint reservoirs 47, 48, and 49 through pumps associated with the reservoirs and through the valves 34, 35, and 36 to the gun 10 via the pressure regulator and the conduit 38.

In operation, the timer and color set control 27 is operative to supply an electrical signal to the solenoid 26 and simultaneously to one of the solenoids, as for example solenoid 30, so as to connect paint from the reservoir 47 and its associated pump 47A through the manifold 37 and conduit 38 to the material flow passage 14 of the gun 10. Simultaneously, the timer and control circuit 27 is operative to energize solenoid 26. So long as the solenoid 26 is energized, air pressure from the source 21 is supplied via the port 23 to the pneumatic motor of the gun so as to open the needle valve 13 and cause paint to be ejected as a spray from the gun. Simultaneously, air from the pressure source 21 is supplied through the open valve 22 to the dump valve 40 so as to hold the dump valve 40 in a closed position and preclude the flow of paint through the dump valve.

At the conclusion of a color cycle and upon signal for a new color or type of material, the timer and color set control 27 is operative to de-energize the solenoid associated with the valve of the first color, in the example solenoid 30 of the valve 34, so as to disconnect the first paint reservoir 47 from the manifold 37 and move the associated valve 34 to a position in which it forms a throughway for the flow of solvent from one end of the manifold to the other. Simultaneously, the timer and color set control 27 energizes the solenoid 29 of the valve 33 so as to move the valve 33 to a position in which solvent from the reservoir 46 is supplied by a pump 46A to one end of the manifold 37. The solvent then is forced through the manifold pushing all of the residual paint in the manifold and in the line 38 and the gun ahead of it through the dump valve 40, which is then opened as a consequence of the solenoid 26 being de-energized by the timer set control 27. After the solenoid valve 29 has been energized for a period of time sufficient for solvent flow to purge the old paint from the system, the solenoid 29 is de-energized and the solenoid associated with the valve for a new paint, as for example solenoid 32 of valve 36, is energized so as to enable paint from the new paint reservoir, 49 in the example, to be supplied via the pump 49A through the manifold 37, the pressure regulator 44, and the line 38 to the fluid passage 14 of the gun 10. When the passage 14 has been filled with a new paint, the solenoid 26 is energized so as to open the valve 22 and close the dump valve 40 via air pressure supplied through the valve 22. The new paint then purges the outlet orifice 15 of the gun of the old paint so that the system is then ready for application of the new paint to the substrate to which it is to be applied.

Prior to the invention of this application, the dump valve 40 has always had to be located several feet away from an electrostatically charged gun 10 in order to preclude a potentially dangerous electrical charge from being stored on the dump valve and possibly creating a spark in a potentially volatile atmosphere. An alternative which would avoid storage of a potentially danger-

ous voltage in the dump valve was to ground it, but unless the dump valve was located several feet from the gun it leaked sufficient electrical charge through the paint to the valve and to ground as to render the electrostatic spray system inefficient.

The dump valve 40 of this invention, which facilitates its being mounted on the gun without either a danger of storing a potentially dangerous charge and without leaking electrical charge to ground, is illustrated in detail in FIG. 2. This dump valve 40 comprises a two-piece housing 40A including a body 50 and a body closure cap 51. These two components of the housing 40A are interconnected by non-metallic elements such as plastic bolts or closure clips (not shown). Between the two pieces 50, 51 there is a diaphragm 52 which serves to divide an axial chamber 53 of the body into a piston chamber 54 and a fluid motor chamber 55. The two chambers are sealingly separated by the diaphragm 52 and an O-ring seal 56 mounted within a groove 57 formed in the face of the body cap 51. A passage 58 interconnects the fluid chamber 55 to an outlet port 59. The pneumatic line 45 is threaded into this port 59.

The piston chamber 54 communicates with a axial passage 60 through the housing body 50 and with a dump port 61. The dump port 61 is threaded for reception of the dump conduit 41 which connects the piston chamber to the waste tank 42.

At its upper end, the body 50 of the housing terminates in a neck 63 which has pipe threads formed over its external surface so that it may be sealingly threaded into a correspondingly threaded port 64 of the spray gun housing. The port 64 is in fluid communication with the main spray material flow passage 14 of the spray gun.

Located internally of the dump valve and slideably mounted within the piston chamber 54, there is a piston 65. A piston mounted needle valve 66 is fixedly secured within this piston and extends upwardly into a valve seat 67 fixedly mounted within a counterbored seat 68 formed in the interior of the body 50 at the lower end of the bore 60. The needle valve 66 is normally biased into sealing engagement with the seat 67 as a result of the diaphragm 52 urging the piston 65 upwardly to a position in which the tapered nose section 69 of the needle valve 66 engages the lip 70 of the valve seat. Opening of the dump valve occurs as a consequence of liquid pressure in the bore 60 from the spray material flow passage 14 of the gun overcoming the pneumatic pressure in the chamber 55 so as to force the resilient diaphragm 52 downwardly. The liquid pressure in the chamber 60 is only able to overcome the pneumatic pressure in the line 45 when the dump valve is to be opened and the chamber 55 is connected to atmosphere through the pneumatic valve 22.

An air bleed or vent (not shown) may be provided through the housing body 50 to open the rear side of the piston chamber to atmospheric pressure. The necessity for such air vent or bleed hole is determined by the fit between the piston 65 and piston chamber 53. In the preferred embodiment the fit is sufficiently loose that air or liquid cannot become entrapped on the back side of the piston between the piston and the diaphragm 52. However, if a tight sliding fit is utilized, then such an air vent is preferably provided to ensure that the piston is always free for sliding movement within the piston chamber.

All of the components of the dump valve which enable it to be mounted directly upon the body of an electrostatic spray gun are made from non-metallic materials. In the preferred embodiment, both sections 50, 51 of the housing of the dump valve are made from either nylon or "Delrin" plastic and the piston 65 is made from Delrin plastic. In the preferred embodiment of the invention the diaphragm 52 is either made from Teflon or Rulon and the needle valve 66 and valve seat 67 are made from a ceramic material. Consequently, the dump valve cannot store an electrical charge sufficient to create a spark and the valve cannot leak electrical energy to ground.

The primary advantage of the invention of this application is that it enables the dump valve to be mounted directly on the gun so that there need be no standoff conduit between the dump valve 40 and the body of the spray gun. Consequently, the paint required to fill that conduit and the solvent required to fill it are saved during each color tank spray cycle. Additionally, the time required to remove the old paint from that conduit and replace it with solvent and subsequently with a new paint is saved.

While we have described only a single preferred embodiment of the invention, persons skilled in the art to which this invention pertains will readily appreciate numerous changes and modifications which may be made without departing from the spirit of the invention. As an example, the dump valve 50 has been illustrated and described as being controlled by the solenoid control valve 22, the same valve which controls actuation of the spray gun piston 12. In most commercial installations the dump valve 40 is controlled by a separate solenoid actuated valve independently of the spray gun controlled solenoid valve, but for the sake of simplicity and clarity the two have been described in this application as being controlled from a single common solenoid valve 22. Therefore, we do not intend to be limited except by the scope of the following appended claims.

Having described our invention, we claim:

1. An electrostatic spray system for selectively spraying any one of a plurality of spray materials from a common spray gun, which system comprises

a spray gun having a spray material flow passage terminating in an outlet orifice and a selectively operable valve for controlling the emission of spray material from said orifice,

means including a high voltage power supply for applying an electrical charge to spray material as it is emitted from said spray gun,

a plurality of spray material reservoirs and a solvent reservoir,

means including an electrical control circuit for selectively connecting any one of said reservoirs to said spray gun so as to enable spray material to be supplied from a selected reservoir to said gun,

a dump tank, and

a dump valve operatively connected to the spray material flow passage of said gun and operable when opened to bypass spray material from said flow passage to said dump tank, said dump valve being positioned immediately adjacent said gun and made from components which have a capacitance sufficiently low as to preclude said dump valve from storing a potentially dangerous electrical charge,

said dump valve comprising a valve housing, said housing having an inlet port and an outlet port interconnected by a dump flow passage, and a needle valve element located within said dump flow passage and operable to control the flow of spray material through said dump valve. 5

2. The electrostatic spray system of claim 1 in which said dump valve is physically attached to and supported from said spray gun.

3. The electrostatic spray system of claim 1 in which said components of said dump valve are all made from non-metallic materials. 10

4. The electrostatic spray system of claim 1 in which all of said components of said dump valve which are exposed to contact with said spray material are made from non-metals. 15

5. The electrostatic spray system of claim 1 in which said dump valve includes a fluid motor for controlling positioning of said needle valve element within said dump flow passage. 20

6. The electrostatic spray system of claim 5 in which said needle valve element is mounted within a piston, said piston being slideable within said dump valve passage.

7. The electrostatic spray system of claim 6 in which said fluid motor includes a flexible diaphragm and a fluid motor chamber, said diaphragm being located between and sealingly separating said dump flow passage from said fluid motor chamber of said dump valve. 25

8. The electrostatic spray system of claim 7 in which said dump valve includes a valve seat located within said dump flow passage, said piston including a section in slideable contact with a wall section of said dump flow passage of said dump valve, said section of said piston being shaped as a sector of a sphere so as to enable said piston mounted needle valve element to be self-centering within said valve seat. 30

9. The electrostatic spray system of claim 8 in which said dump valve is physically attached to and supported from said spray gun. 35

10. The electrostatic spray system of claim 9 in which said components of said dump valve are all made from non-metallic materials. 40

11. The electrostatic spray system of claim 10 in which said dump valve housing and said piston are made from a plastic material and in which said needle valve and needle valve seat are made from a ceramic material. 45

12. The electrostatic spray system of claim 11 in which said diaphragm biases said piston and needle valve to a normally closed position. 50

13. The electrostatic spray system of claim 7 in which said components of said dump valve are all made from non-metallic materials.

14. A dump valve for use in an electrostatic spray system for selectively spraying any one of a plurality of spray materials from a common spray gun, which dump valve comprises 55

a valve housing having an inlet port and an outlet port interconnected by a dump flow passage, a movable valve element located within said dump flow passage and operable to control the flow of spray material through said dump valve, said dump valve being made from components which

have a capacitance sufficiently low as to preclude said dump valve from storing a potentially dangerous electrical charge so that said dump valve is adapted to be positioned immediately adjacent the common spray gun of said system.

15. The dump valve of claim 14 in which said dump valve further includes means for attaching said housing to and supporting it from an electrostatic spray gun.

16. The dump valve of claim 15 in which the components of said dump valve are all made from non-metallic materials.

17. The dump valve of claim 15 in which all of the components of said dump valve which are exposed to contact with said spray material are made from non-metals.

18. The dump valve of claim 14 in which said dump valve includes a fluid motor for controlling positioning of said valve element within said dump flow passage.

19. The dump valve of claim 18 in which said valve element is secured to and mounted upon a piston, said piston being slideable within said dump valve passage. 20

20. The dump valve of claim 19 in which said fluid motor includes a flexible diaphragm and a fluid motor chamber, said diaphragm being located between and sealingly separating said dump flow passage from said fluid motor chamber of said dump valve.

21. The dump valve of claim 20 in which said diaphragm biases said piston mounted needle valve to a closed position.

22. The dump valve of claim 19 which further includes a valve seat located within said dump flow passage, said movable valve element being a needle valve element and said piston including a section in slideable contact with a wall section of said dump flow passage of said dump valve, said section of said piston being shaped as a sector of a sphere so as to enable said piston mounted needle valve element to be self-centering within said valve seat. 35

23. The dump valve of claim 22 in which said dump valve housing and said piston are made from a plastic material and in which said needle valve element and valve seat are made from a ceramic material. 40

24. The dump valve of claim 23 in which said fluid motor includes a flexible diaphragm and a fluid motor chamber, said diaphragm being located between and sealingly separating said dump flow passage from said fluid motor chamber of said dump valve.

25. The dump valve of claim 24 in which said diaphragm biases said piston mounted needle valve element to a normally closed position. 45

26. The dump valve of claim 14 which further includes a valve seat located within said dump flow passage, said movable valve element being a needle valve element mounted upon a movable piston, said piston including a section in slideable contact with a wall section of said dump flow passage of said dump valve, said section of said piston being shaped as a sector of a sphere so as to enable said piston mounted needle valve element to be self-centering within said valve seat. 50

27. The dump valve of claim 26 in which said dump valve housing and said piston are made from a plastic material and in which said needle valve element and valve seat are made from a ceramic material. 55

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