Feb. 12, 1935. E. GUSTAFSSON 1,990,823

FLAT SPRAYING APPLIANCE

Filed Oct. 23, 1933 2 Sheets-Sheet 1

Fig. 3

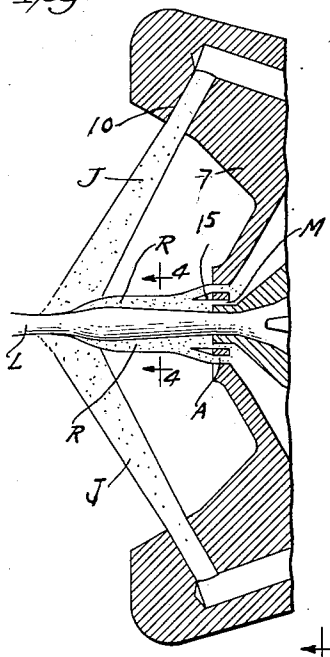


Fig. 1

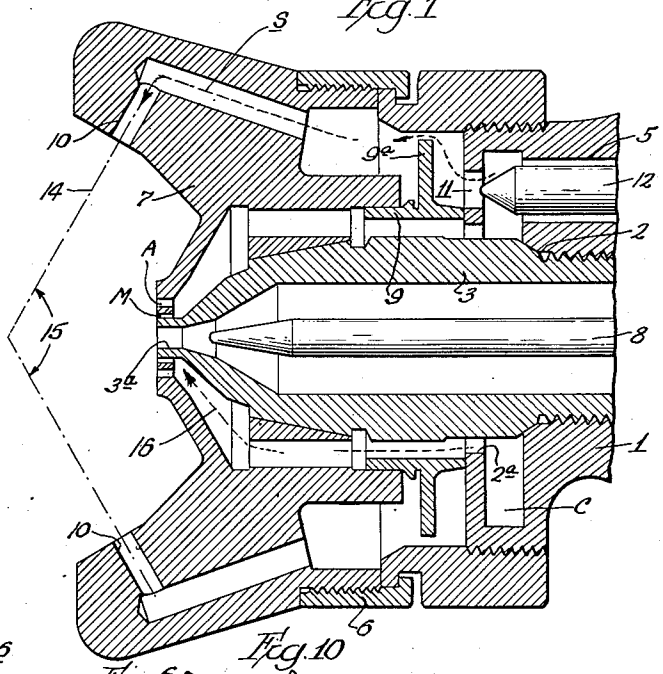


Fig. 5

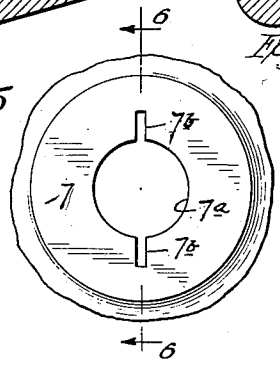


Fig. 6

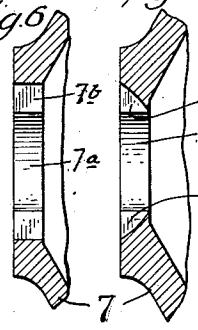


Fig. 10

Fig. 11

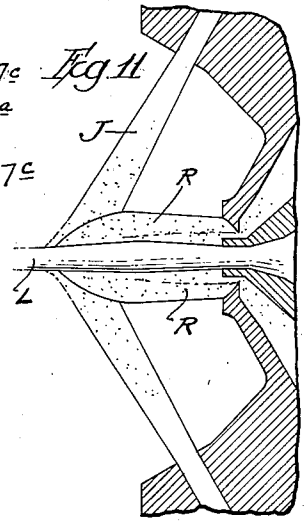


Fig. 2

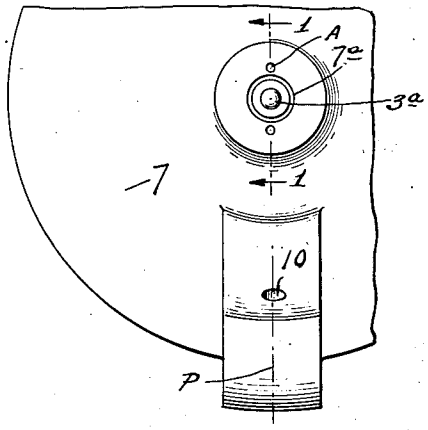
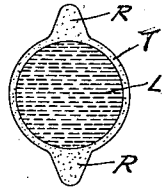


Fig. 4



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FLAT SPRAYING APPLIANCE

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Fig. 12

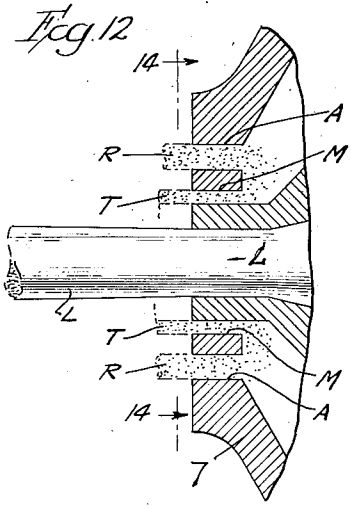


Fig. 13

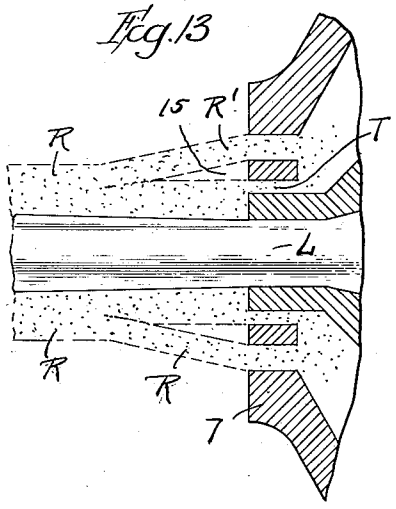


Fig. 7

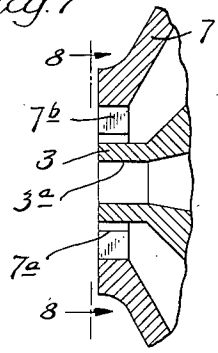


Fig. 8

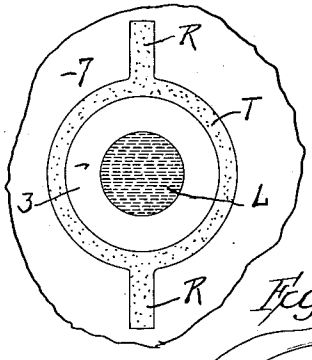


Fig. 9

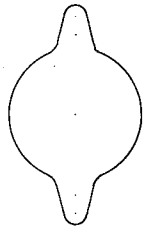


Fig. 14

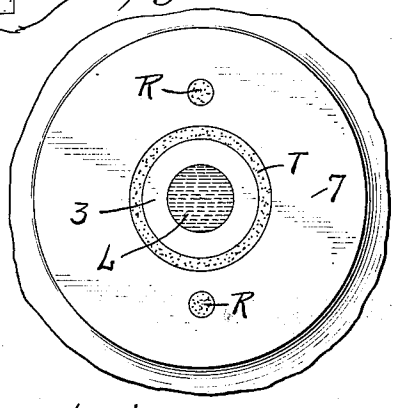
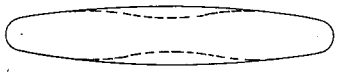


Fig. 15



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Patented Feb. 12, 1935 1,990,823

UNITED STATES PATENT OFFICE

1,990,823

FLAT-SPRAYING APPLIANCE

Eric Gustafsson, Chicago, Ill., assignor to Binks Manufacturing Company, Chicago, Ill., a corporation of Delaware

Application October 23, 1933, Serial No. 694,796

9 Claims. (Cl. 299—140.1)

My invention relates to the class of spraying appliances designed for projecting material in a partially atomized stream and thereafter converting this stream into a socalled flat spray, namely a mass spray having a substantially elliptical cross-section.

In spray appliances of this class, the material is projected from the tubular tip of a nozzle, around which nozzle tip air also issues under such pressure that this air commingles with the material and considerably atomizes the material to form a stream of partly-atomized material of circular cross-section. This stream is then subjected to the impact of two opposed and forwardly converging jets of air which flatten the stream and completes the atomization so that the said stream is converted into a flattened spray; and owing to the forward converging of the two air jets, these cooperate with the air which issued around the nozzle tip to carry the spray further forward so that it can be projected at considerable velocity against an object.

When such an appliance is used for spraying material upon an object to form a coating of a predetermined thickness, the cost of applying this coating over a given area varies in direct proportion to the required amount of compressed air and to the labor required for producing uniformity of thickness in the coating. The cost also varies with the cross-section of the resulting spray, it having been found most advantageous for many purposes to have this cross-section an ellipse in which the major axis is many times as long as the minor axis.

The distribution of liquid coating material in a spray for securing the desired general uniformity of the coating depends both on the degree of the atomization, the rate at which the particles of the material will flow into each other before drying, and perhaps also on the surface tension of these particles.

In practice, a spray gun for this purpose is usually constructed so that the air for the spray-flattening side jets is supplied from a branch of the main air passage which leads to an annular air port around the material nozzle. The pressure of the air supplied to the main air passage is adjusted according to the characteristics of the material to be sprayed and the pressure at which this material is ejected from the material nozzle, and the proportionate amount of air for the converging (or spray-flattening) side jets is also adjusted so as to flatten the spray to the desired pattern.

Since the degree of atomization—or fineness of the spray—depends on the proportion of the air to the material, this atomization can be increased (for material projected at a given volume per minute) by increasing the pressure at which air issues from the said annular port, but the resulting increase in the velocity of the air from this port may dry the particles of material to such an extent before they reach the object which is being sprayed that these particles no longer will flow adequately into each other in the resulting coating. On the other hand, while an increase in the rate at which air is emitted from the usual two side ports for flattening the spray would increase the atomization, this also may increase flattening effect of the side air jets to such an extent as to indent the sides of the otherwise elliptical pattern of the spray, or even to split that spray.

Moreover, the resistance of the partially atomized material to flatten varies with the nature of the material, so that with the recently "synthetic" enamels and lacquers (which are of less specific gravity and which I believe have a synthetic rubber base), the spray gun when adjusted to project the desired completely elliptical pattern emits a spray which is so inadequately atomized that the particles do not all merge into one another in the coating.

As the result, the dried coating shows innumerable stipple-like depressions or quite narrow irregular furrows, giving what the spray-painters call an "orange peel" effect so that the pigment-containing coating must be "sanded" (or rubbed with wet sand-paper to force some of the thicker portions into the minute furrows so as to level the surface of the coating) and thereafter buffed to restore its glossiness by the use of a buffing wheel, thereby requiring two manually conducted operations which involve a considerable labor cost. This additional labor (which may also be needed on some lacquer coatings) cannot effectively be avoided by increasing the air emitted from the side ports of the spray gun to increase the atomization, because the increased flattening effect of the air from these ports then would also modify the cross-section and patern of the spray unduly.

My present invention aims to provide a spray-appliance head construction which will greatly reduce (and for some coating materials entirely eliminate) these "sanding" and buffing operations without modifying the pattern of the spray, which will considerably reduce the required amount of compressed air required, and which will readily permit that pattern of the spray to

be varied without materially affecting the degree of atomization.

Furthermore, my invention aims to accomplish the above recited objects by exceedingly simple and inexpensive changes which can readily be made in the now customary flat-spraying appliances, such as the modern spray guns.

And in another major object, my invention aims to provide a novel method of converting an initially cylindrical stream of partially atomized material into a completely and finely atomized flattened spray without indenting the sides of the generally elliptical pattern projected by the spray.

In the drawings,

Fig. 1 is an enlarged central and vertical section through forward parts of a spray gun constructed in general after the manner more fully described in the Bramsen Patent #1,910,673 (issued May 23, 1933 to the same assignee with my present application), with the air nozzle modified in accordance with my invention.

Fig. 2 is a fragmentary front elevation of the air nozzle.

Fig. 3 is a section similar to the left-hand portion of Fig. 1, taken when the spray gun is in operation, with the stream of liquid material in elevation, and the air streams indicated in cross-section, showing these streams as they appear when the spray gun is in operation.

Fig. 4 is an enlarged section taken along the line 4—4 of Fig. 3, showing the surface ribs of aerated liquid produced by the jets of air from the auxiliary air ports adjacent to the central port in the air nozzle.

Fig. 5 is front elevation of the central portion of another air nozzle embodying my invention, namely one in which slit-like radial enlargements of the central air port of that nozzle are substituted for the separately formed auxiliary air ports of Figs. 1 and 2.

Fig. 6 is a section taken along the line 6—6 of Fig. 5.

Fig. 7 is a section similar to Fig. 6, including the tip of the adjacent material nozzle.

Fig. 8 is an enlarged section taken along the line 8—8 of Fig. 7, showing the cross-section of the fluid streams as initially emitted.

Fig. 9 is a cross-section of the fluid streams of Fig. 8, taken at a greater distance from the points of emission of these streams.

Fig. 10 is a section similar to Fig. 6, showing an alternative shaping of the slit-like port enlargements.

Fig. 11 is a view allied to Fig. 3, showing the shape of the fluid streams when the central portion of the air nozzle is formed as shown in Fig. 10.

Fig. 12 is an enlargement of a portion of Fig. 1, showing the initial sections of the stream of material and of the air streams adjacent to it.

Fig. 13 is a section similar to Fig. 12, showing the deflecting of the auxiliary air jets against opposite sides of the partly aerated material stream so that the air of these jets will form air ribs projecting from this stream.

Fig. 14 is a section taken along the line 14—14 of Fig. 12, showing the initial cross-sections of the air streams which are projected adjacent to the fluid stream.

Fig. 15 shows a desirable elliptical cross-section or pattern of a spray, with dotted lines showing the side indentations in this pattern, which my invention avoids.

In the embodiment of Fig. 1, the barrel 1 of the usual gun body has a longitudinal bore 2 which opens at the forward end of the said barrel, this bore being enlarged in diameter (as shown at 2a) at the extreme forward end of the barrel and undercut slightly behind this forward end to afford an annular air-distributing chamber C. The gun barrel also has a second longitudinal bore 5 through which compressed air is supplied to the said chamber.

Threaded at its rear end into the forward end of the unenlarged portion of the bore 2 is a liquid nozzle 3 having a diametrically contracted and preferably cylindrically tubular tip 3a through which the paint or other material is discharged under pressure, the discharge being controlled by a longitudinally movable needle valve 8. Clamped against portions of this nozzle by a clamping ring 6 is an air nozzle 7 having a central (and preferably cylindrical) bore which is of larger diameter than the exterior of the said nozzle tip so as to leave an annular main air port M between the said bore and nozzle tip.

Extending between the rear end of the air nozzle and the front end of the gun barrel 1 is an annular baffle comprising a tubular portion 9 which subdivides the interior space forward of the gun barrel so that part of the air can flow alongside the liquid nozzle 3 to the main air port M (along lines such as 16), while another part of the air from the chamber C can flow through a port 11 controlled by a control valve 12 to two side air ports 10, as indicated by the air flow line S.

With such a spray gun, the annular air port M discharges a tube of air (T in Fig. 12) coaxial with the initially cylindrical liquid stream L, and at the start of this discharge air the tube presumably is spaced radially from the material stream by a distance equal to the wall thickness of the tubular tip of the liquid nozzle. But both the emitted liquid stream and the said tube of air produce a strong suction for dragging the air in the tubular space between them forwardly also, thereby creating a sufficient vacuum in this space so that the air surrounding the air tube T compresses that tube radially into engagement with the exterior of the liquid stream. This pressure of the atmospheric air also causes the air of the air tube to commingle with the projected liquid long before that liquid is reached by the side air jets J (Fig. 3), so that the velocity at which the air of this tube was projected aids in propelling the liquid forwardly.

These side air jets J (Fig. 3) then flatten the already partly aerated liquid stream and the spray into which this stream is atomized through the joint action of air of the air tube T and the air of the said jets. The extent of the flattening effect on the spray increases with the amount of air issuing from the side ports 10, which the operator controls by adjusting the position of the control valve 12 with respect to the port 11 of Fig. 1.

When the liquid material and the air around the same are ejected at given pressures, the cross-section of the spray (or pattern produced by it on an object) can thus be varied from a circular section to different elliptical sections, such as that of Fig. 13 which shows a pattern heretofore found particularly advantageous in the spray-coating of automobiles with pyroxylin enamels and lacquers.

My present invention is based on my discovering that the interposing of air cushions between

each side air jet and the side of the liquid stream against which that jet is directed will increase the resistance of the said stream to the flattening effect of the side air jets, and that this cushioning air also will increase the atomization, thereby avoiding both the indenting of the pattern and the creating of an "orange peel" effect in the coating. Furthermore, I have found that the needed air cushions can be provided by exceedingly simple and inexpensive modifications of the air nozzles now commonly used on such spray guns, and that with the air of such provisions the so called "synthetic" enamels and lacquers can be sprayed in the desired patterns with the liquid ejected at a much lower pressure than would be required without my modifications.

To secure these advantages, I provide the air nozzle with means for projecting air along opposite sides of the aerated liquid stream, which air intermingles also with the said stream to form ribs of aerated liquid, against each of which ribs one of the side air jets impinges. This I can accomplish either by providing the central bore 7*a* of the air nozzle with two diametrically opposite slit-like enlargements having their axes in the same common plane (axial of the air nozzle and hence diametric of the liquid stream) with the axes of the two side ports 10, as in Figs. 5 and 6 or Fig. 10; or by providing the air nozzle with two similarly disposed auxiliary ports A as shown in Figs. 1 to 3.

With the air nozzle provided as in Figs. 5 to 8 with two slits 7*b* (of uniform cross-section throughout their length) forming diametrically opposed enlargements of the usual central air port 7*a* of that nozzle, the tube of air T (Fig. 8) issuing from the thus enlarged air port has corresponding air ribs R projecting from its opposite sides. When air is first emitted from this port, after the discharge end of the material nozzle 3 (Fig. 7) has been opened to emit a cylindrical stream of material L, the bore of this tube no doubt is initially spaced radially from the said stream by a distance corresponding to the wall thickness of the tubular tip of the material nozzle.

However, both the material stream and the tube of air T draw air with them from the space in front of the tubular tip of the material nozzle, thereby creating such a vacuum in that space that the pressure of the air around the said air tube will compress this tube against and into intermingling with the liquid to form an aerated liquid stream. Since this leaves no space between the main portion T of that air tube and the ribs of air R emitted from the port enlargements 7*b*, these ribs continue along opposite sides of the liquid stream, although the resulting contour of the entire aerated stream becomes more elliptoid and reaches a shape such as that of Fig. 9 by the time this air tube intersects the axes of the air jets J when air is also ejected from the side ports 10 of Fig. 1.

Consequently, when these ribs R on the said stream have their axes in a common plane (diametric of the material stream L) with the axes of the air jets J, each such jet must impact against one of these air ribs before it can reach the material stream. As the result, each side air jet flattens the rib against which it is directed, so as to spread out that rib and distribute the impact of the jet over the entire width of the material stream, instead of having that impact unduly concentrated adjacent to the axis of the jet. In addition, each side jet forces the air of the encountered stream rib into an intimate intermingling with the material stream. To enhance the above described action, I preferably make the outlets for the air of the auxiliary ribs of a width considerably less than the outlet bore of the material discharge nozzle, so that each air rib will have its average width a minor fraction of the diameter of the projected stream L of material.

When the central air port enlargements increase in radial width forwardly, as at 7*c* in Fig. 10, the projected fluid streams then interact as illustrated in Fig. 11, and with the port enlargements 7*b* of Figs. 5 and 6 I have found the shape of the resulting fluid streams to be allied to the showing of Fig. 11 except in that the projecting ribs are of less thickness radially of the material stream L.

In Figs. 1 to 3, the air nozzle has its central portion provided with two auxiliary ports A at diametrically opposite sides of, and equally spaced from the usual central and tubular air port from which a cylindrical tube of air T continually issues, as indicated in Fig. 13, and this tube of air likewise is pressed against and gradually into the material stream by the pressure of air around it. Likewise, the dragging of air from between the material stream and each of the cylindrical air jets R^1 emitted by the two auxiliary ports also causes the outer air to force these air jets against opposite sides of the material stream, as shown in Fig. 13, so as to form the said longitudinal ribs R projecting from this stream, although enough air may be drawn between the said air jets and air tube close to the front of the air nozzle to leave clearly visible air spaces 15 of triangle section also shown in Fig. 13.

When no air issues from the forwardly converging side ports 10, I have found that the resulting stream ribs R will continue to project from the material stream for distances far forward of the intersection of the axes 14 of these ports. Then when the control valve 12 of Fig. 1 is opened to emit air jets J from the said side ports, these jets promptly act as described in connection with the air nozzle of Figs. 6 and 7, so that I have found the cross-sections of the fluid streams (taken in the common plane of all of the ports of the air nozzle) to be such as is shown in Fig. 3, although somewhat modified by variations in the relative pressure at which these streams are projected. Such variations may also alter the rate at which the said tube of air merges with the material, and for part of the way toward the converging air jets the gradually thinning air tube T may sometimes be interposed between the material stream L and the air ribs R as shown in Fig. 4.

In practice, I have also found it advisable to proportion the auxiliary air-emitting provisions so that each stream rib, just before it is impacted by the corresponding side air jet, projects farther radially from the material stream than the average width of that rib; but both the volume of the rib-forming air and the cross-sectional shape of these ribs may be varied according to the nature of the material in the material stream. So also, when using separately formed auxiliary ports A instead of the central air port enlargements, as I preferably do to facilitate the manufacture, the spacing of these auxiliary ports A from the central bore 7*a* in the air nozzle may be varied somewhat, provided

that the spacing is sufficiently small to enable the atmospheric air to force the air jets from the auxiliary ports against the single fluid stream between these two ports.

With the auxiliary air thus moving forwardly along opposite sides of the material stream and across the path of the side air jets, I accomplish these results:

(*a*) The flattening of each stream rib by the corresponding side air jet distributes the pressure exerted by that air jet, so that I can readily avoid having these side air jets indent the cross-section of the spray (after the manner shown in dotted lines in Fig. 15) or even split the spray. Moreover, I can easily vary the extent to which the air ribs stiffen the material stream against indentation, according to the nature of the material of that stream, by varying either the area or the cross-sectional shape of the openings through which air for the air ribs is emitted.

(*b*) Since the completely forward movement of the added air in the air ribs is highly effective for propelling the spray, I do not require the side air jets to converge at so small an angle as to have these jets also supply a large portion of the propelling power for the spray. For example, I have found my here disclosed spray-appliance head highly effective with an angle of about 115 degrees between the axes of the two side air ports, instead of the more commonly used angles of from 90 to 100 degrees. With this change in the angle, the side air jets are also used more effectively for their flattening effect, so that the air needed for them can be correspondingly reduced in volume per minute.

(*c*) Since the air in the air ribs moves entirely in the direction in which the spray is to be projected, this air is utilized much more efficiently for atomizing the material than the same amount of air would be if directed at an angle to the material stream, so that I also obtain a higher degree of atomization with the same total consumption of compressed air and hence can readily avoid the producing of an "orange peel" effect in the resulting coating when spraying a liquid coating material.

(*d*) When my auxiliary air-rib-projecting provisions are applied to a spray appliance in which the air emitted by the auxiliary ports (or by the enlargements of the central air port) can be controlled separately from the air for the spray-flattening air jets, I also secure the following important advantages in comparison to the previously proposed projecting of the auxiliary air through additional ports leading from the same air passages with the ports for the spray-flattening air jets.

(*e*) Since all of the air projected forwardly adjacent to the emitting of the material stream is controlled conjointly, the volume of this air can be controlled (independently of the control of the spray-flattening air (so as to proportion it almost instantly to the rate at which any given material is projected; consequently, with air emitted from the central air ports and from my auxiliary port provisions at a definite pressure I obtain a constant stiffening effect on the material stream. At the same time, the air jets from the converging side ports can be varied, without affecting the emission of air from near the axis of the air nozzle, for altering the spread of the resulting spray.

(*f*) As the joint result of the just recited advantages, I have found in practice that with a double-air control spray appliances constructed as here disclosed, the pressure of the air required at the central air port in the spraying of a given material at a predetermined rate per minute can be reduced from one-sixth to one-third (varying with the rate of the spraying), thus effecting a decided saving in the consumption of air.

(*g*) When the auxiliary air required for overcoming the "orange peel" effect is emitted from the central portion of the air nozzle, the needed ports can be freely open at both ends as shown in Figs. 1, 3, 6 and 7. Consequently, they also can be kept clean much more easily than any auxiliary ports would be if these led from the passages leading to the side ports 10 after a previously proposed manner which I have found far less effective for any of my recited purposes.

However, while I have heretofore described my invention as applied to a portable spray appliance of the type commonly known as a spray gun, I do not wish to be limited in this respect. Nor do I wish to be limited as to details of the construction and arrangement here disclosed, since many changes might be made without departing either from the spirit of my invention or from the appended claims.

I claim as my invention:

1. The method of producing a flattened spray of material, which comprises forwardly projecting a stream composed of the material intermingled with and partially atomized by air; forwardly projecting two opposed jets of air of not more than half the initial diameter of the said projected stream and contiguous to diametrically opposite sides of the said stream, with the axes of the said jets parallel to the axis of the said stream and with the rear end of both of the said jets disposed in a common plane with that of the rear end of the projected stream of material; and projecting two forwardly converging jets of air toward a common point on the axis of the material stream, with the axes of the last named jets in a common plane with all the aforesaid axes.

2. The method of producing a flattened spray by the impact of two opposed and forwardly converging jets of air against a forwardly projected and initially circular-sectioned stream of material intermingled with and partially atomized by air, which consists in forwardly projecting two auxiliary jets of air, each of not more than half the initial diameter of the said projected stream, at opposite sides of and contiguous to the said stream and with the axis of each auxiliary jet spaced from the axis of the said projected stream by a distance not more than twice the initial diameter of the said projected stream, with the axis of all of the said three jets in a plane diametric of the said stream; whereby the two auxiliary jets produce longitudinal ribs along the said sides of the stream, against which air ribs the said opposed jets of air respectively impact before reaching the material stream.

3. The method of producing a flattened spray by the impact of two opposed and forwardly converging jets of air against a forwardly projected and initially circular-sectioned stream composed of material intermingled with and partially atomized by air, which consists in providing forwardly moving rib-like columns of air, each of smaller spread than the material stream, which columns of air produce aerated longitudinal ribs in the said stream respectively at the

sides of the said stream against which the said jets impinge.

4. In the production of a flattened spray of material by the impact, against a stream of material intermingled with and partly atomized by air, of a jet of air having its axis intersecting that of the said stream at a rearwardly open acute angle, the method of preventing an undue flattening of the central portion of the spray, which method comprises the projecting of a stream of auxiliary air of an initial diameter not more than half the initial diameter of the said jet of air longitudinally along and contiguous to the side of the stream against which the jet is directed, thereby compelling the said jet to spread the air of the said auxiliary stream transversely of the axis of the jet before the impact of the jet reaches the stream so as to distribute the said impact laterally of the said stream.

5. In a spraying appliance, means for forwardly projecting the material in the form of an initially cylindrical stream, means for forwardly projecting a tube of air coaxial with the said stream around and in intimate merging and partially atomizing relation to the said stream; means for forwardly projecting two jets of air of not more than approximately half the initial diameter of the said stream and at diametrically opposite sides of the said air tube, with the axes of both jets parallel to that of the stream and with each jet so closely adjacent to the air tube that the said air jets will produce longitudinal ribs of aerated liquid respectively contiguous to two diametrically opposite sides of the material stream; and means for projecting two forwardly converging jets of air against the said air ribs with the axes of the last named jets in the same plane with the axes of the aforesaid parallel jets.

6. In a spray appliance, means for forwardly projecting a cylindrical stream of liquid; means for forwardly projecting a tubular stream of air of uniform wall thickness coaxial with and in intimate merging relation to the liquid stream; and auxiliary means for forwardly projecting two streams of air parallel to and in merging relation to diametrically opposite sides of the tubular air stream, with each of the auxiliary jets of a diameter not materially exceeding half the initial diameter of the liquid stream; and means for projecting two forwardly converging jets of air against the composite fluid stream produced by the aforesaid means, with the axes of the said jets in a common plane with the axes of both of the said parallel air streams.

7. In a material spraying appliance, a material nozzle having a cylindrical tubular tip; and an air nozzle coaxial with the tip of the material nozzle and having a cylindrical central air port housing and coaxial with the said nozzle tip; the air nozzle having two auxiliary ports disposed adjacent to and respectively at diametrically opposite sides of and at equal spacing from the ectnarl air port of the air nozzle, the axes of the said auxiliary ports being parallel to the axis of the central air port of the air nozzle, each auxiliary port being of a diameter not exceeding the radius of the central air port and having its outlet in the same plane with the outlet of the tip of the material nozzle.

8. In a liquid spraying appliance, a material nozzle and an air nozzle as per claim 7, in which the axis of each of the auxiliary ports is spaced from the bore wall of the cylindrical air port by a distance less than the diameter of the cylindrical air port.

9. In a liquid spraying appliance, a material nozzle and an air nozzle as per claim 7, in which the diameter of each of the auxiliary ports is a minor fraction of the diameter of the bore of the tip of the liquid nozzle.

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