Sept. 20, 1971 G. P. SUTTON 3,606,159

MULTI-SPRAY DEVICE

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FIG. 1

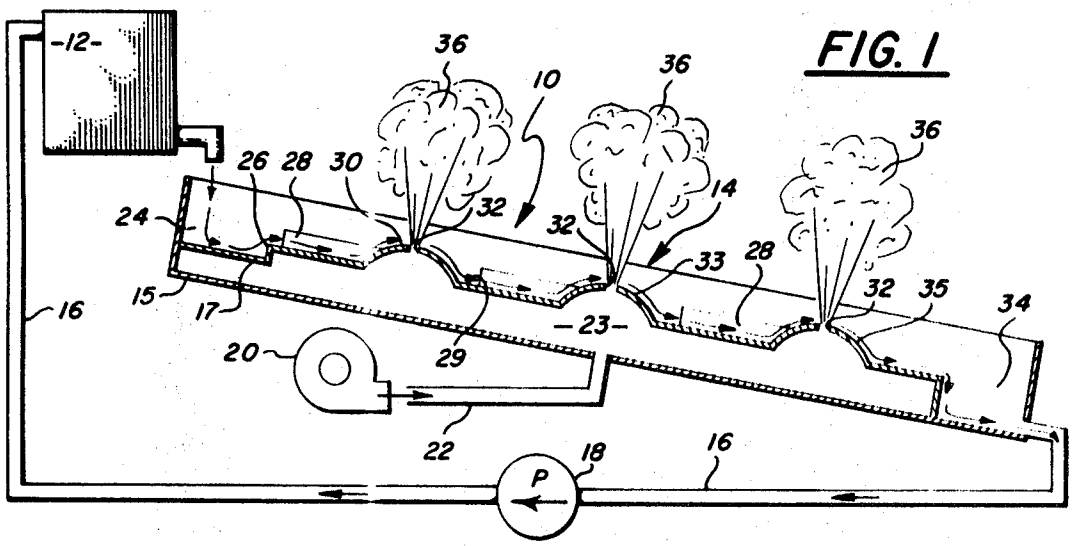



FIG. 2

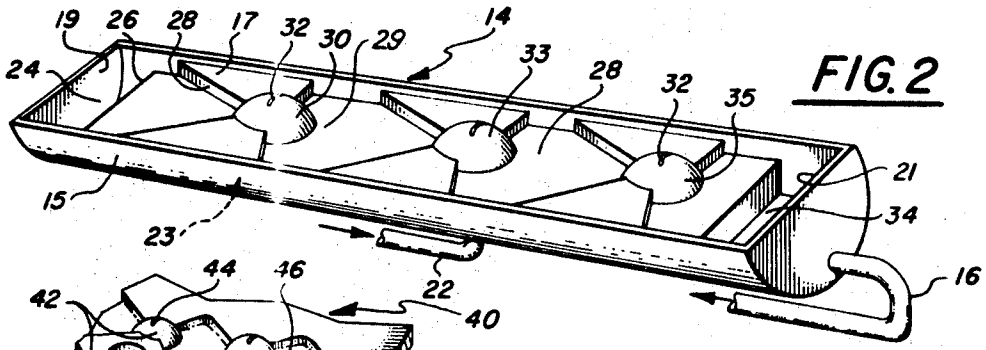



FIG. 3

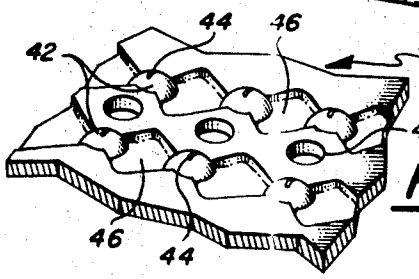
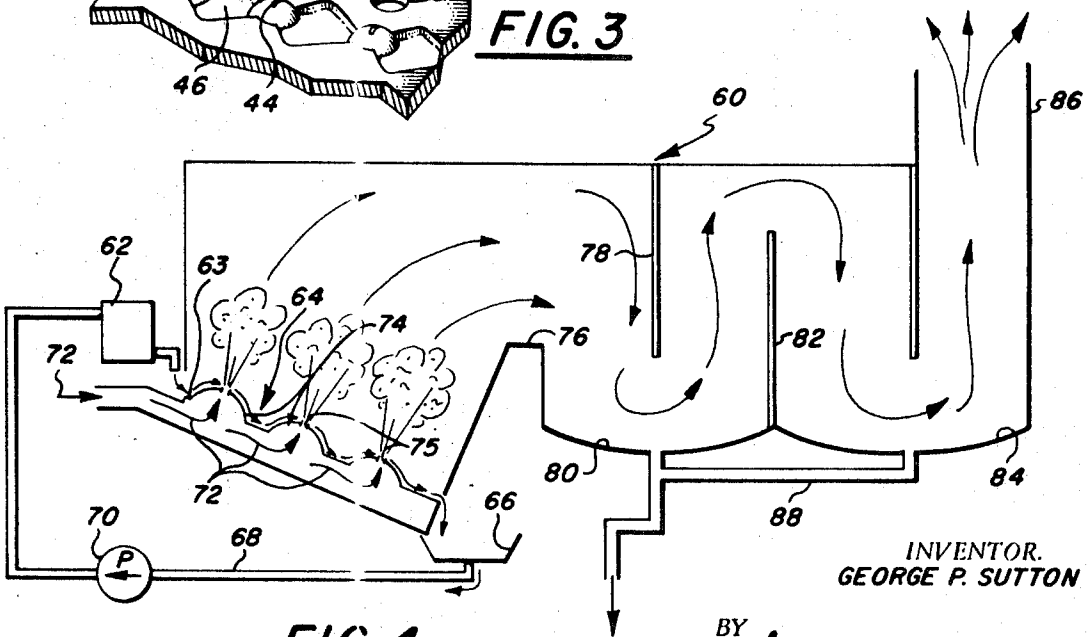



FIG. 4




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FIG. 5

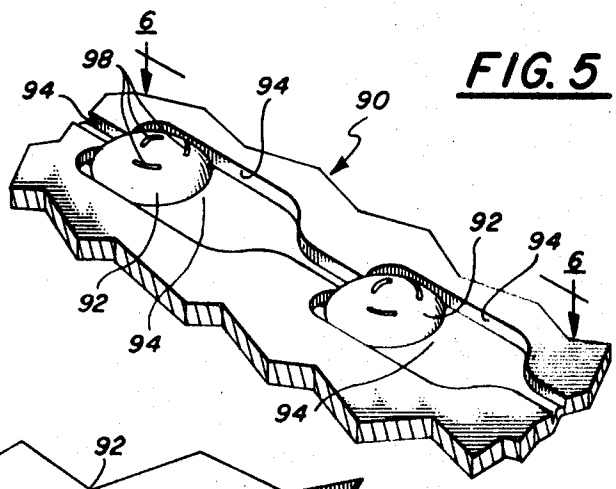
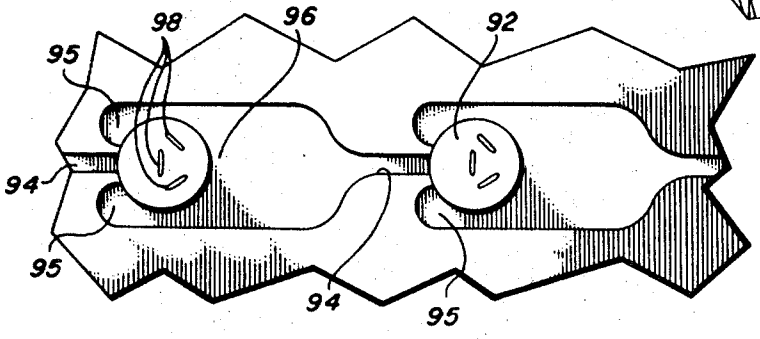



FIG. 6



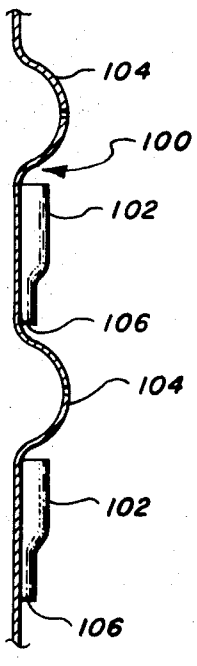




FIG. 8

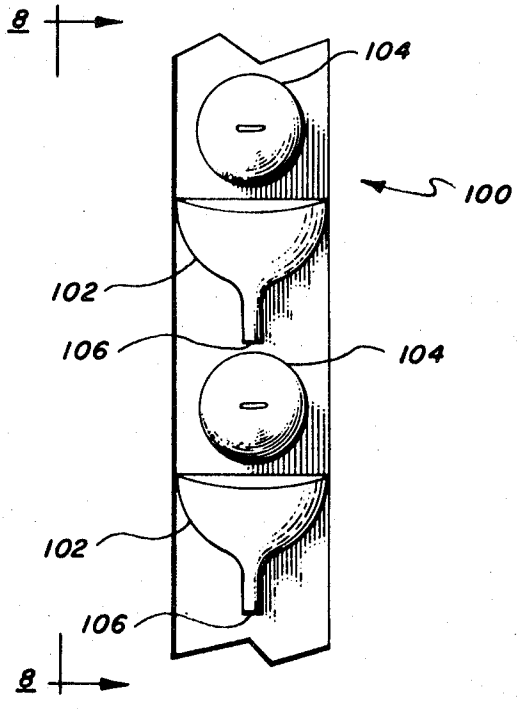



FIG. 7

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3,606,159

# MULTI-SPRAY DEVICE

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Int. Cl. B05b 7/08
U.S. Cl. 239—127 10 Claims

## ABSTRACT OF THE DISCLOSURE

A method of dispersing a liquid in a multiplicity of fine mist spaced patterns is disclosed. The device consists of an inclined trough having a series of substantially inclined bulbous protrusions over which liquid is directed. An orifice is located at the apex of each protrusion through which fluid under pressure passes. A blast of gaseous fluid, for example air, is directed through the apertures thereby atomizing the film of liquid passing over the holes. By inclining the trough, liquid not dispersed by the uppermost bulbous protrusion is collected and directed by means of contoured channels to the next dome under gravity for subsequent atomization thereby. The unused liquid is then collected and circulated back to the liquid supply tank and thence into a weir at the top of the trough, thus completing the cycle. The device therefore provides a multiple spray atomizing unit from one source of liquid supply.

## BACKGROUND OF THE INVENTION

Atomization of a liquid to produce a fine mist or fog is accomplished in the prior art in a number of ways. Notably, four patents issued to R. S. Babington et al., U.S. Patent Nos. 3,421,692; 3,421,699; 3,425,058; and 3,425,059, all disclose a means to produce a fog-like mist dispersing the liquid in extremely small particles of 5 microns or less.

The Babington et al. patents basically comprise passing a bulbous or curved surface which causes the liquid to "film out" or "stretch" if the liquid is applied to a surface which has adhesive properties. By stretching the film of liquid over a curved surface and passing the film over a small aperture near the apex of the curved surface and by directing a jet of gas or air under pressure through the aperture, the film of liquid is stretched to the point of rupture thereby atomizing the liquid into minuscule particles. The liquid atomization principle patented by Babington et al. can be utilized in a number of different areas of technology. A few examples include the following: humidifiers, gas cleaners for industry and fuel burners for both commercial and domestic applications.

The devices depicted in the foregoing patents however are limited to a single spray unit.

Therefore, it is an object of this invention to provide an improvement over the prior art in that a method is disclosed wherein multiple spray functions are provided from a single liquid source.

More particularly, it is an object of this invention to disclose a simplified method for providing multiple spray patterns from a single source of liquid utilizing, for example, a preformed stamped metal plate serving the multiple function of channeling liquid toward the bulbous injector elements on one side while the other side serves as an air chamber wherein air is directed to the elements having apertures therein.

## SUMMARY OF THE INVENTION

Briefly, in accordance with the objects of this invention the multi-spray device is basically a preshaped inclined trough. In both the oil burner and the gas cleaning application the tilted trough can, for example, be a stamped plate having a depression or weir at the uppermost end designed to receive liquid from a supply source. The inboard lip of the weir feeds into a shaped channel which directs by gravitational pull, the liquid toward an upwardly extending rounded protrusion. The liquid spreads over the bulbous dome in a thin film. An orifice in the protrusion is located at the apex through which a gas (for example, air) is directed under pressure to rupture the film passing thereover. Liquid which escapes atomization by the protrusion located nearest the weir is collected downstream of the dome by contoured channels and is directed towards the next protrusion wherein the atomizing operation is repeated. Any number of upwardly extending domes either inline, offset or any other repetitive pattern can be formed into a plate and liquid can be directerd over the domes by channeling between the protrusions as long as the plate is inclined or tilted to take advantage of gravitational forces. A collection bin or catch basin is located at the lowermost edge of the plate to collect the unatomized liquid. The liquid is then recirculated back to the supply source wherein the atomizing process is repeated. Any number of apertures can be located in the domes and they can be in a variety of shapes. The bottom of the plate serves as a manifold to direct the air under pressure through the apertures in the domes. In the oil burner application the atomizing plate may have a series of holes separate from the air manifolds and domes acting as feed holes for admitting a supplemental air supply to enhance oxidation or burning of the atomized fuel oil above the plate.

An advantage over the prior art is realized in that the inclined dimpled and apertured plate provides a means for multiple atomization of a liquid from a single liquid supply source thereby simplifying and greatly expanding the capacity of an oil burning or gas scrubbing operation while taking advantage of the superior liquid atomization process disclosed by the Babington et al. patents.

## DESCRIPTION OF THE DRAWINGS

The above noted objects and further advantages of the present invention will be more fully understood upon the study of the following detailed description in conjunction with the detailed drawings in which:

FIG. 1 is a semi-schematic view of the multi-spray device as utilized in the oil burner application;

FIG. 2 is a perspective view of one embodiment of the invention;

FIG. 3 is a fragmentary perspective view of still another embodiment of the invention;

FIG. 4 is a schematic view of the invention as utilized in the gas cleaning field;

FIG. 5 is a perspective view of an embodiment of the invention wherein multiple slots are utilized in each protrusion;

FIG. 6 is a top view taken along lines 6—6 of FIG. 5;

FIG. 7 is a front view of yet another embodiment of the invention wherein the plate is oriented vertically, and;

FIG. 8 is a side view taken along lines 8—8 of FIG. 7.

Referring now to FIG. 1, the basic system **10** consists of a liquid supply tank **12**, an atomizing trough **14**, a liquid circulating system **16** including pump **18** and a gas supply source **20**.

In the oil burner application, fuel oil from supply tank **12** slowly flows into a depression or catch basin upstream of the weir **24** and the fluid spills over the weir's edge **26**. The oil descends gravitationally down channel **28** and over a bulbous protrusion or dome **30**. Each of the upwardly extending domes **30**, **33** and **35** has at least one aperture **32** through the dome, located near the apex thereof. The oil is stretched over the dome containing

the aperture in part by means of surface tension forces. The blower **20** supplies a gaseous fluid (air) under pressure down conduit **22** into chamber **23**. Since the pressure in chamber **23** is higher than the ambient pressure around the trough **14**, the fluid escapes through the apertures **32** in the domes. Preferably, the pressure within chamber **23** is 4 to 10 p.s.i. above atmospheric pressure while 8 p.s.i.g. would be optimum. When this happens, the surface tension of the fuel oil across the aperture **32** is ruptured causing the oil to atomize into a mist or fog **36** above the trough **14**. The mixture **36** is then ignited above trough **14** in an oil burner housing (not shown). The fuel oil that escapes atomization by the uppermost dome **30** is collected in basin **29** down-stream of the dome **30** and directed via channel **28** to dome **33** where the atomization process previously described is repeated. The remaining unburned oil finally reaches catch basin **34** wherein it empties into conduit **16** and is pumped back to the liquid supply tank **12** by pump **18**.

The inclination of the device as illustrated in FIGS. 1 through 6 can be very small, say, typically 2 to 8 degrees. In extreme cases the inclination may be as high as 12 degrees. Open channel steady flow theory indicates a velocity of channel flow of 4 inches/sec. for 5 degrees of inclination. A near horizontal position of the trough, in the oil burning application, would lend itself to easy conversion from the conventional state of the art oil burners, to the device of the present invention. The trough can be vertical or at any other inclination and still operate as disclosed; however, slightly different design provisions are needed for collecting and redirecting the excess liquid flow, namely, a closed funnel type collector instead of a simple open channel collector (number **28**, FIGS. 1 and 2) as indicated and described in detial with reference to FIGS. 7 and 8.

Referring now to FIG. 2, the trough **14** can be, for example, made up of two stamped metal plates comprising an outer half cylindrical shell **15** with an inner intricately formed plate **17** attached theerto. The inner plate **17** defines the weir **26**, flow channel **28**, upwardly extending domes **30**, **33** and **35** and catch basin **34**. The ends **19** and **21** of shell **15** provide liquid tight walls for basin **24** and catch basin **34** at opposite ends of trough **14**. The cavity or fluid chamber **23** (FIG. 1) is defined by the inside walls of shell **15**, end plates **19**, **21** (FIG. 2) and the bottom of stamped plate **17**. Each of the domes have at least one aperture **32** near the top of the protrusion so that fluid under pressure can escape therethrough. The aperture could be an elongated slot in the dome; in fact, the aperture is preferably an elongated slot with its long axis 90° to the flow of the liquid. Typical aperture dimensions (**32**) are slots .003 to .005 inch wide and 0.100 to 0.200 inch long. Obviously, any number of dome-like protrusions or dimples could be oriented on an inclined plate as seen in the fragmentary view of FIG. 3 and more than one plate could be utilized (not shown) in any suitable arrangement provided they are inclined to gravitationally flow liquid down the plate and over the protrusions.

In the oil burner application (FIG. 1) wherein fuel oil is burning at a rate of 1 to 2 gallons/hour, the flow into a basin **24**, would typically be at the rate of 5 to 12 gallons per hour and the trough is at an inclined angle of 3 to 8 degrees, the pressure in cavity **23** should typically be between 5 to 10 p.s.i. above atmospheric pressure to provide good atomization above the protruding domes. Fuel burning rate from 0.3 to 15 gallons per hour could be attained with a single bulbous slot.

Plate **40** (FIG. 3) has multiple protrusions **42** extending from the plate. Each of these domes has at least one aperture **44** through the domes and there can be a series of channels **46** connecting each dome. The apertures **43** act as supplemental air holes to enhance oxidation or burning of the atomized fuel oil. The angle of inclination of plate **40** would depend upon the rate of flow of the liquid to be atomized, the number of upwardly extending protrusions, the viscosity of the liquid, plate adhesion properties, velocity of the gas flow through the apertures **44**, etc.

An atomization plate of the fragmented configuration partially shown in FIG. 3 could be utilized in the gas scrubbing operation minus the supplemental air holes **43** shown schematically in FIG. 4.

Scrubbers are used to remove solid and certain types of liquid and gaseous impurities from exhaust gas streams. They are used in many power station exhaust stacks, chemical mining, metallurgical and agricultural processes wherein it is desirable indeed, imperative that the various irritants and toxic exhaust properties be removed.

Turning now to the gas cleaning apparatus of FIG. 4, the scrubber generally designated as **60** comprises a liquid supply tank **62** which feeds liquid into a weir **63**, the weir subsequently spills liquid onto the dimpled plate **64**. The liquid not subjected to atomization eventually reaches catch basin **66**. The liquid is recirculated back to tank **62** by conduit **68** and pump **70**. Contaminated gas **72** under a slight pressure (4 or 5 p.s.i. above atmospheric pressure) is directed through apertures **75** in the domes **74** of plate **64**, thereby rupturing the surface tension of the liquid. In the gas cleaning apparatus **60** it is preferable to have more than one slot (**75**) in each protrusion as shown in FIGS. 5 and 6. The liquid can be, for example, water, and the water passing over apertures **74** is atomized by the contaminated gas above the dimpled scrubber plate **64**. When the liquid breaks up into minuscule particles, solid contaminants entrained in the gas are encaptured, i.e., entrapped or dissolved by the liquid, thus collecting the solid particles from the gas. The solid thus entrapped and scrubbed from the polluted gas has to have particle sizes considerably smaller than the openings in the dimples **74**. Gaseous contaminants, such as carbon dioxide, can be dissolved in the liquid. Certain gaseous organic impurities such as phenols (as found in the waste gases from industrial processes) can be dissolved in various organic solvents. There is a great surface area of liquid exposed to the contaminated gases and this will augment the absorption of impurities from the gas as well as the entrainment of solid particles in the gas. The atomized liquid as well as the gas passes over ramp **76** following the path of the arrows. As the substance is directed downwardly by baffle **78** most of the entrapped contaminants tend to fall out or settle in well **80** while the remaining gas is directed over baffle **82** towards well **84** before finally escaping up exhaust stack **86**. The entrapped contaminants are removed from wells **80** and **84** by conduits **88** toward a disposal source (not shown).

Turning now to FIG. 5, the plate designated as **90** comprises a slightly different method of channeling and directing liquid over the domes **92**. Due to the design of the basin **96** around the base of the protrusions **92**, the liquid being guided gravitationally down channel **94** tends to stay within the guide channels because of the wells **95** (FIG. 6). The liquid which tends to go around the protrusions will empty into the well **95** thereby collecting and directing liquid to the next dome downstream.

FIG. 6 more clearly illustrates the particular design of the liquid channeling. The multiple slots **98** in the dome-like protrusions are particularly effective in the gas cleaning operation previously described since the object is to pass as many solid contaminants through the apparatus for encapsulation by the liquid as possible. The orientation of the slots **98** are designed so that their long axes are 90 degrees to the liquid as the liquid moves over the dome radially from the apex of the dome **92**.

FIG. 7 is an embodiment of the invention wherein the dimpled plate or trough **100** is vertical or nearly so. A series of funnel-like catch basins **102** collect and direct liquid over the dimples **104**. By collecting the liquid in this manner, the liquid flow rate can be controlled by the size of the opening **106** at the exit of the diverging funnel **102**.

FIG. 8 is a side view of the vertical spray apparatus, particularly illustrating the depth of the liquid catching funnels **102** and their relationship to the domes **104**.

Although particular embodiments have been chosen to best illustrate the advantages of this invention, it is to be understood that the scope of the invention is not to be limited thereby.

I claim:

**1.** In a spray atomization device of the type that passes a thin layer of liquid over the top of a curved surface and wherein a flow of a gaseous medium under pressure is directed through an orifice on the curved surface to rupture the liquid layer spanning said orifice thereby atomizing said liquid, the improvement which comprises:

an inclined plate having a series of bulbous, discrete, unconfined curved surfaces thereon, each discrete surface having at least one orifice therein, extending outwardly from said plate,

channel means formed in said inclined plate leading to and extending from succeeding ones of said discrete surfaces to direct the flow of liquid from adjacent an upper portion of said plate so that liquid is guided over each of said discrete surfaces of the plate while traversing said plate toward a lower portion of the plate,

means to conduct gaseous fluid under pressure through said orifices in said plate from the side of the plate opposite that containing the flowing liquid to atomize the liquid in a multiplicity of spray patterns.

**2.** The invention of claim **1** wherein said liquid is combustible and is atomized in a multiplicity of spray patterns above said inclined plate, said atomized liquid being subsequently ignited to generate heat thereby.

**3.** The invention of claim **1** wherein said liquid passes over said inclined plate and a contaminated gas under pressure is conducted through said orifices in said plate whereby said contaminants entrained in the gas is captured by the liquid and caused to settle out of the gas for removal therefrom prior to exhausting said gas into the atmosphere.

**4.** The invention of claim **1** wherein said bulbous surfaces on said inclined plate are substantially aligned parallel along the slope of said inclined plate.

**5.** The invention of claim **4**, wherein said substantially aligned bulbous surfaces on said inclined plate are spaced between a first weir in said plate located at the uppermost edge of said plate and a second catch basin located at the lowermost edge of said plate whereby liquid overflows said weir onto said plate and is collected in said basin at the lowermost edge of said plate after said liquid traverses said plate, said collected liquid being recirculated by circulation means back to said weir.

**6.** The invention of claim **1** wherein liquid from a liquid supply source empties into a weir at the top edge of said plate, said liquid traverses said plate gravitationally and is collected in a catch basin at the lowermost edge of said plate and wherein said liquid is circulated back to said liquid supply source by a circulation means.

**7.** In a spray atomization device of the type that passes a thin layer of liquid over the top of a curved surface and wherein a flow of a gaseous medium under pressure is directed through an orifice on the curved surface to rupture the liquid layer spanning said orifice thereby atomizing said liquid, the improvement which comprises:

an inclined plate having a series of discrete, curved surfaces, each having at least one orifice therein, extending outwardly from said plate, said inclined plate being enclosed by a structure forming a trough, the interior of the trough being formed by the underside of the plate and the inside walls of the structure, said interior cavity forming a manifold for conducting said gaseous medium under pressure through said orifices in said plate,

means to flow liquid from adjacent one portion of said plate so that liquid flows over said discrete curved surfaces of the plate while traversing said plate toward another portion of the plate, and

means to conduct gaseous fluid under pressure through said orifices in said plate from the opposite side of the plate to atomize the liquid above said plate in a multiplicity of spray patterns.



**8.** In a spray atomization device of the type that passes a thin layer of liquid over the top of a curved surface and wherein a flow of a gaseous medium under pressure is directed through an orifice on the curved surface to rupture the liquid layer spanning said orifice thereby atomizing said liquid, the improvement which comprises:

an inclined plate having a series of discrete curved surfaces, each having at least one orifice therein extending outwardly from said plate, wherein said outwardly extending curved surfaces on said inclined plate are substantially aligned parallel along the slope of said inclined plate, each of said aligned curved surfaces of said plate are joined by a channel having tapering sides which converge from the base of said curved surface toward the next curved surface so as to concentrate liquid onto the surface of said next curved surface,

means to flow liquid from adjacent one portion of said plate so that liquid flows over said discrete curved surfaces of the plate while traversing said plate toward another portion of the plate, and

means to conduct gaseous fluid under pressure through said orifices in said plate from the opposite side of the plate to atomize the liquid above said plate in a multiplicity of spray patterns.

**9.** In a spray atomization device of the type that passes a thin layer of liquid over the top of a curved surface and wherein a flow of a gaseous medium under pressure is directed through an orifice on the curved surface to rupture the liquid layer spanning said orifice thereby atomizing said liquid, the improvement which comprises:

a plate having a series of discrete curved surfaces, each having at least one orifice therein extending outwardly from said plate and wherein multiple channels are provided in said plate between the outwardly extending curved surfaces to direct liquid from one curved surface to the next,

means to flow liquid from adjacent one portion of said plate so that liquid flows over said discrete curved surfaces of the plate while traversing said plate toward another portion of the plate, and

means to conduct gaseous fluid under pressure through said orifices in said plate from the opposite side of the plate to atomize the liquid above said plate in a multiplicity of spray patterns.

**10.** In a spray atomization device of the type that passes a thin layer of liquid over the top of a curved surface and wherein a flow of a gaseous medium under pressure is directed through an orifice on the curved surface to rupture the liquid layer spanning said orifice thereby atomizing said liquid, the improvement which comprises:

a plate having a series of discrete curved surfaces, each having at least one orifice therein, extending outwardly from said plate, the plate being substantially vertical,

means to flow liquid from adjacent one portion of said plate so that liquid flows over said discrete curved surfaces of the plate while traversing said plate toward another portion of the plate, whereby the means to flow liquid over said curved surfaces in said plate includes a plurality of open-ended funnels attached to the plate and positioned above and in line with each of said curved surfaces, said funnel having its opened widest end on top and its opened narrow end at the bottom adjacent the base of said curved surface so as to direct liquid over the curved surface, and

means to conduct gaseous fluid under pressure through said orifices in said plate from the opposite side of

the plate to atomize the liquid above said plate in a multiplicity of spray patterns.


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U.S. Cl. X.R.

239—337, 426, 434, 566, 559; 261—78