# United States Patent

**Lincoln**

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[54] **LIQUID SPRAY NOZZLE**



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[73] Assignee: **Fuller Company**





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[52] **U.S. Cl.** ................................**239/431**, 239/434.5

[51] **Int. Cl.** ...............................................**B05b 7/04**

[58] **Field of Search**........239/416.5, 424.5, 425, 429, 239/426, 431, 433, 430, 432, 434.5, 451, 456, 457, 581, 582



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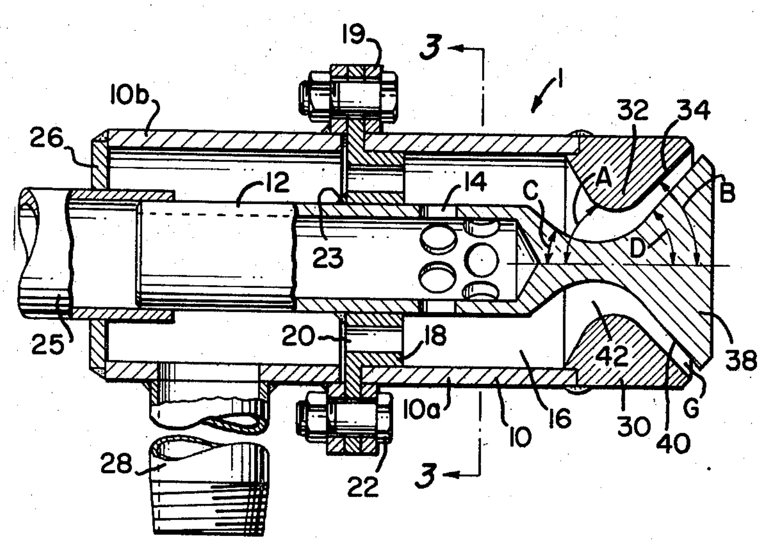
[57] **ABSTRACT**


A nozzle for spraying liquids over a wide range of liquid flow rates which includes a pair of concentric tubular members. Liquid to be sprayed is supplied to the internal tubular member and to a mixing chamber defined by the two tubular members through a plurality of ports in the internal tubular member. Compressed air is supplied to the outer tubular member and mixes with the liquid in the mixing chamber, and the mixture of liquid and compressed air is discharged through a restricting orifice. The restricting orifice is defined by a smooth, substantially continuously restricting contour. The capacity of the spray nozzle as measured by liquid flow rate can be adjusted.


**11 Claims, 6 Drawing Figures**



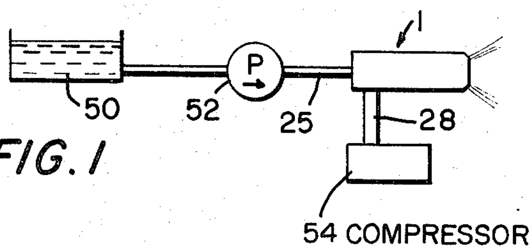



FIG. 1

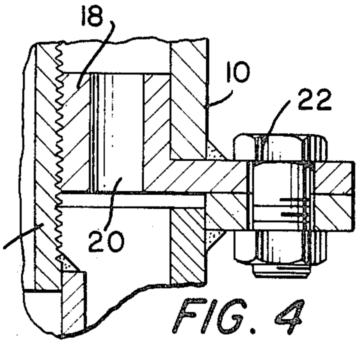
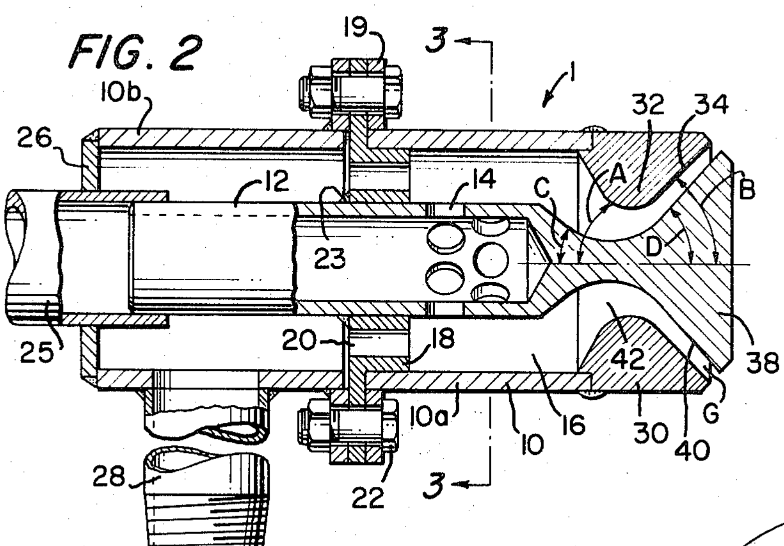



FIG. 4

FIG. 2



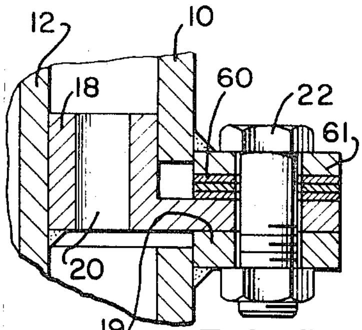




FIG. 5

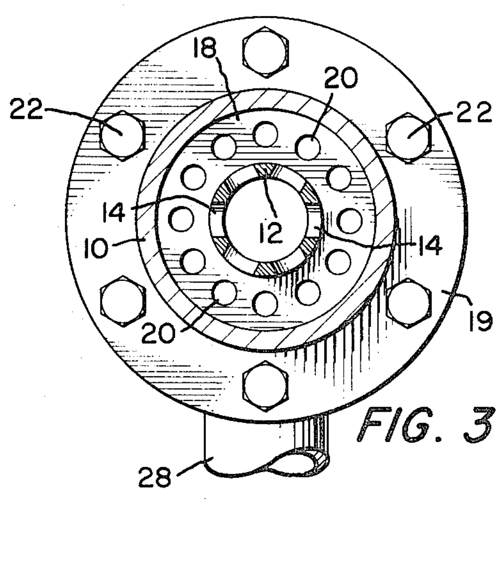
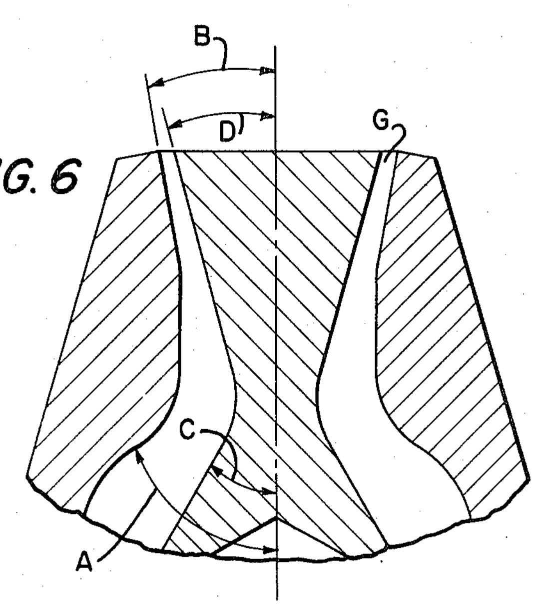



FIG. 3

FIG. 6

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## LIQUID SPRAY NOZZLE

### BACKGROUND OF THE INVENTION

The present invention relates to spray nozzles and in particular to a spray nozzle in which compressed gas is used for atomizing the liquid to be sprayed and is adapted for use where large quantities of liquid are to be sprayed, and where a wide range of liquids are to be sprayed. The nozzle of the present invention is designed to spray liquids at up to 160 gallons per minute.

Prior to the present invention, various types of spray nozzles have been known. With some nozzles, the liquid to be sprayed is pumped through a restricting orifice and the liquid is mechanically atomized. Nozzles employing compressed air to atomize the liquid are known. Aerosol containers employ a compressed gas to spray liquids but such an arrangement is limited to spraying small quantities of liquid. Other nozzle arrangements employ an aspirating arrangement wherein liquid to be sprayed is supplied to a port and compressed gas is supplied to a point adjacent that port.

These prior nozzles have been satisfactory for certain applications but are not adaptable to a wide range of liquid volumes. In addition, many prior arrangements do not emit a spray pattern which is acceptable for many applications. A further disadvantage of prior spray nozzles is that for large liquid flow rates, high pressure air was required to achieve atomization. This often necessitated the use of a more expensive air compressor.

The present invention is particularly applicable for use in water evaporation applications such as the cooling of hot gas streams. In order to cool the stream of hot gas, it is necessary to supply a large volume of water to the gas stream in the form of a fine spray which covers a large area. In most applications where water evaporation is used to cool a gas stream, it is desired to achieve a certain temperature. Because of variations in gas volume and temperature, different applications require different amounts of water to be sprayed into the gas stream. In order to have a nozzle which can be used in many such applications, it is necessary to have a nozzle which is capable of spraying water at many flow rates while still achieving adequate atomization of the liquid. If a nozzle is operative under many flow rates, a single nozzle design can be used for virtually all such applications.

Another characteristic which is essential for liquid spray nozzles which are to be used for many applications is that they must allow dirty water to be sprayed. In water evaporation applications, the water to be sprayed is not filtered and often contains particulate matter. Many prior nozzles often became plugged when attempts were made to spray dirty water. Other liquid spray nozzle applications also require the spraying of unpure liquid. One such application is the atomization of liquids to be burned in an incinerator. This liquid may include particulate matter such as organic combustibles.

### SUMMARY

It is, therefore, the principal object of this invention to provide a liquid spray nozzle which is capable of spraying liquids at a wide range of flow rates while achieving proper atomization of the sprayed liquid.

It is another object of this invention to provide a novel liquid spray nozzle which is capable of spraying liquid containing particulate matter.

It is a further object of this invention to provide a liquid spray nozzle which is substantially trouble-free and is capable of spraying large quantities of liquid.

In general, the foregoing and other objects will be carried out by providing a spray nozzle comprising means defining a mixing chamber; means for supplying liquid to be sprayed to said mixing chamber; means for supplying a compressed gas to said mixing chamber; and means defining a smooth, substantially continuously restricting orifice for discharging a mixture of liquid and compressed gas from said mixing chamber.

### BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be described in connection with the annexed drawing wherein:

FIG. **1** is a diagrammatic view of the circuitry employed with the present invention;

FIG. **2** is a sectional view of the nozzle of the present invention;

FIG. **3** is a sectional view taken on the line **3—3** of FIG. **2**;

FIG. **4** is a fragmentary sectional view on an enlarged scale of a modification of the present invention;

FIG. **5** is a view similar to FIG. **4** showing a second modification of the present invention; and

FIG. **6** is a fragmentary sectional view on an enlarged scale of a further modification of the present invention.

### DESCRIPTION OF THE PREFERRED EMBODIMENT

The present invention relates to liquid spray nozzles and in particular to a spray nozzle to be used for water evaporation applications. The nozzle structure is best shown in FIG. **2**. The nozzle, generally indicated at **1**, includes a first tubular member **10** including first and second portions **10***a* and **10***b*, respectively, and a second, concentric tubular member **12** positioned within the first tubular member. The second tubular member **12** is provided with a plurality of holes **14** which provide communication between the tubular members **10** and **12**. A mixing chamber **16** is defined by the first tubular member **10** and the second tubular member **12**.

An annular member **18** having a plurality of passages **20** therethrough is suitably secured to the first tubular member **10** by means of bolts **22** and to the second tubular member **12** by means of a weld **23**. The annular member **18** serves to center the tubular member **12** within the tubular member **10** to hold the tubular member **12** in a fixed longitudinal position with respect to the first tubular member **10**.

A conduit **25** for supplying liquid to be sprayed is connected to the second tubular member **12** and may be centered within the first tubular member **10** by means of a plate **26**. A conduit **28** is connected to the first tubular member **10** for supplying compressed gas to the inside of tube **10**.

A restricting orifice **30** is mounted on the open end of the first tubular member **10** and includes a venturi-shaped portion **32**. The upstream side of the restricting orifice is tapered at an angle A and the discharge side **34** of the orifice is tapered outwardly at an angle B. A smooth radius interconnects the two sides of the orifice. A head means **38** is connected to the second tubular member **12** and extends through the restricting orifice **30** as clearly shown in FIG. **2**. The head means includes an upstream side tapered at an angle C and an outwardly tapered portion **40** which is angled outwardly at an angle D. A generally smooth radius interconnects the two tapered portions. Angle A is greater than angle C and angle D is greater than angle B. The restricting orifice **30** and the head means **38** define therebetween a smooth, substantially continuously restricting contour **42** which terminates in a gap G. It is essential that this contour be substantially continuously restricting and that there be no sharp shoulders on the contour. There should not be a restriction followed by an area of expansion followed by an area of further restriction. It is believed that such an arrangement would reduce the spraying capacity of the nozzle.

In operation, liquid is supplied from a suitable source **50** (FIG. **1**) through conduit **25** by means of a pump **52** into the second tubular member **12** and through the passages **14** into the mixing chamber **16**. Suitable control means (not shown) may be connected to the pump **52** to control the volume of liquid supplied to the nozzle **1**. Compressed gas is supplied from a constant volume compressor **54** through conduit **28** into the first tubular member **10**, through the passages **20** in the annular member **18** and into the mixing chamber **16**. The compressed gas forces the liquid through the continuously restricting contour **42** and through the gap G. By having the air supply surround the liquid supply, the air flow acts as an insulator to prevent boiling of the liquid to be sprayed when the nozzle is used in high temperature locations.

With the nozzle of the present invention, a single nozzle configuration may be employed for spraying liquids over a wide range of liquid flow rates. If it is desired to increase or decrease the range of liquid flow rates at which the nozzle will best function, some dimensional modifications of the nozzle will be required, but the basic nozzle configuration will remain the same. For example, a particular size nozzle will spray liquids in a range of 0 to 70 gallons per minute when a certain fixed volume of air under pressure is supplied to the nozzle. If it is desired to increase the flow rate range to 0 to 160 gallons per minute, the volume of gas under pressure supplied to the nozzle must be increased in order to achieve the maximum liquid flow rate. In order to insure proper atomization of the liquid being sprayed, it is necessary to supply a certain volume of air. The volume of air under pressure which is supplied to the nozzle of this invention is determined by the desired maximum liquid flow rate. That same volume of air will, of course, provide good spraying of the lesser liquid flow rate.

In order to increase the volume of compressed gas supplied to the nozzle, the size of the passages **20** in the annular member **18** is increased. In order to permit the increased maximum volume of liquid to pass through the nozzle and insure proper atomization of that liquid, the size of the gap G must also be increased. An important feature of the present invention is that once the gap G has been set for a particular maximum liquid flow rate, it need not be adjusted for any variation in liquid flow rate up to that maximum. Even though the nozzle need not be adjusted, proper liquid atomization is achieved.

The size of the gap G can be adjusted in the factory by longitudinally adjusting the position of the tubular member **12** with respect to the tubular member **10**. Such adjustment varies the position of head means **38** with respect to the restriction **30**. For example, if it is desired to increase the size of the gap G, as viewed in FIG. **2**, the tubular member **12** is moved to the right with respect to the tubular member **10**. Once the desired gap size has been reached, the weld **23** is made. The second portion **10*b*** of the first tubular member is then secured to the first portion **10*a*** by means of bolts **22**. The nozzle is then permanently adjusted for a desired flow rate range.

Due to the wide range of flow rates which are obtainable with the present invention, in most applications, once the nozzle of the present invention is installed, no adjustment of the nozzle is necessary. However, if desired, the spray nozzle can be made adjustable. Examples of adjustable arrangements are shown in FIGS. **4** and **5**. In FIG. **4** adjustment is accomplished by providing a threaded connection between the second tubular member **12** and the annular plate **18**. If it is desired to vary the size of gap G, it is only necessary to screw the member **12** through the annular member **18**. Since the annular member **18** is fixed to the tubular member **10** by means of the bolts **22**, there will be an adjustment between the head member **38** and the restriction **30**. In FIG. **5** the adjustment is accomplished by welding the annular member **18** to the tubular member **12** and providing a plurality of shims or washers **60** between the flange **19** on the annular member **18** and a plate **61** which the tubular member **10** is secured. If it is desired to widen the gap G, one or more of the washers **60** is removed. When the bolts **22** are tightened, the tubular member **10** and hence the restriction **30** are moved relative to the tubular member **12** and, the gap G is widened. If it is desired to narrow the gap G, additional washers **60** are added and relative movement takes place between the valve member **38** and the restriction **30** to narrow the gap G.

From FIG. **6** it can be seen that the size of angles A to D can be varied. The important feature is that angle A should be greater than angle C and angle D must be greater than angle B so that there is a continuously restricting contour. When angles B and D are smaller as shown in FIG. **6**, it is believed that a nozzle suitable for low liquid flow rates is achieved. The wider angle shown in FIG. **2** is more suited for the high flow rates desired for water evaporation nozzles. The nozzle of FIG. **6** is believed to be more desirable for the low flow rates associated with an incinerator application.

From the foregoing it should be apparent that the objects of this invention have been carried out. A nozzle structure which is adjustable and adaptable to a wide range of flow rates has been provided. Excellent atomization of the liquid being sprayed is achieved. The continuously restricting contour of the nozzle assures proper atomization and liquid flow. Large quantities of water can be sprayed. The nozzle has been successfully tested at liquid flow rates of up to 160 gallons per minute. Because of the relatively wide gap, the nozzle of the present invention is capable of spraying liquid which contains particulate matter. This is particularly important in incinerator applications wherein the liquid being sprayed contains particulate matter and in water evaporation cooling where dirty, unfiltered water is used.

It is intended that the foregoing description be merely that of a preferred embodiment and that the invention be limited solely by that which is within the scope of the appended claims.

I claim:

1. A spray nozzle comprising:

a first tubular member having a restricting orifice at one end thereof;

a second tubular member mounted within said first tubular member and having at least one aperture therein for providing communication between said first tubular member and said second tubular member;

head means mounted on said second tubular member and extending through the restricting orifice of said first tubular member;

said restricting orifice and said head means defining a smooth, substantially continuously restricting contour which terminates in a gap;

means for supplying liquid to be sprayed to one of said first and second tubular members; and

means for supplying compressed gas to the other of said first and second tubular members whereby said liquid mixes with said compressed gas in said first tubular member and the mixture is discharged from the first tubular member through said gap.

2. The spray nozzle of claim 1 wherein liquid to be sprayed is supplied to said second tubular member and compressed gas is supplied to said first tubular member.

3. The spray nozzle of claim 2 further comprising means for centering said second tubular member within said first tubular member; said centering means including at least one opening therethrough for the passage of compressed gas.

4. The spray nozzle of claim 3 wherein said restricting orifice includes a necked-down portion and a flared portion downstream of said necked-down portion which is flared at a first angle; and said head means includes a portion flared at a second angle, greater than said first angle.

5. The spray nozzle of claim 4 wherein said head means is adjustable with respect to said restricting orifice.

6. The spray nozzle of claim 4 wherein said second tubular member is adjustable with respect to said first tubular member to thereby provide means for adjusting the position of said head means with respect to said restricting orifice.

7. The spray nozzle of claim 6 wherein said centering means includes an annular member fixedly secured to said first tubular member and threadedly secured to said second tubular member to thereby define means for adjusting said second tubular member.

8. The spray nozzle of claim 6 wherein said centering means includes an annular member fixedly secured to said second tubular member and adjustably secured to said first tubular member to thereby define means for adjusting said second tubular member.

9. The spray nozzle of claim 1 wherein said restricting orifice includes a necked-down portion and a flared portion downstream of said necked-down portion which is flared at a first angle; and said head means includes a portion flared at a second angle, greater than said first angle.

10. The spray nozzle of claim 1 wherein there are a plurality of apertures in said second tubular member which are adapted to communicate with said first tubular member at an angle to the longitudinal axis of said first tubular member.

11. A spray nozzle capable of spraying liquids containing particulate matter comprising:

a first tubular member having a venturi-shaped restricting orifice at one end thereof and adapted to be connected to a source of compressed gas;

a second tubular member mounted within said first tubular member and having at least one aperture therein and adapted to be connected to a source of liquid to be sprayed;

said first and second tubular members defining a mixing chamber upstream of said restricting orifice and liquid supplied to said second tubular member is supplied to said mixing chamber directly through said aperture;

head means mounted on said tubular member and extending through said restricting orifice;

said restricting orifice and said head means defining from said mixing chamber a smooth, continuously restricting contour which terminates in a gap whereby liquid is adapted to mix with compressed gas in said mixing chamber and the mixture is discharged from said mixing chamber through said gap.

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