

May 13, 1958

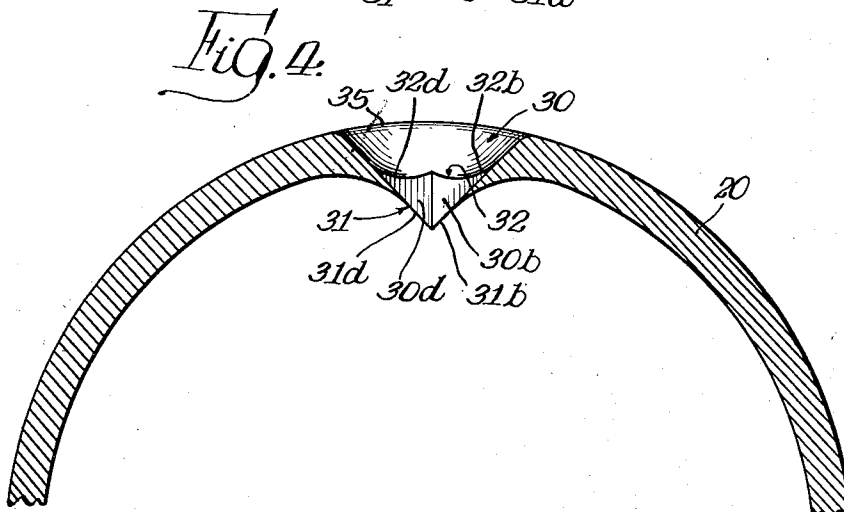
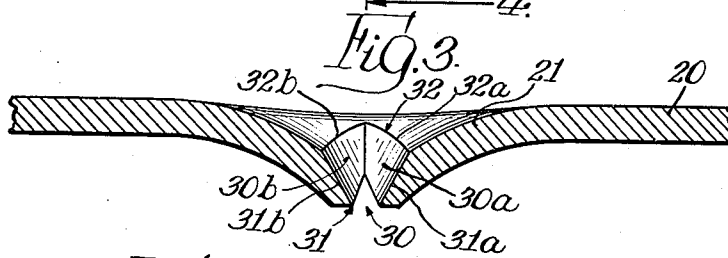
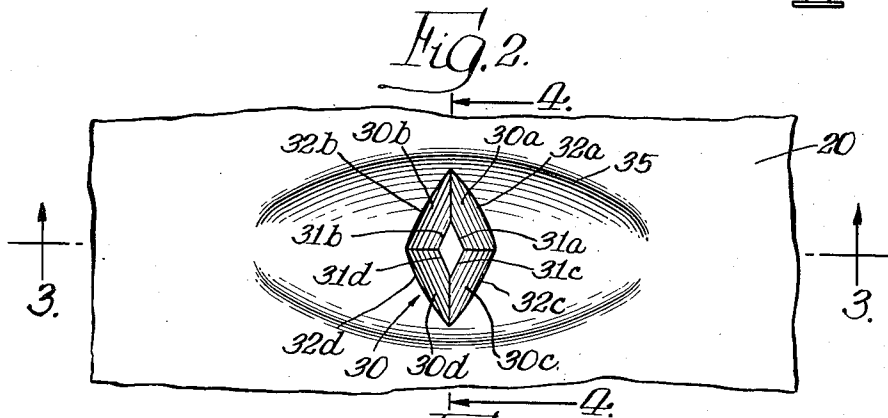
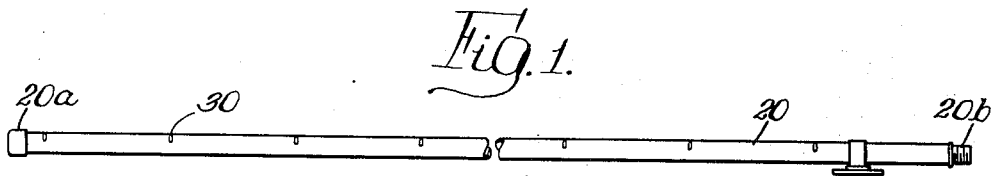
M. W. MILLER

2,834,635

LIQUID SPRAY DEVICE

Filed June 22, 1955

2 Sheets-Sheet 1



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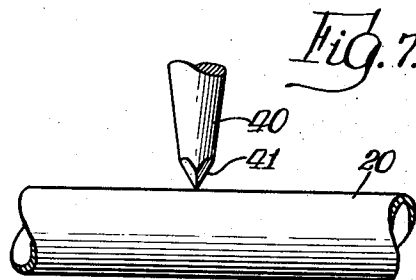
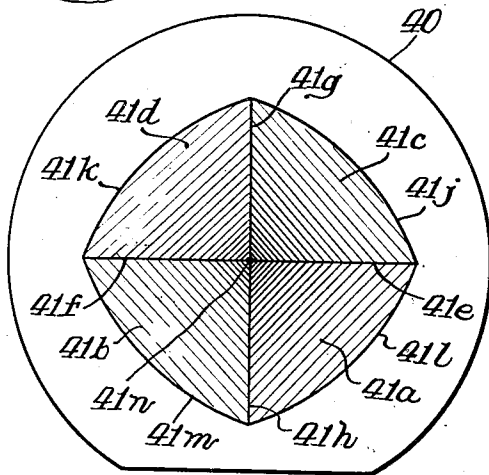
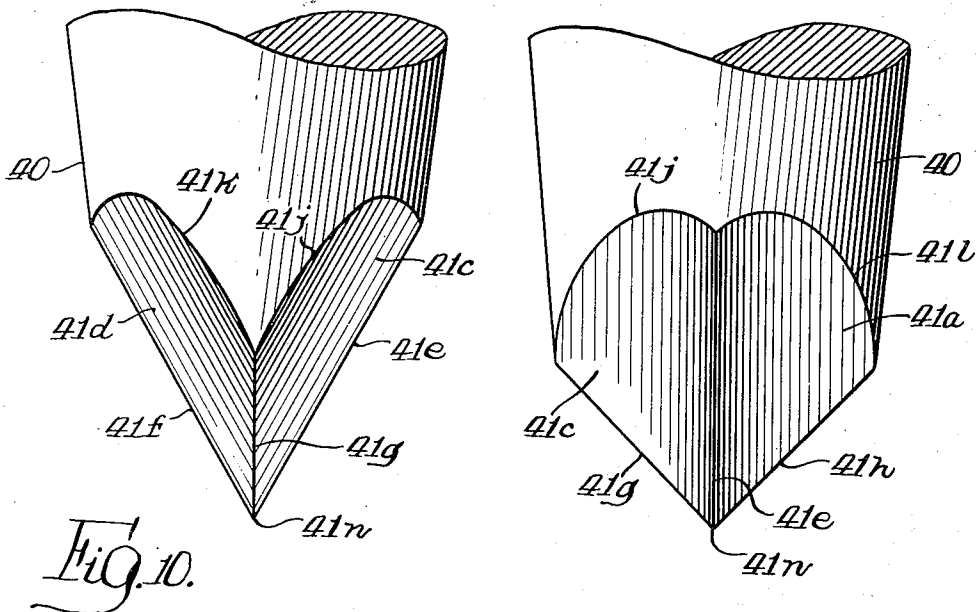
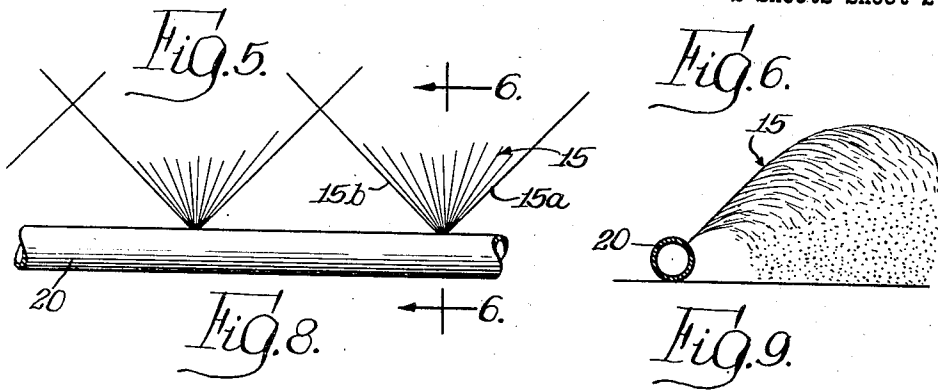
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LIQUID SPRAY DEVICE

2,834,635

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2 Sheets-Sheet 2



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2,834,635

LIQUID SPRAY DEVICE

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Application June 22, 1955, Serial No. 517,246

11 Claims. (Cl. 299—104)

This invention relates to a liquid discharging means and in particular to means for discharging liquid in a fan-like sheet from a source outwardly into an atmosphere.

Where it is desired to spray a liquid in the form of mist or fine droplets, different forms of spray nozzles have heretofore been employed in the art. As such spray nozzles are relatively costly, however, the use thereof is limited in applications wherein a large number of spray discharge means is required, as in a lawn sprinkling system, a roof cooling system, or the like. In such an application, it has been found efficacious to use small, round openings in the duct forming the liquid distributing system in lieu of utilizing the more costly nozzle elements.

Such small openings have proven considerably disadvantageous in that they tend to clog rapidly, limiting the flow therethrough and, in many cases, completely obstructing it. Such clogging is particularly prevalent where the holes are of extremely small size as in roof cooling systems where it is desirable to obtain a discharge in the form of a very fine mist.

Another pronounced disadvantage of the openings now in the art is that the discharge appears in the form either of a relatively solid stream or of a relatively conical spray configuration. The relatively circular spray pattern produced by such a discharge makes it quite difficult to obtain a uniform dispersal of the liquid over a flat area without considerable overlapping of the individual discharges.

It is therefore the principal object of this invention to provide a new and improved means for discharging a liquid into an atmosphere.

Another object is to provide means for discharging a liquid into an atmosphere in the form of a fan like spray, comprising a wall having an opening therethrough of new and improved configuration.

A further object is to provide a means for discharging a liquid into an atmosphere, comprising a wall having a small, self-cleaning opening therethrough.

Still another object of the invention is to provide a discharging means as described above wherein the opening is frusto-pyramidal and outwardly widening.

Yet another object is to provide such means wherein the opening is frusto-pyramidal, outwardly widening, and having a rhomboidal lateral cross-section.

A yet further object of the invention is to provide means for discharging a liquid in a fan like sheet, comprising a tube adapted to receive a liquid under pressure and provided with a frusto-pyramidal, outwardly widening opening therethrough having a rhombic lateral cross-section, with the shorter axis of the rhombus extending longitudinally of the tube whereby the plane of the fan like sheet of liquid is caused to extend longitudinally of the tube.

A yet further object is to provide a new and improved method of spraying liquid in a fan-like sheet from a source outwardly into the atmosphere.

Other features and advantages of this invention will

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be apparent from the following description taken in connection with the accompanying drawings wherein:

Fig. 1 is a side elevational, broken view of a duct having liquid discharging means embodying the invention;

Fig. 2 is an enlarged fragmentary plan view of a portion of the duct wall having a liquid discharging opening therein;

Fig. 3 is a sectional view taken approximately along the line 3—3 of Fig. 2;

Fig. 4 is a sectional view taken approximately along the line 4—4 of Fig. 2;

Fig. 5 is a somewhat enlarged fragmentary view of the duct of Fig. 1 and with liquid being discharged from the openings therein;

Fig. 6 is a sectional view taken approximately along the line 6—6 of Fig. 5;

Fig. 7 is a fragmentary view of a duct with a tool juxtaposed for forming an opening therein;

Fig. 8 is an enlarged fragmentary elevational view of the tool of Fig. 7 looking from one side thereof;

Fig. 9 is a view similar to Fig. 8 but rotated 90° therefrom; and

Fig. 10 is a fragmentary end view of the tool of Fig. 7. In the exemplary embodiment of the invention disclosed in the drawings, the liquid discharging means may be seen to comprise a suitable duct 20 adapted to receive liquid, as water, under pressure. One or more discharge passages or openings, generally designated as 30, are provided in duct 20 for discharging the liquid from the interior of the duct into the circumambient atmosphere. As will be explained more fully here following, openings 30 are constructed and arranged to cause discharge of the liquid in a fan like sheet, generally designated 15, of extremely small droplets or mist. Control over the desired qualities of sheet 15, as size of the droplets, angle of spread, distance of throw, or plane of the fan is obtained through control of the opening configuration as taught hereinafter. Opening 30 is formed in duct 20 by a non-rotative piercing operation conducted with a novel tool 40 having a pyramidal tip 41 adapted to be forced through the wall of the duct 20.

While duct 20 may have any suitable configuration, in the illustrative embodiment depicted it comprises a tube of circular cross-section having a fluid blocking cap 20a at one end and means such as threaded portion 20b, for connection to a fluid supply (not shown) at the opposite end. A typical and suitable example of such a tube is that formed of nominal 1/2" copper tubing, type "M" hard, having an outside diameter of .625" and a wall thickness of .028". Typical pressures of the liquid within the tube are those in the range of 0 to 50 pounds per square inch above the ambient pressure.

As best seen in Figs. 2, 3 and 4, opening 30 comprises a frusto-pyramidal, outwardly widening opening extending radially through the wall of the tube 20 and having four similar generally planar surfaces 30a, 30b, 30c and 30d. The lateral cross-section of opening 30 (taken at right angles to the radial axis of the opening) is generally rhomboidal and as shown in Fig. 2 is preferably rhombic. To obtain the fan configuration of sheet 15, the ratio of the length of the longer diagonal of the rhombic cross-section to the length of the shorter diagonal thereof may be in the range of from just greater than 1 to 1 to upwards of 3 to 1, and I have found a ratio of 1 1/2 to 1 produces completely satisfactory results. Such a cross-section is obtained, as seen in Figs. 3 and 4, when the edges of the pyramid defining the ends of the shorter diagonal extend at an angle of 60° relative to each other and the edges of the pyramid defining the ends of the longer diagonal extend at an angle of 90° relative to each other. I have found that an opening having a 1 to 1 ratio of the diagonals does not produce the desired

fan shaped sheet but rather produces a generally conical spray, and, further, does not have the self-cleaning characteristic of the openings having the diagonal ratio range set out above.

As seen in Figs. 3 and 4, the edge 31 at the inner end of opening 30 and the edge 32 at the outer end of the opening 30 do not respectively define true planes in that segments 31a, 31b, 31c and 31d comprising the edge 31 extend outwardly from the shorter diagonal and the segments 32a, 32b, 32c and 32d comprising the edge 32 are somewhat arcuate. This deviation of edges 31 and 32 from true planar figures is a function of the deformation in the tube 20 and varies with the surface configuration of the tube, the wall thickness thereof, the physical properties of the tube such as tensile strength, shear strength, and ductility, and the included angles between the opposed pyramidal edges. For purposes of this disclosure therefore, I define frusto-pyramidal as the pyramidal surface between the generally planar surfaces defined by the edges 31 and 32. In the preferred embodiment of the drawings an appreciable inward deformation of the tubing is produced resulting in a deviation from the true planar configuration, as shown.

Immediately concentrically surrounding opening 30 at 21, tube 20 is dished radially inwardly. The depth of portion 21 may be varied over the range of practically zero to several times the wall thickness of the tube; I have found that with a 1/2" copper tube of the type described above a depth of approximately the thickness of the tube is satisfactory.

Because of the self-cleaning action produced by the fluid in passing through the frusto-pyramidal opening 30, the opening may be made extremely small while yet avoiding the clogging tendencies of the openings now found in the art. In openings adapted to discharge the liquid in a very fine mist, the length of the shorter diagonal, or the distance across the opening at the innermost portion of edges 31 (as seen in Fig. 3) may be .01" or smaller. Where heavy droplets are desired, this dimension may be .045" or greater. Intermediate size openings produce different size droplets ranging gradually from those comprising a very fine mist to those comprising relatively large and heavy droplets. I have further found that, with a given size opening a direct relationship exists generally between the size of the droplets and the fluid pressure. Illustratively, an opening having a .01" shorter diagonal and a .015" longer diagonal formed in the nominal 1/2" tube described above produces a very fine mist suitable for spraying planting bins, with negligible variation in droplet size between the low and high extremes of pressure normally encountered. An opening having a .023" shorter diagonal and a .0345 longer diagonal in such a tube produces a very fine mist with the lower pressures and some heavy droplets with the higher pressures so that it is particularly well suited for use in roof spray cooling systems.

With the discharge means described above, the liquid is caused to be sprayed into the atmosphere in a relatively planar, fan like sheet 15, as best seen in Figs. 5 and 6. Outer edges 15a and 15b of sheet 15 are formed having somewhat larger size droplets than those in the intermediate portions of the sheet. The angular extension of edges 15a and 15b to each other may be varied in a direct relationship by changing the size of opening 30, increasing the pressure of the liquid in the tube, or varying the angle between opposed edges of opening 30.

The distance the liquid particles travel from opening 30 varies in direct proportion to the size of the opening, the angle of the pyramidal edges, or the pressure of the fluid in the tube 20. Thus, as can best be seen in Fig. 6 although sheet 15 is relatively planar, fall out of the droplets therefrom occurs at different distances from the tube 20 so that a relatively uniform dispersal of the droplets is provided horizontally laterally of the tube 20. As the angle prescribed by edges 15a and 15b and the maxi-

mum travel of the droplets in fan 15 are readily controlled by the methods indicated above, a relatively uniform dispersal over large areas may be readily effected by so controlling the characteristics of the individual sheets 15 and coordinating a plurality of them in suitable patterns.

The openings 30 are preferably formed by piercing the wall of the tube 20. As best seen in Figs. 7-10, a piercing tool 40, formed of suitable tool material, is provided at one end with an axially aligned pyramidal-shaped tip 41 forming surfaces 41a, 41b, 41c and 41d. The pyramidal configuration is preferably one having a rhombic base so that the included angle between one pair of opposed edges 41e and 41f is less than the included angle between opposed edges 41g and 41h which lie in a plane extending perpendicularly to the plane of edges 41e and 41f. The intersection of the pyramidal tip surfaces 41a, 41b, 41c and 41d with the periphery of the rounded shank 40 (in the illustrative embodiment disclosed in the drawings shank 40 is slightly frusto-conical) is a broken arcuate line 41i having segments 41j, 41k, 41l and 41m. The specific configuration of line 41i varies with the dimensional characteristics of the pyramidal edges, the diameter of the shank 40, and the taper of the shank; I have found a tool wherein the shank taper is approximately 25%, the included angle between edges 41e and 41f is 60° and the included angle between edges 41g and 41h is 90°, for use with a tube as described above having a 1/2" nominal size produces excellent results.

In forming an opening 30, the vertex 41n of pyramidal tip 41 is forced into the wall of tube 20 with the tool 40 extending radially outwardly therefrom. Any suitable means (not shown) for providing the piercing force may be used. Tube 40 is forced through the wall of tube 20 until the vertex 41n has penetrated through the wall and is disposed interiorly thereof a suitable distance. As the amount of penetration of vertex 41n is directly related to the size of the opening produced, ready and accurate control over the opening size is obtained through the simple control of the forcing means. As the tool is non-rotatively moved during this operation, opening 30 may have the frusto-pyramidal configuration described above with the resultant self-cleaning and sheet-forming characteristics indicated.

During the piercing operation, tube 20, immediately surrounding the opening being formed, becomes dished as seen in Figs. 2, 3 and 4. Such dishing is an automatic concomitant of this method of forming the opening and the depth of the dishing may be varied by modifying the physical characteristics of the tubing or tool.

Where the liquid discharge sheet 15 is to extend in a plane parallel to the longitudinal axis of tube 20, tool 40 is positioned during the piercing operation with the edges 41e and 41f defining the smaller included angle, extending in the plane of the desired sheet. Although the resultant opening 30 has its greatest dimension in a plane perpendicular to the plane of desired sheet 15, an unexpected disposition of the sheet parallel to the plane of the edges 41e and 41f is obtained. Further, the opening 30, formed by such a method of piercing, is non-clogging and self-cleaning thereby avoiding the flow obstructing disadvantages of the opening configurations now found in the art and allowing the use of extremely small openings to obtain very fine mist discharges when desired.

While I have shown and described certain embodiments of my invention, it is to be understood that it is capable of many modifications. Changes therefore in the construction and arrangement may be made without departing from the spirit and scope of the invention as defined in the appended claims.

I claim:

1. Means for discharging a liquid in a fan like sheet from a source outwardly into an atmosphere having a lower pressure than that of the liquid in the source, com-

prising a tube of circular cross section adapted to form a bounding portion of the liquid source, said tube having wall surfaces defining a frusto-pyramidal, outwardly widening opening therethrough having a rhombic lateral cross-section with the shorter diagonal of the rhombic configuration extending longitudinally of the tube, whereby liquid may be discharged through the opening to form a fan like sheet extending generally in a plane longitudinal of the tube.

2. Means for discharging a liquid under pressure from a source outwardly into an atmosphere having a lower pressure than that of the liquid in the source, comprising a wall adapted to form a bounding portion of the liquid source, said wall having orifice-forming surfaces defining a frusto-pyramidal, outwardly widening opening therethrough having a rhombic lateral cross-section, said surfaces being disposed at an angle no less than 30° with the axis of the orifice.

3. Means for discharging a liquid in a fan like sheet from a source outwardly into an atmosphere having a lower pressure than that of the liquid in the source, comprising a wall adapted to form a bounding portion of the liquid source, said wall having four generally planar intersecting orifice-forming surfaces defining a frusto-pyramidal, outwardly widening opening therethrough having a rhombic lateral cross-section, said surfaces at the intersections being disposed at an angle to the axis of the orifice of not substantially less than 30° and not substantially greater than 45°.

4. Means for discharging a liquid under pressure from a source outwardly into an atmosphere having a lower pressure than that of the liquid in the source, comprising a wall adapted to form a bounding portion of the liquid source, said wall having orifice-forming surfaces defining a frusto-pyramidal, outwardly widening opening therethrough having a rhombic lateral cross-section, wherein the included angle between one pair of opposed edges of the pyramidal configuration is approximately 90° and the included angle between another pair of opposed edges of the pyramidal configuration lying in a plane perpendicular to the one pair of edges is approximately 60°.

5. Means for discharging a liquid under pressure in a fan-like sheet from a source outwardly into an atmosphere having a lower pressure than that of the liquid in the source, comprising a tube adapted to form a bounding portion of the liquid source, said tube having generally planar wall surfaces defining a frusto-pyramidal, outwardly widening opening therethrough having a rhombic lateral cross-section, the shorter diagonal of the rhombus being disposed to lie in the desired plane of the fan-like sheet.

6. Means for discharging a liquid under pressure from a source outwardly into an atmosphere having a lower pressure than that of the liquid in the source, comprising a tube having a circular cross-section with an outside diameter of approximately .625 inch and a wall thickness of approximately .028 inch, said tube being formed of type "M" hard copper and forming a bounding portion of the liquid source, and said tube having generally radial orifice-forming surfaces defining a frusto-pyramidal, outwardly widening opening therethrough having a rhombic lateral cross-section.

7. Means for discharging a liquid under pressure from

a source outwardly into an atmosphere having a lower pressure than that of the liquid in the source, comprising a tube of circular cross-section and having an outside diameter of approximately .625 inch and a wall thickness of approximately .028 inch and formed of type "M" hard copper and forming a bounding portion of the liquid source, said tube having orifice-forming surfaces defining a frusto-pyramidal, outwardly widening opening therethrough having a rhombic lateral cross-section wherein the length of the shorter diagonal at the inner end of the opening is in the range of .005 inch to .05 inch.

8. Means for discharging a liquid in a fan like sheet from a source outwardly into an atmosphere having a lower pressure than that of the liquid in the source, comprising a tube of circular cross-section having an outside diameter of approximately .625 inch and a wall thickness of approximately .028 inch formed of type "M" hard copper and forming a bounding portion of the liquid source, said tube being provided with a radially inwardly dished portion having a centrally located frusto-pyramidal, outwardly widening opening therethrough having a rhombic lateral cross-section with the longest diagonal of the rhombic configuration approximately 1½ times the length of the shortest diagonal and the length of the shortest diagonal at the inner end of the opening lying in the range of .005 inch to .05 inch and extending longitudinally of the tube, whereby liquid may be discharged through the opening to form a fan like sheet extending generally in a plane longitudinal of the tube.

9. The method of spraying a liquid in a fan-like sheet from a source outwardly into the atmosphere having a lower pressure than that of the liquid in the source comprising forcing the liquid under the pressure differential through an opening in means constituting a bounding portion of the liquid source, the opening being bounded by wall surfaces defining a frusto-pyramidal outwardly widening orifice having a rhombic lateral cross section.

10. The method of claim 9, in which the surfaces defining the orifice form an angle of no less than 30° with the axis of the orifice.

11. The method of claim 9, in which the wall surfaces are generally planar and intersecting, said surfaces at the intersections being disposed at an angle to the axis of the orifice of not substantially less than 30° and not substantially greater than 45°.

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