

Nov. 7, 1967

R. THOLOME
SPRAYING APPARATUS HAVING IMPROVED
SPRAY CONTROLLING MEANS

3,351,285

Filed June 22, 1965

4 Sheets-Sheet 1.

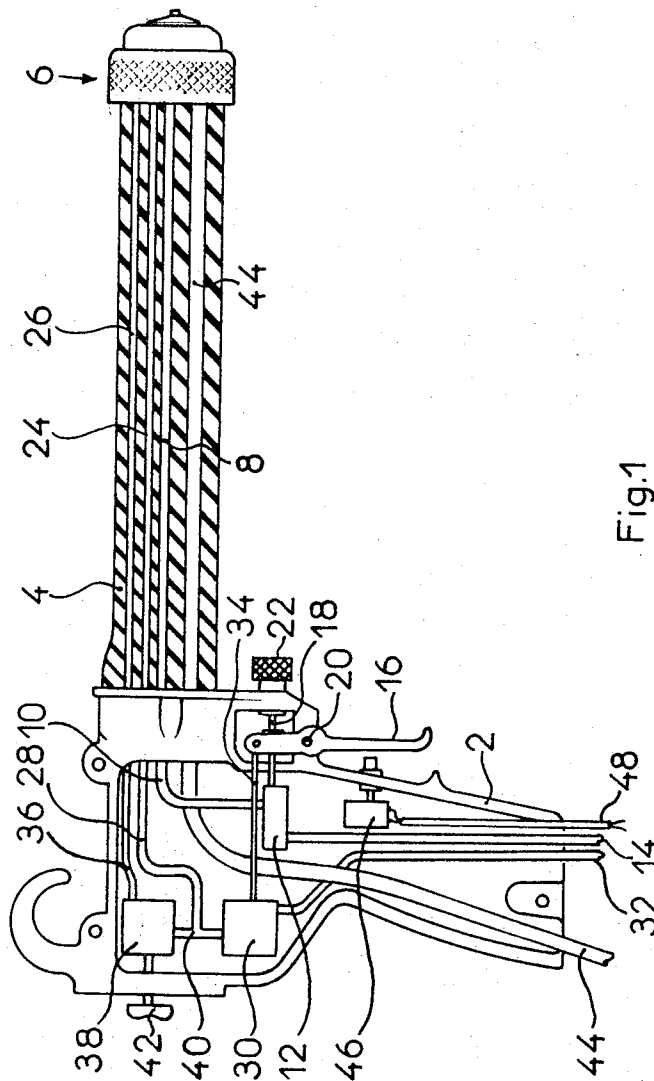


Fig. 1

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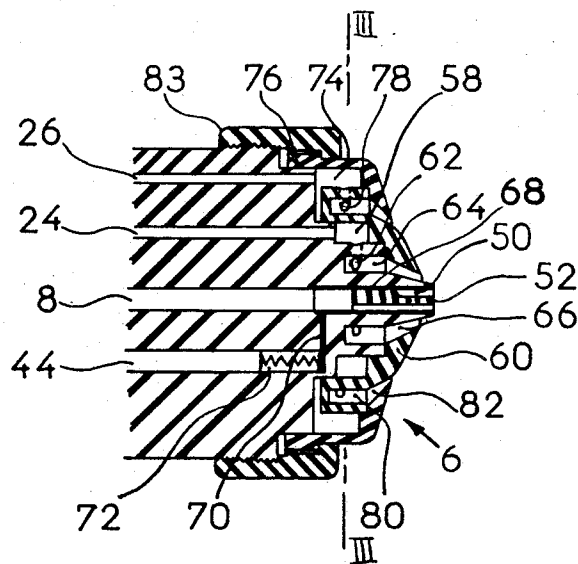


Fig. 2

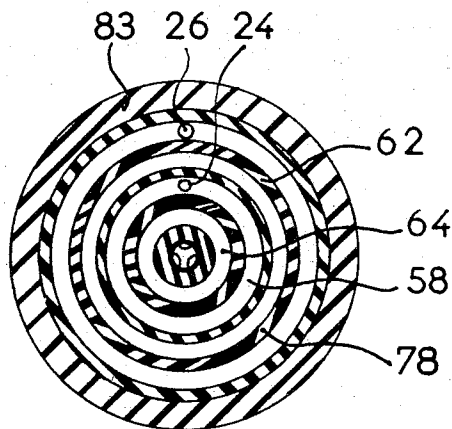


Fig.3

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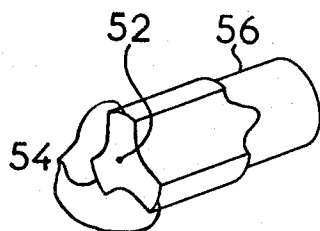


Fig. 4

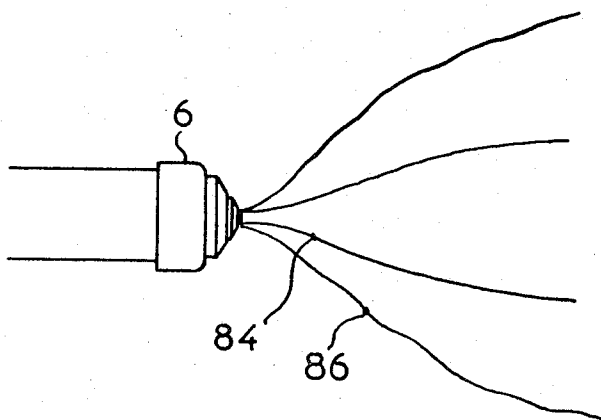


Fig. 5

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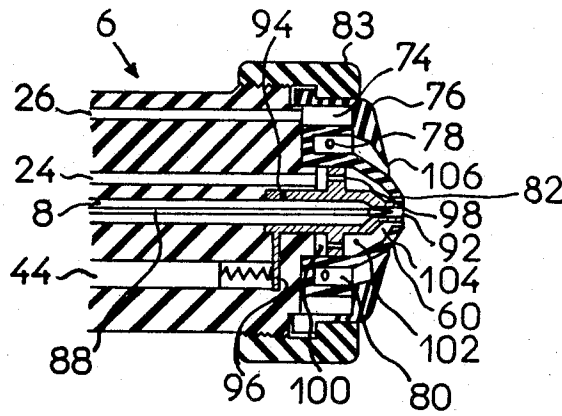


Fig. 6

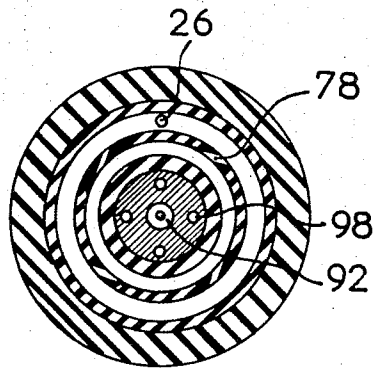


Fig. 7

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SPRAYING APPARATUS HAVING IMPROVED SPRAY CONTROLLING MEANS

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4,706, Patent 1,408,758

18 Claims. (Cl. 239—15)

ABSTRACT OF THE DISCLOSURE

An electrostatic spraygun in which the coating material is dispersed by a surrounding stream of vortically or axially moving air. A second stream of air surrounds the first stream and is directed along a vortical path to produce a low pressure zone around the dispersed material and thereby change the angle of spray to a comparatively wide angle spray pattern.

Background of the invention

This invention relates to apparatus for spraying liquid or solid (particulate) compositions as used in spray-painting, spray-coating and similar processes.

The invention is more especially concerned with apparatus of this kind, which are provided with means for carrying the spray particles to a high electric potential prior to discharge as a spray from the apparatus, in order to cause the charged spray particles to follow the lines of force of an electrostatic field created between the sprayer and an article to be spray-coated or treated. The particles are thereby caused to settle over the surfaces of the article with only minor losses to surrounding objects, and thereafter adhere to said surfaces by electrostatic attraction. Electrostatic spray processes of this type are now widely used in various fields.

In most spraying apparatus, whether electrostatic in character or not, a stream of gaseous fluid, usually air, is generally required for placing the particles of spray composition into suspension and thereby forming the actual spray. This gaseous fluid must of necessity possess some initial pressure and consequently imparts a substantial initial velocity to the spray issuing from the apparatus.

When considering spraying apparatus of the electrostatic type outlined above, this initial velocity of the spray is sometimes an asset, and at other times a nuisance. The initial velocity may be an advantage whenever it is desired to produce a "hard" jet of spray possessing substantial directive force, for example in coating the surfaces of articles having relatively deep narrow recesses therein, into which the particles would not penetrate in large numbers under the sole action of the electrostatic field, since the field lines are essentially normal to the equipotential surfaces of the article.

Usually, however, the initial velocity of the jet is a disadvantage because it prevents the particles from responding solely to the electrostatic forces and being conveyed positively thereby on to the surfaces of the article. Theoretically, in an efficient electrostatic coating process, the cloud of charged particles would be driven by the field forces to settle even over article surfaces that face away from the sprayer. This is one of the outstanding advantages of electrostatic coating. The initial velocity of the spray, however, tends to drive the particles in straight paths regardless of the configuration of the field lines, and thus forfeits much of the benefits derivable from the electrostatic feature. This defect is especially marked when coating articles having wide gaps and surfaces directed in different directions.

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It would, therefore, be very desirable if electrostatic spraying apparatus could be provided with means for selectively controlling the characteristics of the spray produced thereby, as between a first condition in which the spray is in the form of a "hard" jet of narrow cross sectional dimensions and high initial velocity, and another condition wherein the spray forms a "soft" cloud of wide transverse dimension and low velocity, to respond substantially solely to electrostatic forces.

In the U.S. patent application Ser. No. 346,662, assigned to the same assignees as the present application, an electrostatic sprayer was disclosed in which the above object was accomplished by the provision of means for modifying the geometry of the spray discharge orifice. The device operates satisfactory, but its construction involves certain unnecessary mechanical complications, requiring accurately-machined, relatively movable parts in the sprayer. This detracted from the economy and service life of the apparatus.

Objects of this invention are to provide spraying apparatus having improved means for controlling the characteristics, specifically width and velocity, of the cloud or spray issuing therefrom, and to provide such spray-control means which will be pneumatic in character, and will consequently not involve any complex and delicate mechanism. Other objects will appear.

The invention is based on the discovery that when a spray of liquid or solid particles is exposed to the action of a vortex, i.e. a whirling stream of air or other gaseous fluid, surrounding the spray generally coaxially with it, the spray is caused to spread or fan out transversely, so that its transverse dimensions are increased while its linear velocity is correspondingly reduced. Apparently this is due at least in part to the suction created by the vortex which draws the spray particles radially outwards.

Exemplary embodiments of the invention will now be described for purposes of illustration but not of limitation with reference to the accompanying drawings, wherein:

FIG. 1 is a side view, generally in longitudinal section, of an electrostatic spraygun provided with improved spray control means according to the invention;

FIG. 2 is a longitudinal sectional view, on an enlarged scale, of the spray head section of the spraygun of FIG. 1;

FIG. 3 is a cross section on line III—III of FIG. 2;

FIG. 4 is further enlarged perspective view of a component part of the spray head of FIGS. 2 and 3;

FIG. 5 depicts the general aspect of a spray produced by the spraygun in the two different operating conditions;

FIGS. 6 and 7 are views similar to FIGS. 2 and 3, but relate to a modified embodiment of the sprayer head.

The electrostatic spraygun shown generally in FIG. 1 includes a pistol-grip part 2 and a barrel part 4 made of electrically insulating material, e.g. acetal resin sold as "Delryn" or the resin sold as "Araldite." At the outer end of the barrel 4 a spray nozzle 6 is provided, which is shown in greater detail in FIGS. 2 to 4.

An axial duct 8 for paint (or other composition to be sprayed) is formed through the barrel 4 and is connected at its rear end by way of a connector tube 10 and a paint flow control valve 12 with a paint supply line 14 connectable with any suitable source of paint, not shown. A trigger 16 pivoted to the pistol grip at 20 is connected with a valve-actuating link 18 whereby depression of trigger 16 against the bias of a spring (not shown) will open valve 12 and permit paint to flow from line 14, to duct 8. Also associated with valve 12 is an adjusting control shown as a knob 22 rotation of which will alter the flow passage offered in the open condition of the valve 12, through conventional needle means not shown.

The gun barrel 4 also has two longitudinal air ducts 24 and 26 formed through it, duct 24 being shown closer to

the axis of the barrel than duct 26. Inner air duct 24 at its rear end connects by way of a connector tube 28 with the outlet of a primary air valve 30 having its inlet connected with an air delivery line 32 connectable with a suitable source of compressed air. Air valve 30 has an actuating link 34 extending therefrom and pivoted to trigger 16, so that depression of the trigger at the same time as it opens paint valve 12 also opens primary air valve 30.

The outer, or vortex, air duct 26 is connected at its rear end through a connector tube 36 with the outlet of a secondary air valve 38 having its inlet connected to the outlet of primary air valve 30 through a branch tube 40. Secondary air valve 38 has an actuator rod extending therefrom through a rear wall of the pistol grip and having a push-button 42 at its outer end, position for convenient depression by the thumb of an operator while the latter has his forefinger on trigger 16. The arrangement in this embodiment is such that secondary or vortex air valve 38 is normally opened, and is closed only on depression of button 42.

Extending through another longitudinal duct formed in the barrel 4 is a high-tension conductor cable 44 which at its rear end issues out of the gun and is connectable to a suitable source of high-voltage, low-current D.C. energy such as an electrostatic generator not shown. A switch 46 mounted in the pistol grip and having an actuator knob engageable by a part of trigger 16, is connected by way of conductors 48 in the high-voltage supply circuit for conductor 44, so that actuation of switch 46 on depression of the trigger applies voltage from the high-voltage generator to conductor 44.

Turning now to the spray head section 6 at the forward end of the gun, the axial paint duct 8 discharges centrally of a forwardly jutting nose portion of the spray head (FIG. 2). Preferably, the discharge orifice 50 for the paint is made annular, and for this purpose an insert member 52 is press-fitted in the terminal section of paint duct 8. Insert 52 (see FIG. 4) includes a body part formed with three longitudinal ribs 54 circumferentially spaced 120° and having part-cylindrical outer wall surfaces fitting tightly within the cylindrical wall of bore 8, these ribs defining between them arcuate-section channels for the flow of paint. Projecting from the outer end of said body of insert 52 is a cylindrical shank 56 the outer surface of which defines with the inner surface of said bore 8 the annular discharge opening 50 for discharge of the paint from out the spray head 6 of the gun.

The inner air duct 24 at its forward end opens into an annular pressure chamber 58 of rectangular cross section. The outer circumferential wall and front transverse wall of this chamber 58 are defined by surfaces of an inner cap member 60 of suitable shape positioned around the central nose of the head section concentrically therewith. The inner circumferential wall of pressure chamber 58 has four circumferentially spaced, tangentially directed apertures 62, which are best seen in FIG. 3, and which communicate at their inner ends with an inner vortex chamber 64, partly defined by cap member 60. The inner vortex chamber 64 is of generally rectangular cross section and connects at its forward end with an annular, tapered air discharge orifice 66 which is defined between spaced, coaxial surfaces of the jutting central nose of the spray head and the inner cap member 60.

In the operation of the spraygun as so far described depression of trigger 16 opens paint valve 12 so that a stream of liquid paint is delivered from line 14 through duct 8 and issues as an annular film or sheet through annular paint discharge orifice 50. Simultaneously, depression of trigger opens primary air valve 30, so that compressed air is delivered from line 32 through duct 24 and into pressure chamber 58. From this chamber the air is discharged inwardly through the tangential apertures 62 into the inner vortex chamber 64, where it assumes a rapidly whirling motion owing to the tangential arrange-

ment of said apertures 62. This whirling air stream or vortex issues from chamber 64 through the tapered annular air discharge opening 66, so as to surround and intersect the annular film of liquid issuing from the central annular discharge orifice 50. This effects a highly efficient atomization of the liquid.

As the paint or other liquid is discharged from the annular orifice 50 it is charged to a high electric voltage from the cable 44. For this purpose, tubular metallic liner 68 inserted in an end part of duct 8 adjacent to insert 52 is connected by a conductive strip 70 with a conductive spring 72 abutting the forward end of conductor 44. Preferably, said conductor 44 includes a protection resistor portion, not shown, in its terminal part adjacent spring 72. The high D.C. potential to which conductor 44 is connected is thus applied to the liner 68 and thence to the film of liquid flowing therepast, so as to charge the liquid particles to a corresponding high potential as they issue out of the orifice 50 and are atomized by the vortex issuing from the surrounding annular orifice 66.

The charged liquid particles then tend to follow the lines of force of the electrostatic field between the spray head and the object being coated. It sometimes is found, however, that the particles will not follow the lines of force closely enough, as a result of their excessive initial velocity, and there is a risk of their not reaching any surfaces which are not directly intercepted by the jet.

The type of operation thus described is generally conventional, being similar to the operation of the vortex spraygun disclosed to Fraser's U.S. patent application No. 285,470, now Patent No. 3,233,831 granted Feb. 8, 1966, assigned to the same assignee as the present application.

It has been found in practical operation of such devices that whereas in some circumstances it is desirable to provide a spray possessing a relatively high initial velocity and small cone angle, so as to have substantial directivity, in many other circumstances the better spray coating results are obtained if the atomized spray issues from the spray head as a cloud of relatively wide solid angle and low velocity. In such a low-velocity cloud the paint particles will more freely submit to the action of electrostatic forces causing them to travel along the field lines leading to the surfaces of an article to be coated, even when such surfaces do not directly face the spray nozzle. More efficient spraying will then be possible especially in the case of articles having large gaps therein, such as bicycle frames, chairs, latticework, and the like.

According to the invention, to increase the width and reduce the velocity of the spray, means are provided for creating an outer vortex of air surrounding the spray. For this purpose, the outer air duct 26 at its forward end opens into an outer annular pressure chamber 74 defined in part between an outer cylindrical surface of inner cap member 60 and an inner cylindrical surface of an outer cap member 76 seated concentrically around member 60. Four apertures 78 formed through the inner circumferential wall of outer cap member 76 open tangentially into an outer annular vortex chamber 80 defined by the inner cap 60. This outer vortex chamber 80 connects at its forward end with a tapered, annular discharge orifice 82 defined between outer and inner cap members 60 and 76, which has its annular discharge end positioned concentrically with and radially outward from the inner annular air discharge orifice 66, as well as being spaced rearward therefrom a substantial distance, as shown. A ring nut 83 having an inner flange interengageable with an outer flange of member 76 is screwed on a thread of spray head section 6 to hold the parts in assembly.

When the operator wishes to produce a low-velocity spray of relatively large cross sectional dimension, he refrains from depressing the push-button 42, thereby leaving secondary air valve 38 open. Secondary air is then delivered to the outer pressure chamber 74 and creates a vortex in the outer vortex chamber 80 owing to the

tangential positioning of openings 78. The resulting outer vortex is preferably in the shape of a converging cone that converges at a more rapid rate than does the inner vortex, as will be evident from a consideration of the angular relationship between the taper angles of the inner air discharge orifice 66 and the outer air discharge orifice 82.

The creation of this outer vortex has an immediate and striking effect in modifying the characteristics of the spray issuing from spray head 6. As indicated in FIG. 5, the relatively narrow, high-velocity jet of spray 84 produced in the absence of the outer vortex is, when the outer vortex is applied, converted into a cloud 86 of substantially increased width (or solid angle) and correspondingly reduced velocity. The charged spray particles are then freer to respond to the electrostatic forces to which they are exposed rather than submitting predominantly to their initial velocity. Should a high-velocity "hard" spray be desired, push-button 42 is depressed to close valve 38.

While the precise reasons responsible for this effect are not fully understood and it is not desired to make the invention depend on any explanatory theory, it is believed that the change in form of the spray cloud is ascribable at least in part to the vacuum created around the spray by the outer vortex of the invention. This vacuum apparently tends to draw the spray radially outward, this radial expansion of the spray cloud being sufficient to result in a net reduction of the overall forward velocity of the spray particles.

With other conditions remaining the same, it is found that the degree of spreading or fanning-out of the spray by the action of the outer vortex depends directly on the rate of air flow discharged by said outer vortex and this action can in theory be made as great as desired. In fact, the outer vortex if made strong enough will cause the spray to reverse direction, i.e. fan out by an angle greater than 180°, and hence propagate back towards the operator. To avoid this undesirable situation, the strength of the outer vortex is preferably adjusted in a permanent or semi-permanent manner so as to limit the angle of spread of the spray, when said outer vortex is turned on, to an angle not exceeding 90° or 100°. If this angular range is exceeded, the resulting jet tends to be unstable when the outer vortex is used, so that small fluctuations in the air supply pressure or other factors may then cause objectionable temporary reversals of the spray in the manner just indicated.

If desired, however, means may be made available to the operator for readily adjusting the strength or rate of delivery of the outer vortex, and such adjustment may conveniently be effected through rotation of the actuator button 42 so as to modify the effective flow section through secondary air valve 38 e.g. through conventional threaded needle valve means not shown.

It will be apparent from the foregoing description that the function and operation of the outer vortex which can be made to issue from the outer annular air discharge orifice 82 differs radically from the function of the conventional inner vortex provided through inner air discharge orifice 66. The function of said inner vortex is to atomize the sprayed liquid, while the function of the outer vortex is, when used, to cause the spray to fan out and reduce its velocity. In the embodiment of the invention now to be described with reference to FIGS. 6 and 7, no inner vortex is used, the atomizing function being performed by an axially flowing, rather than whirling, inner air jet.

In FIGS. 6 and 7, parts similar to parts of the first embodiment are designated with the same numerals and will not be described in detail. Extending through the axial paint duct 8 is a longitudinally movable flow adjusting rod 88 having at its forward end a conical valve head which co-operates with a seat in bore 92 to provide a controllable discharge orifice for the paint or other spray liquid. The rod 88 is arranged to be longitudinally mov-

able by finger pressure on a trigger similar to trigger 16 (FIG. 1).

The paint discharge orifice or bore 92 is formed in the outer end part of a tubular insert or nozzle member 94 fitted in an enlargement of the paint duct 8 and having a transverse flange which is spaced axially beyond the end of the duct and has its peripheral surface engaging the inner surface of the inner cap member 60. The insert 94 is made of conductive material and has a lateral extension 96 which makes contact with high-tension conductor 44 by way of a spring. Formed through the transverse flange of insert 94 are a plurality of circumferentially spaced openings 98 extending in a longitudinal direction, i.e. parallel to the center axis of the spray head. The openings 98 connect at their rear ends with a pressure chamber 100 defined behind the rear surface of said flange, which chamber has the inner air duct 24 opening into it. The openings 98 at their forward ends open into a discharge chamber 102 which tapers forwardly to connect with the annular air discharge gap 104, defined between the inner surface of cap member 60 and the outer surface of the forward end part of insert 94.

In the operation of this embodiment depression of trigger 16 (FIG. 1) at the same time as it retracts rod 88 to discharge the spray liquid through axial orifice 92, also opens primary air valve 30 to deliver compressed air by way of duct 24 into pressure chamber 100 and through axial openings 98 into the discharge chamber 102, whence the air issues as an axially flowing annular sheet to atomize the electrically charged solid jet of paint discharged through axial orifice 92.

If the operator while depressing trigger 16 simultaneously depressed push-button 42 with his thumb to close secondary air valve 38, the resulting spray of atomized paint issues in the form of a high-velocity, "hard" jet diverging at a relatively narrow cone angle. If on the other hand push-button 42 is not depressed, compressed air is passed through valve 38 and duct 26 to pressure chamber 74 and thence through tangential orifices 78 into vortex chamber 80, to discharge a whirling sheet of air through outer annular air discharge orifice 82, as in the first embodiment. The effect of this air vortex again is to cause the spray to fan out into a broad cloud travelling at reduced velocity and hence better able to respond to the electrostatic forces between the spray head and the surfaces of an article being sprayed.

It will be understood that in an embodiment similar to the one just described, using a non-vortical inner air jet for atomizing the spray liquid, the liquid discharge arrangement may if desired be made similar to that shown in FIGS. 2-4, flow adjusting rod 88 being omitted and an insert similar to 52 being used to impart an annular shape to the discharged jet of liquid.

As will be apparent from the disclosure, the fanning-out action of the outer air vortex remains effective whatever the form of the inner air stream serving to atomize the spray composition, e.g. paint. While in FIGS. 2-4 the inner air stream is shown as a vortex revolving in the same sense as the outer or fanning-out vortex, and in FIGS. 6-7 the inner air stream is axially flowing, similar effects are obtained if the inner, atomizing air jet is discharged in the form of a vortex revolving in the reverse sense from the outer vortex. If desired to provide such an arrangement, it would be necessary merely to angle the set of inner tangential orifices 62 in FIG. 3 in a direction reverse from that of the outer tangential orifices 78.

As earlier indicated, the maximum degree to which the spray can be made to fan out, or in other words the maximum rate of flow which can be safely imparted to the outer vortex is limited in practice by the onset of an unstable condition which may cause the spray at times to tend to reverse its direction of travel. While usually this does not cause trouble, in that the said upper limit of the fan-out angle is amply sufficient for most practical purposes, it has been found that the stability of the spray in the

presence of the outer vortex can be somewhat improved by providing vortex-deflecting means such as an axially directed annular lip or flange 106, shown in FIG. 6, around the discharge orifice of the outer air vortex. Instead of such a continuous annular axial lip or flange, radial or helical vanes have also been found effective in improving the stability of the vortex and spray.

In a practical embodiment of the invention, in the construction shown in FIGS. 1-4, the annular paint discharge orifice 50 had a width of 0.5 millimeter and an average diameter of 3.5 mm. The inner and outer air discharge orifices 66 and 82 each were about 0.5 mm. in width. The compressed air source pressure and the pressure losses through the paths of air flow were such that the air pressure in each of the chambers 58 and 78 was about 500 grams per square centimeter gauge. The inner tangential orifices 62 were four in number, with a total flow section area of 3 sq. mm. The outer tangential orifices 78 were four in number, with a total flow section area of 3 sq. mm. In the absence of the outer vortex (push-button 42 depressed) the jet of spray 84 (FIG. 5) as measured 30 cm. beyond the forward end of spray head 6 was about 5 to 10 cm. across (an aperture angle of 10-20°), and had an average velocity of about 10 meters/second. With the outer vortex in operation, the spray 86 formed a cloud about 40 cm. across (an aperture angle of about 70°) and travelling at only about 2 m./sec. as measured at the same distance from the spray head.

The invention has also been tested and found effective in connection with the discharge of solid powder particles rather than liquid, and is therefore useful in such applications as electrostatic spray coating with plastic powder compositions, and the like. The construction of the spray head may generally be the same as described, except that all flow section areas should be substantially increased, sharp angles and obstructions avoided and similar generally conventional precautions taken to avoid clogging of the powder in any section of the apparatus. The means for electrically charging the particles may, if desired, take the form of ionizing means positioned to ionize the air molecules instead of, or in addition to, ionizing the particles.

It is to be understood that the word "spray" as used in the specification and claims is intended to cover a suspension of fine particles in air or another gas, regardless of whether the particles are in the solid or liquid phase.

While the chief utility of the invention lies with electrostatic spray devices for the reasons indicated, it will be apparent that the invention would be operative in the absence of an electric charge applied to the spray material, and would be applicable in such cases should this be considered useful.

Various modifications may be made in the exemplary embodiments disclosed. Thus the invention may be embodied in sprayer apparatus other than sprayguns, e.g. fixed sprayer installations.

What is claimed is:

1. In spraying apparatus, the combination comprising: spray-producing means including spray discharge orifice means connectable with a source of sprayable composition and with a source of gaseous fluid under pressure for discharging a spray of said composition through said orifice means; spray-controlling means including an annular discharge orifice surrounding said spray discharge orifice means and connectable with a source of gaseous fluid under pressure, including vortex means for imparting a revolving motion to said fluid to discharge a vortex of gaseous fluid through said annular orifice, said annular orifice being positioned to discharge said vortex externally of the apparatus; and selector means operable to a first condition in which no gaseous fluid is discharged through said annular orifice and said spray is discharged from said orifice means as a jet having a given angle of spray, and operable to a second condition in which said vortex of gaseous fluid is discharged through the annular orifice to increase the angle of spray.

2. In spraying apparatus, the combination comprising: spray-producing means including spray discharge orifice means connectable with a source of sprayable composition and with a source of gaseous fluid under pressure for discharging a spray of said composition through said orifice means; electrode means connected with a high-voltage source interposed in the path of said spray to charge the spray particles electrically as they issue from the orifice means; spray control means including an annular discharge orifice surrounding said orifice means and connectable with a source of gaseous fluid under pressure, including vortex means for imparting a revolving motion to said fluid to discharge a vortex thereof through said annular orifice, said annular orifice being positioned to discharge said vortex externally of the apparatus; and selector means operable to a first condition in which no gaseous fluid is discharged through said annular orifice and said spray is discharged from said orifice means as a jet having a given angle of spray, and operable to a second condition in which said vortex of gaseous fluid is discharged through the annular orifice to increase the angle of spray.

3. Spraying apparatus comprising: means defining a central discharge orifice and flow means connected therewith and connectable with a source of divisible coating substance for discharging a jet of said substance from said central orifice; spray-forming means including means defining a first annular orifice surrounding the central orifice and flow means connected therewith and connectable with a source of gaseous fluid under pressure for discharging a first stream of said fluid through said first annular orifice over a path intersecting the path of said jet to disperse and thereby form a spray of said substance; and means for controlling the angle of spray for the dispersed substance comprising: means connectable with a source of gaseous fluid under pressure and operable for discharging an additional stream of said fluid; vortex means interposed in the path of said additional stream for imparting a revolving motion thereto and creating a vortex of said fluid; means defining a further annular orifice surrounding the first annular orifice and connected with said vortex means to discharge said vortex in surrounding relationship to said spray, said further annular orifice being positioned to discharge said vortex externally of the apparatus; and selector valve means connected in the path of said additional stream and operable to a first position in which no gaseous fluid is discharged through said further annular orifice and said spray is discharged as a jet having a given angle of spray, and operable to a second position in which said vortex is discharged from said further annular orifice to increase the angle of spray.

4. Spraying apparatus comprising: flow means connectable with a source of divisible coating substance and operable for discharging a jet of said substance; electrode means connectable with a source of voltage and interposed in the path of said jet to electrically charge the same; spray forming means connectable with a source of gaseous fluid under pressure for discharging a stream of said fluid over a path having at least a part in common with the path of said jet, said stream dispersing said jet to form a spray of the charged substance issuing from the apparatus with substantial linear velocity; and means for modifying the velocity and the angle of spray for the dispersed substance comprising: means connectable with a source of gaseous fluid under pressure and operable for discharging an additional stream of said fluid; means for imparting a revolving motion to said additional stream to create a vortex of said fluid; and selector valve means operable to a first position in which no vortex of gaseous fluid is discharged from the apparatus and operable to a second position for discharging said vortex externally of the apparatus in surrounding relation with said spray, said vortex producing a low pressure zone around the dispersed spray to draw said spray outwardly and thereby increase the angle and

reduce the velocity thereof for improved response of said charged jet to electrical forces.

5 The spraying apparatus defined in claim 3, including other vortex means interposed in the path of said first stream of gaseous fluid and imparting a revolving motion thereto.

6. The spraying apparatus defined in claim 3, wherein said vortex means comprises an annular vortex chamber communicating with said further annular orifice a pressure chamber connected with said fluid source, and tangentially directed aperture means extending in a plane perpendicular to the axis of discharge of said spray for interconnecting said pressure and vortex chambers.

7. The spraying apparatus defined in claim 3, including pressure chamber means connectable with said source of fluid under pressure, a first annular vortex chamber communicating with said first annular orifice, a second annular vortex chamber communicating with said further annular orifice, first aperture means interconnecting said pressure chamber means and first vortex chamber in tangential relation with said latter to create a first vortex of gaseous fluid for discharge through said first annular orifice, and further aperture means interconnecting said pressure chamber means with said further vortex chamber in tangential relation with said latter to create a further vortex of gaseous fluid for discharge through said further annular orifice.

8. An electrostatic spraygun including a grip portion and a spray head; a first line connected with the spraygun and connectable with a source of sprayable composition; a second line connected with the spraygun and connectable with a source of gaseous fluid under pressure; a conductor connected with the spraygun and connectable with a source of high voltage; separately operable first and second manual controls on said grip portion; spray discharge orifice means in said spray head; means including an annular vortex discharge orifice in the spray head coaxially surrounding the spray discharge orifice means; first passage means and positioned to discharge a vortex of gaseous fluid externally of the spraygun in the spraygun connecting said first and second lines with said spray discharge orifice means and including first valve means therein; second passage means in the spraygun connecting said second line with said vortex discharge orifice and including vortex means imparting a revolving motion to fluid flowing through said second passage means; second valve means interposed in said second passage means; electrode means in said first passage means and conductive means connecting said conductor with said electrode means, including switch means operable for effectively connecting said electrode means through said conductor to said voltage source; first linkage means connecting said first manual control with said first valve means and said switch means, manual actuation of said first control initiating the discharge of an electrically charged dispersed spray of said composition through said spray discharge orifice; and other linkage means connecting said second manual control with said second valve means, manual actuation of said second control initiating the discharge of a vortex of said fluid through said vortex discharge orifice, said vortex producing a low pressure zone around the dispersed spray to draw said spray outwardly and thereby increase the angle of spray.

9. The spraygun defined in claim 8, wherein said first manual control is in the form of a trigger.

10. The spraygun defined in claim 8, wherein said second manual control is in the form of a push-button.

11. The spraygun defined in claim 8, wherein said spray discharge orifice means includes a central orifice and a further annular orifice coaxially surrounding said central orifice and spaced inward of said annular vortex discharge orifice, said first passage means includes a duct connecting said first line with said central orifice and another duct connecting said second line with said further annular orifice, said first valve means includes one valve interposed in said first-mentioned duct and another

valve interposed in said other duct, and said electrode means is positioned in said first-mentioned duct.

12. The spraygun defined in claim 11, wherein said other valve forming part of said first valve means has an inlet connected to said second line and an outlet connected to said other duct, and said second valve means has an inlet connected to the outlet of said other valve and an outlet connected to the outlet of said other valve and an outlet connected to said second passage means.

13. The apparatus defined in claim 3, wherein said central discharge orifice is annular for discharging said jet in the form of an annular film.

14. The apparatus defined in claim 3, including circumferential vortex-deflecting means surrounding said further annular orifice.

15. In spraying apparatus, the combination comprising a supply of coating material, orifice means connected to said supply for discharging particles of coating material along a predetermined path, a source of gaseous fluid under pressure, means defining a first passage for supplying first stream of gaseous fluid from said source to said orifice means, said first stream interacting with the particles moving along said path and being under sufficient pressure to disperse said particles to form a fine spray of coating material, means defining a second passage connected to said source for forming a second stream of gaseous fluid, vortex means interposed in said second passage for imparting a revolving motion to said second stream and thereby creating a vortex of fluid, and means defining a fluid discharge opening communicating with said second passage and disposed around said orifice means in closed juxtaposition therewith for discharging said vortex in surrounding relationship with the dispersed particles of coating material, said fluid discharge opening being positioned to discharge said vortex externally of the apparatus, said vortex producing a low pressure zone around the dispersed particles to draw the particles away from their predetermined path and thereby increase the angle of spray.

16. In electrostatic spraying apparatus, the combination comprising a supply of coating material, means forming a central orifice connected to said supply for discharging particles of coating material along a predetermined path, means for electrostatically charging said particles of material prior to their discharge from said central orifice, means forming a first annular orifice surrounding said central orifice, a source of gaseous fluid under pressure, means defining a first passage for supplying a first stream of gaseous fluid from said source to said first annular orifice, said first stream interacting with the particles moving along said path and being under sufficient pressure to disperse said particles to form a fine spray of coating material, means defining a second passage connected to said source for forming a second stream of gaseous fluid, vortex means interposed in said second passage for imparting a revolving motion to said second stream and thereby creating a vortex of fluid, and means forming a second annular orifice communicating with said second passage and disposed around said first annular orifice for discharging said vortex in surrounding relationship with the dispersed particles of coating material, said second annular orifice being positioned to discharge said vortex externally of the apparatus, said vortex producing a low pressure zone around the dispersed particles to draw the particles away from their predetermined path and thereby increase the angle of spray.

17. In electrostatic spraying apparatus as defined in claim 16, insert means disposed within said central orifice to form an annular discharge opening for the particles of coating material.

18. In electrostatic spraying apparatus, the combination comprising a supply of coating material, orifice means forming a central orifice connected to said supply for discharging particles of coating material along a predetermined path, means for electrostatically charging said

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particles of material, means forming a first converging orifice adjacent said central orifice, a source of gaseous fluid under pressure, means defining a first passage for supplying a first stream of gaseous fluid from said source to said first converging orifice, said first stream converging toward the particles moving along said path and being under sufficient pressure to disperse said particles to form a fine spray of coating material, means defining a second passage connected to said source for forming a second stream of gaseous fluid, vortex means interposed in said second passage for imparting a revolving motion to said second stream and thereby creating a vortex of fluid, and means forming a second converging orifice communicating with said second passage and disposed around said central orifice and said first converging orifice for discharging said vortex in surrounding relationship with the dispersed particles of coating material, said second converging orifice being positioned to discharge said vor-

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tex externally of the apparatus, the axis of discharge from said second converging orifice meeting the predetermined path of said particles at an angle greater than that of the axis of discharge from said first converging orifice, said vortex producing a low pressure zone around the dispersed particles to draw the particles away from their predetermined path and thereby increase the angle of spray.

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