United States Patent [19]

Piggott

[11] **3,784,111**

[45] **Jan. 8, 1974**

[54] **FOAM PRODUCING NOZZLE**

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[22] Filed: **Mar. 29, 1972**

[21] Appl. No.: **239,167**

[52] **U.S. Cl.** **239/427.3,** 239/432, 239/590.3

[51] **Int. Cl.** **B05b 7/00**

[58] **Field of Search** 239/343, 370, 427, 239/428.5, 432, 590.3, 590.5, 597, 171, 427.3; 169/15, 14

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[57] **ABSTRACT**

A foam producing nozzle of the type using an air and fluid mixing chamber for discharging a foaming stream from the nozzle. A pair of spaced orifice plates are between the nozzle inlet and the mixing chamber and arranged to enhance the foam producing effect.

5 Claims, 6 Drawing Figures

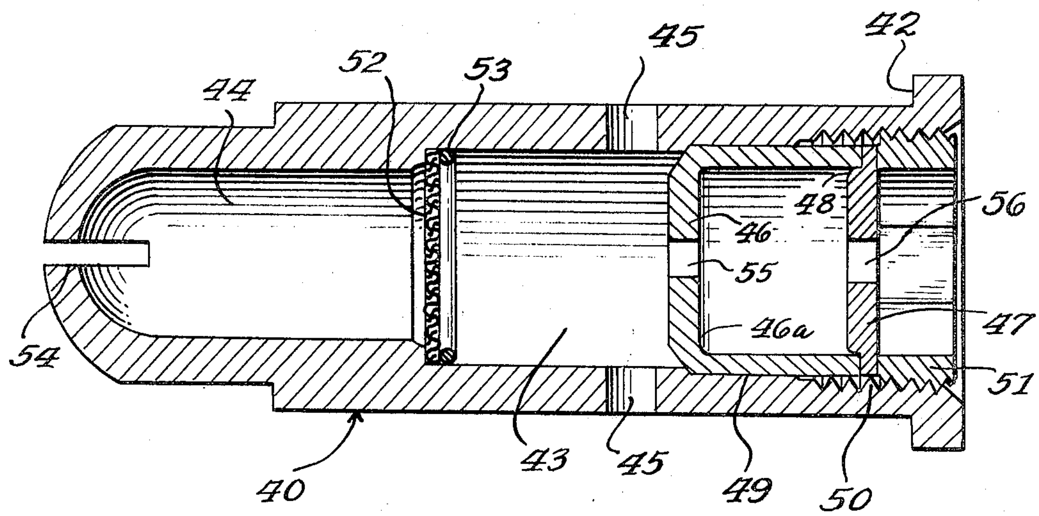

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Fig. 1.

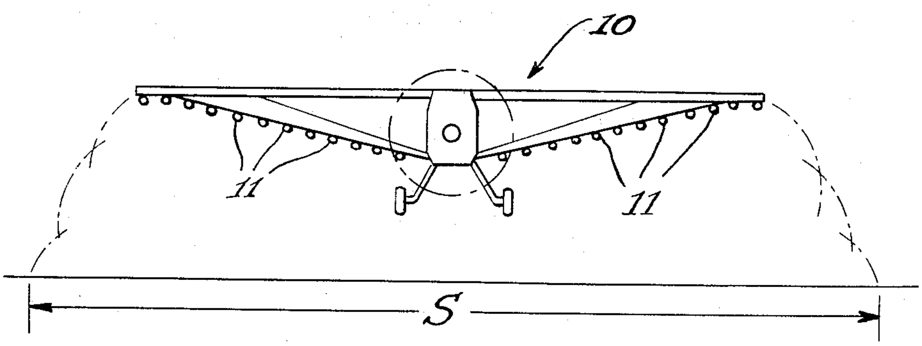


Fig. 2.

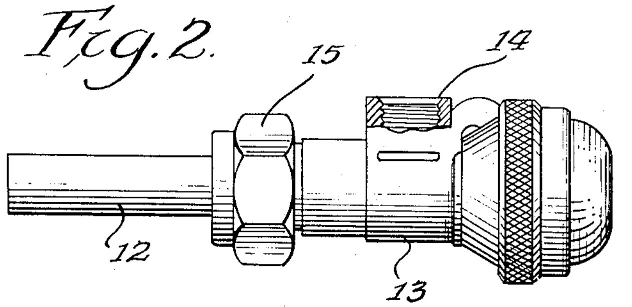


Fig. 3.

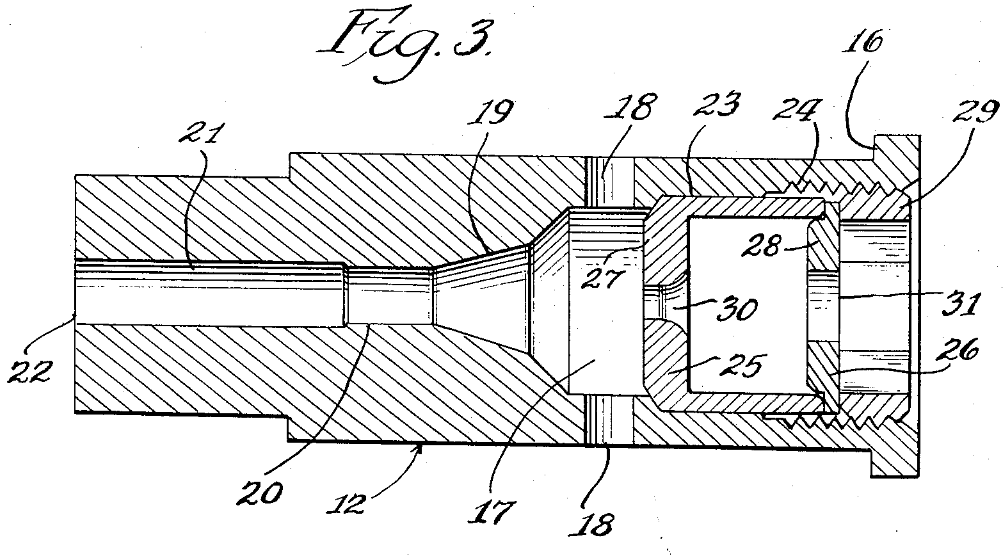


Fig. 4.

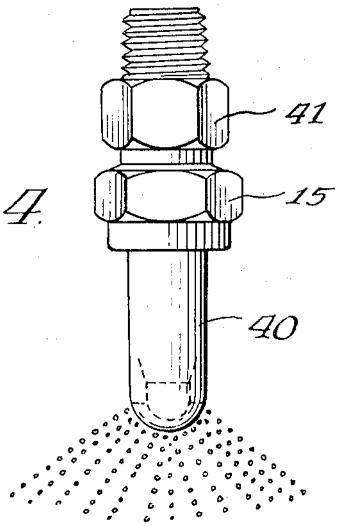


Fig. 6.

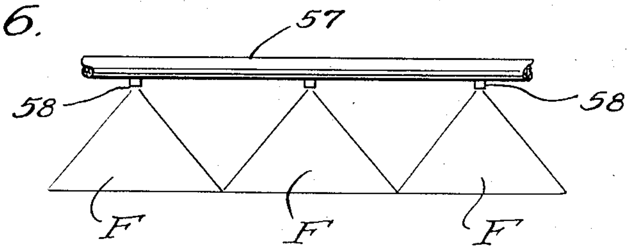
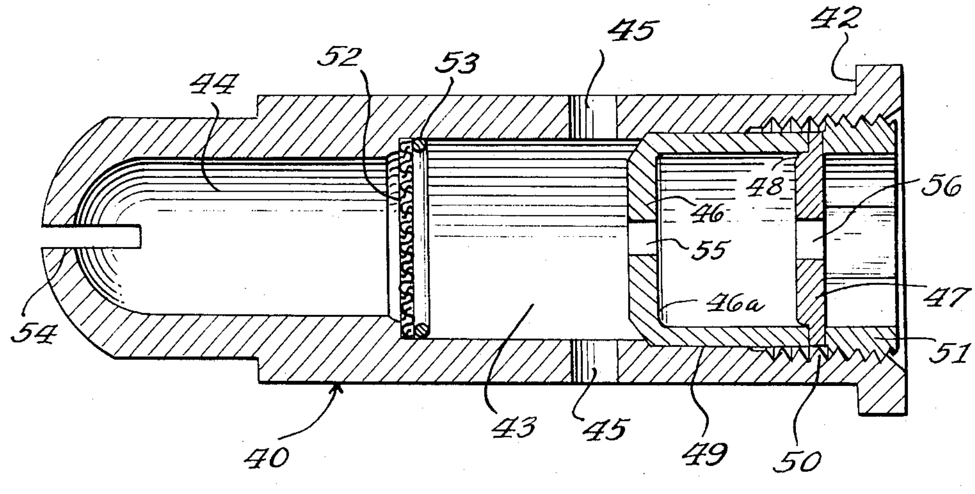


Fig. 5.



FOAM PRODUCING NOZZLE

The present invention is directed to new and useful improvements in nozzles of the type used to mix air with a fluid stream for the purpose of emitting a foaming stream from the nozzle.

Foaming streams are produced by a mixture of a chemical, water and air. Foam type streams are sometimes used for the purpose of rendering a sprayed area visible due to the easily identified particles of foam. Foam type sprays are also used in aircraft spraying to reduce wind dispersion of the spray. A foaming action causes coagulation of small particles into larger liquid particles which are more easily identified than small particles and which are less susceptible to drifting due to wind effects.

In producing a foam type spray the extent of the particle size and efficiency of the foam produced for the above mentioned purposes is dependent upon the thorough mixing of air with the liquid. With this in mind, the major purposes of the present invention are to arrange air entraining, foaming nozzles in such a way as to provide a more efficient mixing of air and liquid with a resultant increased foaming effect to provide a larger particle size and a more easily identified foam, and at the same time arrange such nozzles in such a way that they are economical to manufacture and easy to use with existing spraying equipment.

These and other purposes will appear from time to time in the course of the ensuing specification and claims when taken with the accompanying drawings, in which:

FIG. 1 is a diagrammatic view illustrating a typical aircraft spraying operation;

FIG. 2 is a side view of a nozzle assembly incorporating the present invention and intended for use with an existing spraying assembly;

FIG. 3 is a sectional view of the nozzle body utilized in the nozzle assembly of FIG. 2;

FIG. 4 is a side view of another nozzle assembly incorporating the principles of the present invention;

FIG. 5 is a sectional view of the nozzle body illustrated in FIG. 4; and

FIG. 6 is a diagrammatic illustration of a boom spraying installation which is particularly suitable with nozzle assemblies of the type illustrated in FIGS. 4 and 5.

Like elements are designated by like characters throughout the specification and drawings.

With specific reference to the drawings, and in particular to FIG. 1, the numeral 10 generally designates an aircraft carrying plural nozzles 11 intended to emit fluid, insecticides, herbicides or other chemicals over a predetermined swath width shown by the dimension S in FIG. 1. In aircraft spraying of this type utilizing nonfoaming sprays, wind drift may carry the sprayed particles considerably outside of the swath width with the result that the spray may be deposited on undesired areas. Also, wind drift may make it difficult to control the spray to provide a relatively uniform dispersal of sprayed particles. It is known that use of a foaming agent and a foaming spray will reduce the wind drift effect, due to increase in particle size, and thus increase the efficiency of the spraying operation.

FIGS. 2 and 3 illustrate one embodiment of the invention utilizing a spray tip body 12 in a nozzle assembly which includes an inlet body 13 having a strainer therein and an inlet fitting 14. A cap 15 is screw-

threaded on the inlet body so as to couple the nozzle tip body 12 thereto.

A nozzle inlet body 13 and cap 15 as illustrated may be found in existing spraying installations for use with other types of nozzle tip bodies.

The nozzle tip body 12 as illustrated in FIGS. 2 and 3 is intended and arranged for use when emitting a substantially solid stream which is suitable for use with aircraft spraying as described with respect to FIG. 1.

In accordance with the present invention, the nozzle tip body 12 is formed with an enlargement 16 at the inlet thereof for coupling to the cap 15 in FIG. 2. The nozzle tip body 12 is formed with an enlarged bore leading from the inlet end to a mixing chamber 17 in an intermediate location in the body. Apertures 18 are formed in the wall portion of the nozzle tip body which surrounds chamber 17 to allow air to be induced into the chamber 17 under the action of liquid flowing therethrough.

The nozzle tip body includes a tapered portion 19 of gradually reducing diameter from chamber 17 to an intermediate portion 20 having a diameter smaller than an outlet bore 21. Outlet bore 21 extends from portion 20 to the discharge end 22 of the nozzle tip body. The outlet bore 21 and portion 20 have a substantially smaller diameter than that of mixing chamber 17. The tapered portion 19, intermediate portion 20 and bore 21 define a discharge passage from the mixing chamber. The reduced intermediate portion 20 defines a nozzle orifice for a generally solid stream emitted through the discharge end 22 of the nozzle tip body.

The inlet end of the nozzle body is provided with a bore 23 of slightly larger diameter than the bore which defines mixing chamber 17 and the outer end of this bore is threaded as at 24.

A pair of nozzle orifice plates 25 and 26 are positioned within bore 23 in spaced relation. The front surface 27 of one plate 25 defines the rear side of mixing chamber 17. Orifice plate 25 is preferably formed as the inner wall of a cup-shaped element 25a seated in bore 23, while orifice plate 26 is preferably formed to bear against the outer rim of the cup-shaped element while having a projection 28 of reduced diameter which seats within the rim. A lock nut 29 is engaged with the threaded portion 24 to hold the plates 25 and 26 in the assembled relation shown.

In accordance with the present invention, the orifice 30 in the plate 25 next to the mixing chamber has a smaller cross-sectional flow area than the orifice 31 in the second plate 26 closet to the inlet end. By arranging the flow area as described and by arranging two orifice plates in a spaced relation in the inlet passage, an expansion chamber is defined between the plates 25 and 26 which produces turbulance and a thorough mixing of the liquid passing through orifice 30 and the air admitted through the apertures 18 to mixing chamber 17. The thorough mixing thus provided increases the foaming effect on the foaming agent carried by the liquid being sprayed.

The solid stream passing through orifice 30 flares out to entrain the air entering through the apertures 18. This in turn produces a flood effect through the tapered portion 19 and at the orifice defining portion 20. As the stream passes from the orifice defining intermediate portion 20 it is allowed to expand in the enlarged bore 21 which produces an additional mixing action to further improve foam quality. The length of the bore 21 should be at least three and one-half times its diameter to prevent flaring of the spray as it leaves the nozzle tip body.

Generally speaking, an increase in flow velocity through the mixing chamber increases the foaming effect and particle size. As contrasted with this, the orifice plates actually reduce flow velocity below that velocity obtained with a single orifice plate However, with the two orifice plates, the mixing effect actually increases and particle size is increased above that obtainable with a single orifice plate even though velocity is reduced.

Orifice **30** can be shaped to provide a sharp edge orifice which further improves foaming effect. A radius type orifice as shown may also be used.

The diameter of the chamber defined between the plates **25** and **26** should be at least one and one-fourth times the diameter of the orifice **30** to produce proper turbulance and mixing with the air.

FIG. **4** illustrates another embodiment of the invention in which the principles of the invention are utilized with a nozzle tip body producing a flat or fan-shaped foaming spray. The nozzle tip body **40** in FIG. **4** is coupled to an inlet fitting **41** through use of a cap **15** of the type illustrated in FIG. **1.** The nozzle tip body **40,** as will be apparent in FIG. **5,** includes an enlargement **42** at the inlet end thereof to allow coupling of the nozzle tip body to the inlet fitting **41** by the cap **14.** In FIG. **5** the nozzle body is bored to define an intermediate mixing chamber **43** and a discharge passage **44** of smaller diameter than the mixing chamber **43.** Apertures **45** are formed in the nozzle body to allow air to enter the mixing chamber **43** under the influence of fluid passed therethrough. In FIG. **5** a pair of spaced orifice plates are used as in FIG. **3.** A first plate **46** is defined as the transverse wall of a cup-shaped element **46*a*,** while the second plate **47** is positioned across the rim of this cup-shaped element and includes a projecting portion of reduced diameter **48** fitting snugly within the rim of the cup-shaped element. The cup-shaped element **46*a*** is seated in the nozzle tip body in a bore **49** of slightly larger diameter than that of the mixing chamber **43.** The outer end portion of this bore is threaded as at **50** to receive a lock nut **51** which holds the orifice plates **46** and **47** in the assembled relation illustrated.

In FIG. **5,** a screen **52** is positioned across the opening between the mixing chamber **43** and outlet passage **44.** A ring **53** may be utilized to hold the screen against the shoulder between the mixing chamber **43** and outlet passage **44.** The outlet end of the discharge passage **44** has a curvilinear form and the end of the nozzle tip body is slotted as at **54** to produce a fan-shaped or flat spray in a manner known to the art.

As in FIG. **3,** the two orifice plates **46** and **47** have orifices sized so that the flow area through the orifice **55** in plate **46** is less than the flow area through the orifice **56** in plate **47.** Again, an expansion chamber is defined between the two plates **46** and **47.**

In the embodiment of FIG. **5,** the use of the two orifice plates produces a turbulent effect on liquid passing through orifice **55** and into the mixing chamber for a thorough mixing of the air and liquid in the mixing chamber **43.** The use of the screen enhances the formation of foam passing to the outlet passage **44.**

In FIG. **5** the stream flares out as it passes orifice **55.** Additional flaring occurs at the screen **52.** A flooding condition occurs in the outlet passage **44.**

As in FIG. **3,** the orifice plates increase th foaming and mixing effect, even though flow velocity is reduced.

The ratio of the diameter of the expansion chamber between the orifice plates in both FIGS. **3** and **5** should be at least in the amount stated because with a lesser ratio and a lesser degree of expansion of the stream passing through the orifice in the outer plate, the pressure conditions tend to reduce the turbulent effect in the mixing chamber.

FIG. **6** illustrates a typical spray application utilizing foaming nozzle tips of the type described with respect to FIGS. **4** and **5.** In FIG. **6,** for example, a spray boom **57** carries a plurality of nozzle assemblies of the type illustrated in FIG. **4** and designated at **58.** In FIG. **6,** the nozzles are arranged for the purpose of providing plural fan-shaped spray areas F positioned next to one another.

In both embodiments the spacing dimension between the orifice plates should be in the range of around one-half to two times the internal diameter of the cup-shaped element to obtain proper action in the expansion chamber. In the embodiments illustrated, the spacing dimension is around seven-tenths the diameter. Spacings less than this tend to produce too much flow straight from one orifice through another while greater spacings minimize the double orifice effect to an extent substantially like the effect obtained with a single orifice plate.

Use of the cup-shaped element for one orifice member in the arrangement recited allows a simple changeover from one set of selected sizes of orifices to another, through endwise removal and replacement through the inlet bore.

Foaming nozzles of the type herein illustrated and described may be used in installations other than aircraft spraying and boom spray installations. They may, for example, be used with spray guns or other spraying equipment wherein a foaming effect is desired.

I claim:

1. In a foam producing nozzle of the type defined by a nozzle body having an air and liquid mixing chamber defined in the body between an inlet end and an outlet end, and having air inlet apertures in the body leading to said chamber to induce the flow of air to said chamber under influence of a fluid stream passing through said chamber, the improvement comprising a pair of spaced orifice plates positioned in a passage in said body leading to said chamber, each of said orifice plates having orifices axially aligned with said chamber and the outlet from said chamber, one of said plates defining a side of said chamber opposite to the outlet side thereof and the other of said plates being positioned in spaced relation to said one plate and between said one plate and the inlet side of said body, said plates defining therebetween an expansion chamber having a diameter substantially greater than the diameter of said orifices, the orifice in said one plate being smaller than the orifice in said other plate, said chamber defined between said plates being closed to the exterior except for the orifices in said plates.

2. A nozzle as set forth in claim **1** wherein said first plate is defined as a wall of a cup-shaped element positioned within said nozzle body and said second plate is seated against the end of said cup-shaped body remote from said one plate, said cup-shaped element and second plate being held within a bore of said body and against a shoulder therein by a retainer in screw threaded relation to said body and bearing against said second plate.

3. The structure of claim 2 wherein said second plate includes a portion of reduced diameter fitting snugly within said cup-shaped element.

4. The structure of claim 3 wherein said chamber includes a screen remote from said first plate and on the side of said chamber opening to said discharge passage, said nozzle body being shaped, between said screen and the discharge end thereof, to provide a flat, fan-shaped spray from the nozzle.

5. The structure of claim 3 wherein said nozzle body is shaped to provide a discharge passage of smaller diameter than said mixing chamber, said discharge passage including an intermediate portion of a reduced diameter to define an orifice, said nozzle body including a tapered passage having a gradually reducing diameter from said mixing chamber to said orifice diameter, said discharge passage having a substantially uniform diameter from said intermediate portion to the outlet end thereof to provide a relatively solid discharge stream.

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