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3,157,359

LARGE VOLUME LIQUID ATOMIZER EMPLOYING AN ACOUSTIC GENERATOR

Filed Dec. 24, 1962

2 Sheets-Sheet 2

FIG. 2

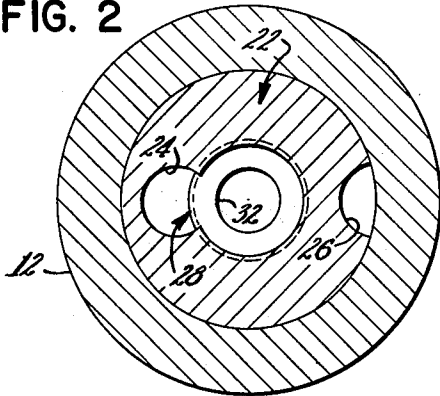


FIG. 3

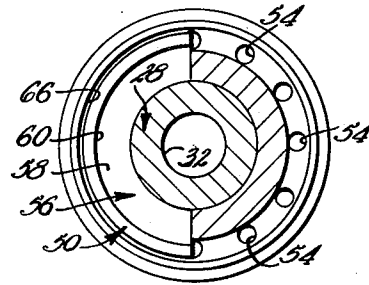


FIG. 4

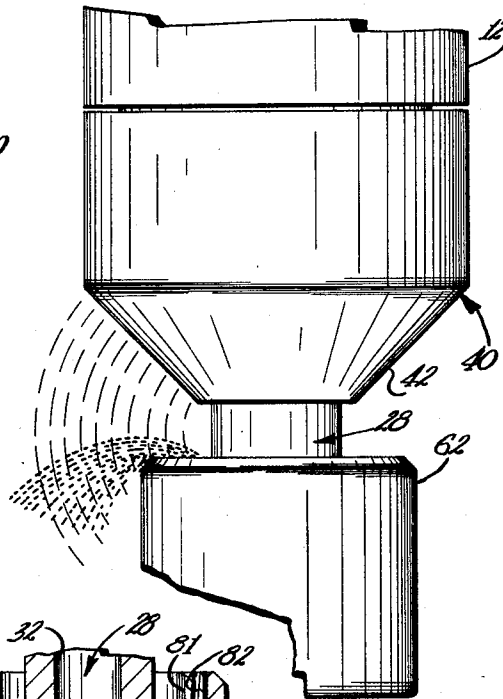
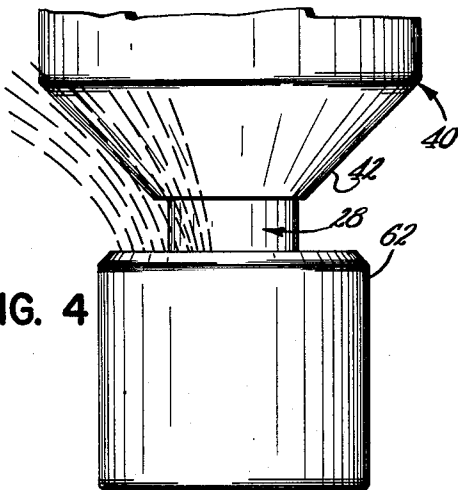


FIG. 5

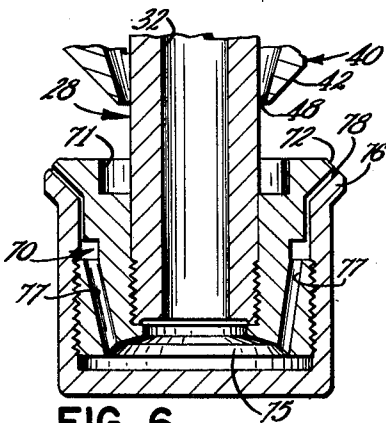


FIG. 6

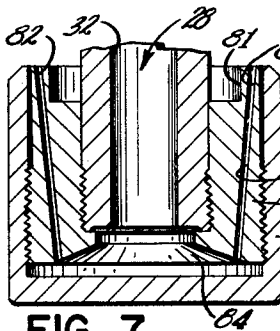


FIG. 7

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3,157,359 LARGE VOLUME LIQUID ATOMIZER EMPLOYING AN ACOUSTIC GENERATOR

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13 Claims. (Cl. 239-102)

This invention relates to liquid atomization apparatus and in particular to devices for the conversion of large volume liquid streams into a micro-mist by the use of a high intensity sonic energy field produced by an improved acoustic generator.

In U.S. Patent No. 2,519,619, granted to Yellott and Savory, there is disclosed an acoustic generator. As disclosed in the patent, a high energy, vibratory sound field is produced when a tuned, cavity resonator is excited into resonance under the influence of an impinging supersonic jet stream. The resonator will periodically load and unload violently at the imposed resonator frequency. Thus, the high velocity jet stream is converted or transduced into a high intensity sonic output.

The operating frequency may cover a rather wide band if there is variation in the pressure of gas supplied to the resonator. Therefore, the configuration of the nozzle and the resonator cavity must be such as 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.

The apparatus of the present invention creates a thin, annular curtain of liquid which is interrupted by a high intensity sonic energy field produced by the Yellott-Savory generator. The interaction of the liquid and the sonic energy field serves to rupture and outwardly disperse the annular film of liquid thereby forming a micro-mist of fine droplets in a range generally under 100 microns. In addition, there will also be formed some particles in the sub-micron range. The generator of the present invention is constructed so that the nozzle and the cavity are coaxial with a connecting, hollow, center stem contained within and extending beyond the body of the generator. The material to be vaporized is fed from an inlet port through the hollow center stem to a resonator jacket from which it is subsequently expelled upwardly through apertures or annulus proximate the lip of the resonator. At this juncture, the liquid stream enters the sonic energy field produced by feeding a gas under pressure from another inlet port through an annular nozzle concentric with the hollow stem and in to the cavity spaced thereapart. An important advantage accrues thereby in that a wide dispersal angle of the resulting fog or mist is formed. By having each unit cover a wide angle, fewer units are required to cover an area, e.g., in fighting fires with fogs.

The present invention may be constructed so as to have a total length of only three inches. Despite its small size the present invention will have a large output capacity and, moreover, will result in liquid atomization with very high uniformity of particle size.

In contrast to the prior art, the construction of the present invention provides for the upward propulsion of liquid away from the resonator cavity in an annular configuration whereby it is acted upon from within and directed outwardly by the high intensity sonic energy field. Thus the resonator cavity is kept free of the contamination found in the prior art device. Heretofore, where liquid was directed downwardly into the sonic energy field, some liquid found its way into and remained within the resonator cavity causing an undesirable change in operating frequency. This shortcoming has now been overcome and a trouble free, accurate and longer operational life is assured.

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In the present invention, the stream of liquid is directed by novel means in such a manner as to virtually eliminate contamination of said cavity.

It is therefore an object of the present invention to provide a spray nozzle which reduces the contamination of the cavity used to generate a sonic field.

It is a further object of the present invention to provide a liquid feed means which directs the liquid up into the sonic field, and away from the cavity of the resonator.

It is still another object of the present invention to utilize more fully the direct action of the liquid stream upon the sonic field.

It is a further object to provide an acoustic generator having a wide angle spray cone.

Another object is to construct a micro-mist acoustic generator capable of atomizing liquids to a high uniformity of particle size.

Still another object is to provide an acoustic generator capable of producing a very small particle size in the order of microns and sub-microns.

These and other objects and advantages of the invention will, in part, be pointed out with particularity and will, in part, become obvious from the following more detailed description of the invention, taken in conjunction with the accompanying drawing, which forms an integral part thereof.

In the various figures of the drawing like reference characters designate like parts.

In the drawing:

FIG. 1 is a longitudinal cross-section of the present invention.

FIG. 2 is a transverse cross-section thereof taken along line 2-2 of FIG. 1.

FIG. 3 is a transverse section taken along line 3-3 of FIG. 1.

FIGS. 4 and 5 are enlarged elevational views of the nozzle/resonator area illustrating liquid flow patterns without and with the action of sonic energy. It should be noted that, for clarity of illustration, only a portion of the flow patterns are shown in each case.

FIGS. 6 and 7 are longitudinal cross-sections of a portion of the present invention, representing two additional embodiments of jet configurations.

Acoustic generator 10 comprises an elongated cylindrical body portion 12 having a pair of spaced inlet ports 14 and 16 at its upper end 18. A longitudinal central bore 20 within body 12 receives cylindrical core member 22 having longitudinal passages 24 and 26 extending throughout and communicating with ports 14 and 16, respectively. The lower portion of passage 24 is internally threaded to receive hollow center stem 28 and provide a coaxial extension beyond the externally threaded lower end 30 of body portion 12. Bore 32 extends the length of center stem 28, opening at its upper end into passage 24 and liquid inlet port 14. Center stem 28, intermediate its extremities, is provided on its outer surface with a compression ring 34 and a compression fitting 36 to assure a liquid-tight seal between stem 28 and core 22.

Nozzle 40, secured by mating threads to the lower end 30 of body 12 is provided with an inwardly tapered external surface 42 at its lower end. At its upper end, conical bore 44 of nozzle 40 is substantially the same diameter as bore 20 of body 12. At its lower end, bore 44 is only slightly larger than the enclosed central stem 28, thus defining an annular chamber 46 in communication with passage 26 and gas inlet port 16, and also defining a constricted orifice 48 from which the gas emanates under pressure greater than initially imparted, due to the Bernoulli effect. Directly below and coaxial with orifice 48 is a cavity resonator 50 secured to the lower threaded end of stem 28.

Resonator 50 is constructed and positioned so that hollow stem 28 may first deliver the material to be vaporized into a closed chamber 52 formed in the lower face of the resonator and then up through passageways 54 extending substantially vertically through at least a portion of the resonator 50. This arrangement has the effect of diverting the liquid flow to an upward direction (FIG. 4). Concurrently, the gas stream is directed downwardly through orifice 48 into cup-shaped resonator cavity 56 defined by bottom wall 58 and coaxial side wall 60. The wave and atomization pattern shown in FIG. 5 is thus formed. The annular, thin film curtain of upwardly diverted liquid is formed by enclosing resonator 50 within a spaced jacket 62. Bottom wall 64 of jacket 62 completes the closure of chamber 52.

In the embodiment illustrated by FIG. 1, the liquid stream is directed upwardly from passageways 54 into the annular chamber 66 formed between the outside surface of resonator 50 and jacket 62. In order to provide a uniform mist flow the area of chamber 66 orifice should be approximately equal to the cross-sectional area of the center stem bore. Further, the sum of the passageways 54 cross-sectional areas should be substantially the same as the cross-sectional area of the center stem bore. In the embodiments illustrated, the space between the jacket 62 and the outside surface of resonator 50 is approximately 0.040". Assuming that the proper combinations of dimensions are chosen, then the spraying rates and patterns will be a function of liquid and air feed pressures and also sound wave frequency.

FIG. 6 illustrates an alternative embodiment wherein resonator 70, having a cavity 71, is provided with an outwardly flared flange 72 and spaced, coaxial jacket 74 has a mating outwardly flared and spaced flange 76. The liquid delivered by center stem 28 passes through closed chamber 75 and passageways 77 before passing through the annular chamber 78 from which it is deflected radially outward. The resonator 80, including cavity 81, of FIG. 7 has self-contained longitudinal passageways 82 for diverting the liquid stream to an upward direction. Once again, the liquid path is down through stem 28, through closed chamber 84, and up through apertures 82, before passing to the atmosphere where it is deflected outwardly in a mist by the high intensity sonic energy field intermediate the nozzle and the resonator.

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. The exposed portions of the device which are subject to wear caused by the force of the streams of air and liquid upon them, may be constructed of a variety of abrasion resistant materials, such as ceramics, tungsten carbide, ceramic or metal coatings, such as chrome alloys and stellites, to mitigate this abrasive action.

In a preferred embodiment of the present invention employing the aforesaid Yellott-Savory sonic generator, adjustable spacing means are provided for displacing the 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.

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 liquid atomization device comprising:
 - a hollow body member having a gas inlet port;
 - a nozzle including an orifice in communication with said gas inlet port;
 - a cavity resonator having a well that is coaxial with and in spaced opposition to said gas orifice; and

liquid orifice means to direct a curtain of liquid coaxially about and axially towards said gas orifice in a direction substantially opposite to the flow of gas from said nozzle.

2. The device of claim 1 wherein said liquid orifice means is arranged to provide a cylindrical curtain of liquid.

3. The device of claim 1 wherein said liquid orifice means is arranged to provide a conical curtain of liquid.

4. The device of claim 1 wherein said liquid orifice means is arranged to provide an outwardly flaring conical curtain of liquid.

5. The device of claim 1 wherein said means to direct a curtain of liquid comprises:

a liquid inlet port;

an outwardly turned flange at the end of the resonator proximate said well; and

a jacket spacedly enclosing said flange to define an annular chamber therebetween terminating in an annular liquid orifice, said annular chamber being in communication with said liquid inlet port.

6. An apparatus for converting a large volume liquid stream into a dispersible mist comprising:

a body member having separate liquid and gas inlet ports disposed therein;

a nozzle integral with said body and having an orifice in communication with said gas inlet port;

longitudinally disposed hollow support means having an interior bore in communication with the liquid inlet port and extending outwardly through said nozzle orifice providing an end portion spaced from said nozzle;

a cavity resonator body secured to said end portion of said support means, said resonator body having a well formed therein that is coaxial with and in spaced opposed relationship with said nozzle orifice; and

a cup-shaped jacket secured to said resonator body, said jacket having an open end and a closed end, the closed end of said jacket being axially spaced from the bottom of said resonator body to define a reversing chamber, the open end of said jacket being radially spaced from the upper end of said resonator body to define an annular liquid discharge chamber proximate to and in opposition to said nozzle orifice whereby the liquid flowing downstream from said liquid inlet port impinges on the closed end of said jacket and is thereby reversed and caused to flow upstream to said annular chamber, the liquid being discharged from the annular chamber in a direction substantially opposite the direction of the air from said nozzle and in the field of sonic energy generated by said resonator.

7. The apparatus of claim 6 wherein said resonator body is provided with a hollow chamber joining the bore of said hollow support means and said annular chamber.

8. An apparatus for converting a large volume liquid stream into a dispersible mist comprising:

a body member having separate liquid and gas inlet ports disposed therein;

a nozzle provided with a restricted orifice in communication with said gas inlet port;

longitudinally disposed support means extending outwardly of said nozzle and having an end portion spaced from said nozzle; and

a cavity resonator secured to said support means end portion, said resonator having a coaxial well formed therein that is in spaced, opposed relationship with said nozzle orifice, said resonator having an open ended, annular chamber proximate to and spaced concentrically about said support means end portion and in communication with said liquid inlet port, said resonator having a plurality of circumferentially placed longitudinal passageways communicating at one end thereof with said chamber and communicat-

ing at the other end thereof with the atmosphere proximate said gas orifice, said passageways being arranged to direct liquid in a direction substantially diametrically opposite to the flow of gas from said nozzle orifice.

9. In combination with an acoustic generator of the "Hartmann" whistle type having a body portion provided with separate liquid and gas inlet ports, a constricted orifice nozzle for the discharge of gas into a well formed in a spaced resonator member adapted to receive both liquid and gas from said body for the conversion of said liquid to a fine particle mist, the improvement comprising:

said resonator member having a plurality of substantially longitudinal passageways radially spaced proximate the periphery of said resonator and in communication with said liquid inlet port; and

a jacket concentrically secured to and enclosing the periphery of said resonator in a spaced relation to form an annular, open ended chamber thereabout, said chamber being in communication with said apertures and defining a liquid discharge aperture arranged to direct liquid substantially opposite to the direction of discharge of the gas from said orifice nozzle.

10. The apparatus of claim 9 wherein said resonator member has a second chamber formed in the lower end thereof, said second chamber being in communication with and interposed between said liquid inlet port and said passageways.

11. The apparatus of claim 9 wherein said resonator is provided with an outwardly turned flange at its upper end in the well region, and wherein said jacket is provided with an outwardly turned flange in spaced relation to said resonator flange forming an annular chamber therebetween, said chamber being in communication with said liquid inlet port.

12. The apparatus of claim 9 wherein said resonator is provided with a chamber formed in the lower surface thereof and a plurality of substantially longitudinal passageways radially spaced proximate the outer surface of said resonator, said apertures communicating with said chamber and the atmosphere intermediate said resonator and said nozzle and closure means for said chamber.

13. An acoustic generator of the "Hartmann" whistle type for converting a large volume liquid stream into a dispersible mist comprising:

a cylindrical, elongated body member having spaced,

longitudinal liquid and gas inlet ports disposed therein;

a core member concentrically disposed along the longitudinal axis within said body, said core member having spaced, longitudinal passages communicating with said inlet ports;

a hollow central stem longitudinally disposed within said core and having one end extending outwardly thereof, said end in direct communication with said liquid inlet port;

sealing means disposed between said core and said stem; an annular nozzle secured to the lower end of said body member proximate to and encompassing the intermediate portion of said stem to define a constricted orifice thereabout, said nozzle having downwardly and inwardly tapering inner and outer surfaces, the narrowest and lowermost portion of said tapered nozzle being in closely spaced relation to said stem;

a resonator member secured to the lower end of said stem in spaced relation to said nozzle orifice, said resonator member having a well formed therein that is coaxial with and in spaced opposed relation to said nozzle orifice, said resonator member having a plurality of substantially longitudinal passageways extending at least part way through said resonator member, said passageways terminating in a chamber formed in the lower surface of said resonator member, the other end of said apertures terminating at the outside surface of said resonator member; and

a cup shaped, chamber closure jacket secured to said resonator member, said jacket being in spaced relation to the upper end of said resonator member to define an annular orifice, in communication with said other end of said passageways.

References Cited by the Examiner

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LOUIS J. DEMBO, *Primary Examiner*.

EVERETT W. KIRBY, *Examiner*.