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SONIC SPRAY NOZZLE
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3,081,946

FIG. 1

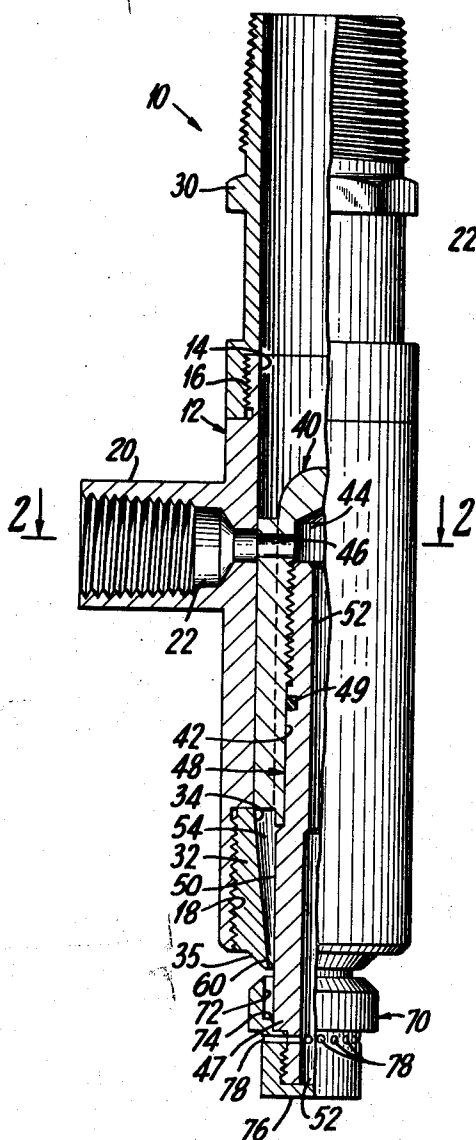


FIG. 2

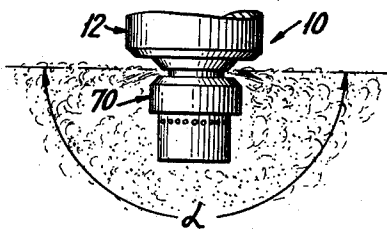
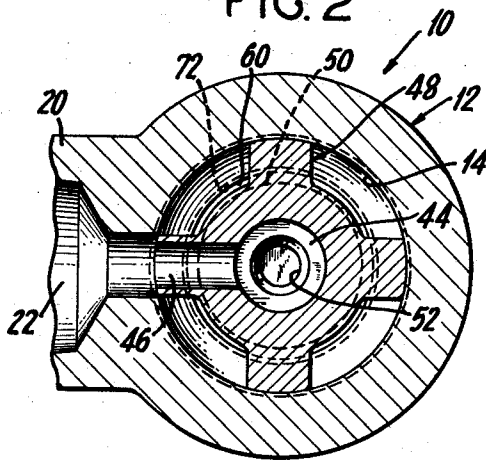


FIG. 3

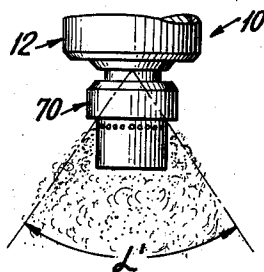


FIG. 4

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SONIC SPRAY NOZZLE

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4 Claims. (Cl. 239—102)

The present invention relates to an improved device adapted to atomize a liquid into a micromist by means of a high intensity sonic energy field, and more particularly to an extremely compact device provided with novel means for uniform distribution of liquid to the sonic energy field whereby minimal amounts of liquid are required for the desired volume of atomization.

In U.S. Patent 2,519,619 granted to Yellott and Savory, there is disclosed a sonic generator adapted to generate a high energy vibratory sound field when a tuned cavity resonator is excited into resonance under the influence of an impinging supersonic jet stream. Such a resonator will periodically load and discharge violently at the imposed resonator frequency. Thus, the high velocity jet stream is converted or transduced into a high intensity sonic output. Devices utilizing such sonic energy have proven very efficient in fields such as spray-drying, defoaming, cleaning, atomization, etc., in many instances showing marked advantage over conventional devices utilizing much higher pressures and complex mechanical or electronic components.

The operating frequency may vary over a rather wide range of frequency if there is variation in the pressure of gas supplied to the resonator. Thus, a typical sonic transducer device utilizing an inlet pressure varying from 35 to 50 p.s.i. will have an operating frequency of 7600 to 9400 c.p.s. It will be appreciated therefore that the configuration of the nozzle and the resonator cavity must be such that sonic waves are generated over a rather wide fluctuation of pressure to permit of continuous reliable operation of the device. The device disclosed in the aforesaid Patent No. 2,519,619 is an example of a suitable acoustic generator.

Using this type of acoustic generator, a very powerful sonic jet can be emitted from a small nozzle. In addition, the liquid feed system of the device of this invention is made concentric with this nozzle, providing a device of minimal dimensions. The device of the present invention can readily be constructed so as to have a total length of but three inches. Despite its small size, the device of this invention will have the output capacity of typical prior art spray nozzles of far larger dimensions and which, moreover, will result in atomization with very high uniformity of particle size.

In many conventional spray nozzles, the mixing of air and liquid takes place within the unit and an aerosol emerges from the spray orifices, hence mixing chambers located within the device are necessary.

In the present invention, employing a sonic generator, formation of the micromist takes place in the atmosphere externally of the device; hence the mixing chamber can be eliminated and extreme compactness results.

An important feature of the design is that the liquid is fed into a sonic energy beam at a point downstream from the resonator thus minimizing the likelihood of contamination of the resonator and nozzle by liquid.

It is therefore a primary object of the present invention to provide a spray nozzle having high efficiency in atomization consonant with compact size.

It is a further object of the present invention to provide an extremely sturdy spray nozzle having no moving parts and adapted to withstand high pressures of air and liquid within relatively small space.

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It is a further object of the present invention to provide a spray nozzle having air and liquid mixing means exterior of the casing of the device.

Still a further object of the present invention is to provide a precision spray nozzle device adapted to operate over a relatively wide range of air and liquid pressures.

A particular object is to provide a sonic spray nozzle having liquid feed means located below the resonator.

It is yet another object of the present invention to provide a micromist forming device having means for selectively altering the diffusion pattern of the micromist.

Another object is to provide an apparatus for forming a micromist wherein the particles remain in suspension without wetting.

These and other objects and advantages of the present invention will be pointed out with further particularity or will be apparent from the following description and the drawings appended thereto, in which:

FIG. 1 is a longitudinal view, partly in section, of the device of the present invention.

FIG. 2 is a transverse cross-section of the present invention taken along line 2—2 of FIG. 1.

FIGS. 3 and 4 illustrate schematically two typical discharge patterns obtainable with the device of the present invention.

Referring now more particularly to the figures, the device of the present invention characterized generally by the numeral 10 comprises an external housing 12 having a cylindrical bore 14, an externally threaded end portion 16 adapted to serve as an air inlet and an opposed internally threaded end portion 18. Integrally formed on the outside surface of housing 12 and conventionally at right angles to same is an internally threaded liquid inlet port 20 having a bore 22.

Removably attached at end portion 16, as by mating threads, is a conventional coupling 30 for connection, in turn, to a gaseous fluid pressure source. Rigidly attached at end portion 18, also by mating threads, is a sleeve 32 having an inwardly converging or tapered inner diameter 34 and a tapered or beveled bottom surface 35. As may be seen in FIG. 1, sleeve 32 extends somewhat beyond end 18 of housing 12 with the inner diameter smallest at its exposed end. Sleeve 32, together with other components, to be described in detail hereinafter, form the nozzle of the invention.

Mounted concentrically in spaced relation within housing 12 and secured thereto is an internally threaded spider 40 having a central bore 42 terminating in a chamber 44. Port 46 in one arm of spider connects chamber 44 with bore 22 of liquid inlet port 20. Concentrically secured within bore 42 of spider 40 as by mating threads, is a hollow stem 48 comprising a substantially straight outer diameter portion 50 and a full length, longitudinal central bore 52. Outer diameter 50, in conjunction with and enveloped by tapered inner diameter 34, form a plenum chamber 54 in which the velocity of the gaseous driving medium is increased. Since the tapered inner diameter 34 is smallest at its outer end and therefore most proximate to end 47 of plug 48, a choked nozzle 60 is formed, the functions and operations of which will be subsequently described. O-ring 49 secured on the outer diameter of stem 48 forms a liquid-tight seal between stem 48 and bore 42 of spider 40. O-rings are commercially available in a variety of materials and it is to be appreciated that a material suitable for the temperature and atmosphere will be selected for a given application.

At its end opposite liquid inlet port 20, external threads are formed on hollow stem 48 for the purpose of mounting an end cap 76. End cap 76 seals off central bore 52 of plug 48. Either at assembly, or at some stage prior thereto, radial apertures 78 are formed in both cavity

resonator 70 and end 47 of plug 48 and communicate with central bore 52 of plug 48. The apertures 78 serve as orifices for the liquid being discharged into the sound field. The internal configuration of resonator 70 comprises a substantially cylindrical side wall 72 concentric with and spaced from end portion 47 of plug 48. Wall 72 terminates in a shoulder 74 closely fitted about end 47 of plug 48.

In operation, air under pressure, introduced into bore 14, is emitted as a D.C. supersonic jet stream from choked nozzle 60 and converted into sonic waves of compression and rarefaction by cavity resonator 70. It is preferred to operate the apparatus at inaudible ultrasonic frequencies. As has been noted, end portion 18 of sleeve 32 is provided with beveled edge 35 which offers a deflecting surface to high velocity sonic waves generated by cavity resonator 70. The configuration of surface 35 is such that a low pressure area is formed adjoining openings 78 by the air jet discharging radially from the resonator. This low pressure draws liquid emerging from openings 78 into the downwardly reflected sound field. The high intensity sonic wave action of alternate pressure and rarefaction operating on the air molecules causes turbulence within this field resulting in atomization of the liquid into a micromist. It will be appreciated that this atomization has been effected by a device of minimal dimensions compared with conventional spray nozzles. In the embodiment illustrated in FIG 1, the length of the device is approximately three inches, disregarding the terminal portion 30, which is threadedly engaged to the device and separable therefrom. The device is adapted to withstand relatively high input pressures of air and liquid and is adapted to convert the liquid into an aerosol characterized by a very high degree of uniformity of size of the particles.

In a preferred embodiment of the present invention, the aforesaid Yellott-Savory sonic generator is employed, wherein adjustable spacing means are provided for displacing the cavity resonator relative to the nozzle over a relatively narrow operational range. This has the very useful property of altering the pattern of the sonic energy field produced, the angle of diffusion being a function of the distance of the resonator from the nozzle.

As shown in FIG. 3, angle α , here shown as approximately 180° , represents a spacing of resonator to nozzle within the operational range, which will result in maximum acoustic output and maximum area of diffusion of the micromist.

FIG. 4 illustrates a small directional cone, of angle α' , for forward fogging. This mode of operation would, for example, be employed for spraying material in a conveyor belt. In this case the micromist is concentrated towards a specific area. The advantages of such an arrangement will be readily apparent. To obtain the pattern, the spacing between nozzle and resonator is increased beyond that position providing maximum acoustic output.

Typical performance obtained from a unit by $4\frac{1}{4}$ " long and $1\frac{3}{8}$ " diameter is as follows:

Actuating gas	Air.
Gas pressure	15-70 p.s.i.g.
Gas flow	9.0-28 s.c.f.m.
Frequency	19,000-22,000 c.p.s.
Liquid flow (water)	Up to 1.5 lbs./min.
Particle size	Sub-micron to 15 microns.

With a water flow rate of 4 oz./min., the resulting droplets were under 10 microns.

There has been disclosed heretofore the best embodiment of the invention presently contemplated and it is to be understood that various changes and modifications may be made by those skilled in the art without departing from the spirit of the invention.

What is claimed is:

1 A sonic spray device comprising:

a sonic generator comprising a hollow body member terminating in a choked nozzle;

a hollow stem having an axial bore positioned partially within said body and having a portion extending through said nozzle;

a resonator cup supported by said extending stem portion in spaced opposition to said nozzle;

an end member carried by said stem and extending downstream from said resonator cup and provided with a plurality of radial bores communicating with said axial bore and terminating in spray orifices; means for connecting said device to a supply of liquid so as to feed liquid through said axial bore to said spray orifices; and

means for introducing a supply of gas into the interior of said body for expulsion through said nozzle.

2. The apparatus of claim 1 provided with means to vary the output pattern, said means comprising means to vary the spacing between said nozzle and said resonator cup.

3. A device as in claim 1 wherein the outer surface of said nozzle proximate to the orifice thereof is formed in a generally tapered configuration whereby gas expelled from said resonator at high velocity is adapted to flow along said tapered surface in a direction away from said orifices formed in said end portion, to thereby create an area of low pressure effective to draw liquid emerging from said orifices towards said low pressure and into the said high intensity sonic energy field.

4. A device as in claim 1 wherein said resonator is axially displaceable relative to said nozzle over the operational range of said device to thereby selectively alter the diffusion pattern of a micromist formed by said device.

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