

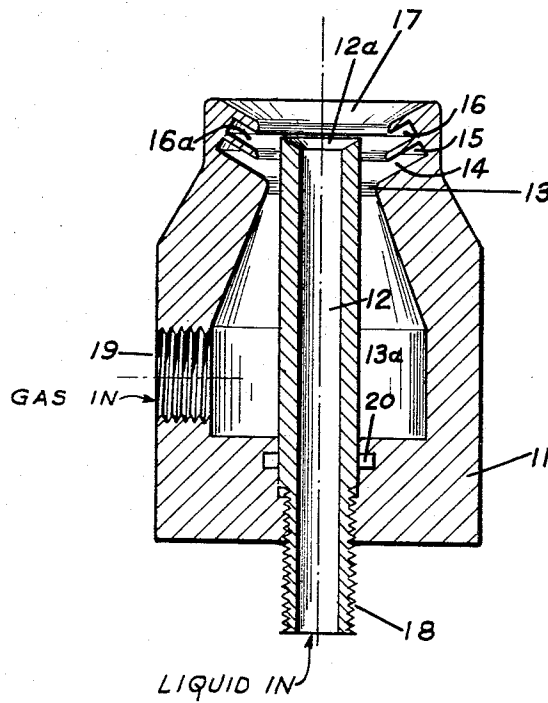
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ATOMIZER WITH MULTI-FREQUENCY EXCITER

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3,326,467 ATOMIZER WITH MULTI-FREQUENCY EXCITER

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The present invention relates to two fluid sonic atomizers, and more particularly to a two fluid sonic atomizer wherein the current flow of both fluids is uni-directional but oscillating.

There are presently many two fluid atomizers on the market in which air or some other gas is forced at high velocity past a stream of liquid thus converting the liquid into fine droplets by means of shear forces. In air atomizers such as the DeVilbiss, or that of the Jones U.S. Patent No. 3,084,874 dated Apr. 9, 1963, the two fluid streams (gas and liquid) travel longitudinally down a nozzle generally with the liquid in a center tube. The air intercepts the liquid stream at an angle and shear forces cause the liquid to be atomized. In a unit of this type the air stream is not disturbed and pressure or velocity fluctuations are avoided. The shearing forces are caused by relatively large difference in the fluid velocities. Very often the liquid is aspirated by the creation of a slight vacuum at the orifice by means of the high velocity air jet passing over it. This syphoning action is widely used in creating aerosol sprays for the agricultural and market gardening industries. This type of laminar non-turbulent gas stream can be called a D-C flow by analogy to electrical current flow.

Another type of two-fluid nozzle has been generally designated as a sonic atomizer. In this type of unit sound is generated aerodynamically as a by-product of an air flow as opposed to sounds produced by the vibration of solids. In a nozzle of this type as shown in the W. K. Fortman et al. U.S. Patent No. 3,117,551 gas at super-sonic velocity is directed into a resonator cavity and pressure fluctuations are produced when the gas charges and discharges from the cavity at the natural resonance of the cavity. The liquid is introduced either around or through the resonator. An advantage of this type of atomizer lies in the controlled particles break up brought about by the regular chopping action of the sonically excited gas stream passing the liquid discharge.

As is well known in the art, for example as shown in the William K. Fortman U.S. Patent No. 3,064,619 a high energy vibratory sound field is produced when a tuned cavity resonator co-axially opposes a nozzle and a high velocity gas jet is impinged upon it. The cavity periodically loads and unloads the gas stream emitting shock waves and creating a sonically excited gas stream. This action fundamentally converts a dynamic D-C gas stream into a sonically excited A-C gas emission which have as a by-product powerful sound shock waves. One problem encountered in this type of atomizer has been the structurally weak member supporting the resonator which when exposed to rough industrial usage can easily be bent. Another problem arising from exposed resonators which destroys the sonic emission as well as the spray pattern occurs when viscous fluids are being atomized. As these sometimes enter the cavity and block it thereby disturbing or entirely eliminating the sonic field. Still another disadvantage arises from the frequency limitations of the sonic spray device as in their present forms as far as is known only single cavity resonators are employed. As a general rule high frequencies result in fine particles and low frequencies give larger particles. It therefore follows that a single or limited frequency generator utilized in aerosol production will only be effective

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for a limited particle size distribution. In terms of efficiency, power losses occur in many sonic spray nozzles due to the manner in which the gas jet is directed into the resonator cavity. For example if the resonator is directly opposed to the jet, the air enters and discharges from the cavity and then pulses outwards at an angle generally out of phase to the axis of the initial air stream. In fact the air jet has completely reversed itself before discharging from the resonator nozzle gap. Considerable power losses occur when dynamic gases are forced through tortuous passages.

The present invention in its broader aspects eliminates a separate cavity resonator by incorporating it within the body member and in such a manner that the fluids to be atomized never impinge upon it. Neither the gas passage or resonator chambers protrude beyond the lip of the body thus making a very rugged unit. The sound generator is so constructed that a plurality of resonators can be incorporated thus producing a multiplicity of frequencies for selective treatment of the fluid or fluids. A broad band sonic spectrum can be produced by incorporating a 10 kc. and a 50 kc. generator within the same unit. The sound generator is not limited to 10 and 50 kc. but could span approximately 6 to 150 kc. range with even higher frequencies in helium. In terms of efficiency the gas passages are provided around the outside diameter of a simple tube which is placed inside the body resonator. The body resonators or pulsators are placed in a revolution around the gas passage but at a forward angle in line with the direction of flow. The advantage herein gained lies in the fact that the gas does not reverse its direction of travel thus permitting greater sonic energy conversion.

Therefore, it is the object of this invention to treat one or a plurality of fluids by means of a multiplicity of gas excited sonic frequencies provided within one atomizing nozzle.

With the foregoing and other objects in view, the invention resides in the novel arrangement and combination of parts and in details of construction hereinafter described and claimed.

Other objects and advantages will become apparent from the following description taken in conjunction with the accompanying drawing in which:

FIGURE I is a longitudinal cross-sectional view of the atomizer and the multi-frequency exciter.

Generally speaking, the present invention contemplates the combination of cylindrical fluid feed pipe within a combination nozzle and multi-frequency exciter which are integral with one another. By means of the fluid feed pipe liquids are delivered into a multiple frequency excited gas zone where they are subjected to intense multiple frequency excitation. In this manner the liquids can be atomized and distributed into particles of various sizes. A unit of this type can be used to direct a relatively narrow spray, i.e., the angle formed between the sprayed particles and the nozzle outlet is under about 60° total angle over a fairly long trajectory. In order to accomplish this task it is necessary to have larger droplets as well as smaller aerosols. The large droplets create an aerodynamic drag to act as carriers for the fine aerosols. This means for example, that good coatings of paint or other fluids could be applied to surfaces over a considerable distance by selecting a combination of coarse and fog like particles.

The contemplated atomizer shown in FIGURE I, comprises a cylindrical nozzle 11, having a cylindrical fluid feed pipe 12 passing through the center of the cylindrical nozzle 11 to provide a bulky chamber 13a with concentric choked gas passage between the outside wall of the fluid feed pipe defined by an inner tapered opening 13 of the body nozzle. The liquid fluid is transmitted

through the fluid feed pipe 12 to an orifice 12a which can be any shape but is generally round to provide a tapered spray cone of circular shape. The orifice could be a, for example, slit which would tend to constrict the spray into a flat fan-like shape. The gas medium enters opening 19 and is then choked and forced through the narrow throat of tapered opening 13 where according to Bernoulli's law, it expands and diverges, then by the boundary effect it locks onto wall 14 by the Coanda effect as described in "Missiles and Rockets," Feb. 18, 1965, page 19. This boundary effect eliminates the use of diverters or cavity deflectors thus conserving considerable dynamic gas energy losses. The gas then charges into last resonator cavity chamber 15 and piles up before discharging due to instability at the natural frequency of the tuned cavity. After this discharge a secondary expansion pulse can be utilized exactly in the same manner to charge second resonator cavity chamber 16. The cavity chambers are placed in revolutions in a step like manner one above the other at an angle of the order of 60° to the central fluid feed pipe 12, measured in the direction of fluid flow in order to permit the gas to discharge from the resonators towards the liquid stream in several acoustically excited concentric air streams. For the purpose of illustration two cavity chambers are shown. Additional cavity chambers could be incorporated. In the device herein described liquid breakup occurs in a post resonator position. The liquid as it emits from the liquid feed pipe delivery end or orifice 12a is subjected to the impact or primary acoustically excited gas stream beyond the orifice and then is further selectively subjected to a secondary concentric impact. This insures good fluid breakup and turbulence. The final cup or reflector 17 can be shaped to influence the free air stream which will be induced by the velocity of the exciting aerosol mass and its excited gas carrier. In order to permit the optimum contact between the liquid and the excited gas streams an adjustment is provided between liquid exit 12a and reflector cup 17 by means of the screw thread 18 on liquid fluid pipe 12.

In order to prevent air leaks to atmosphere between the liquid feed pipe 12 and the body 11 an O-ring seal 20 is provided.

Of particular importance is the construction of tapered opening 13 and first and second resonator cavity chambers 15 and 16. The wall 14 of tapered opening 13 is rounded, avoiding a jagged edge effect. In a similar manner wall 16a between cavity chambers 15 and 16 is also rounded.

As previously mentioned, the advantage of the present nozzle is the fact that the atomized spray will not form an agglomeration in space, in the vicinity of the nozzle, but on the contrary, will plunge forward for upwards of 100 feet to slam against a wall. A careful consideration of the action of the sprayed atomized stream requires an understanding of Reynolds criterion, in the light of the system herein described. Simply stated, what is needed are small aerosols. But, because of the Reynolds number of these small particles, they will merely form an agglomeration in space in the vicinity of the nozzle. To carry these small aerosols upwards of 100 feet, large droplets within the criterion of the Reynolds number of flow are essential so that these larger droplets can carry the smaller droplets along. Nevertheless, the size of the larger drop-

lets is such that they are subject to the action of the sound waves.

It is to be observed therefore that the present invention provides for a sonic spray nozzle, comprising in combination, an elongated housing with a fluid delivery concave end section; a central fluid feed passage through said housing for delivery of the main fluid stream therethrough a bulky gas chamber surrounding the central fluid feed passage having a tapered opening defined by a wall towards said end section; and, at least one cavity chamber defined by a second wall in said end section. The cavity chamber in the end section is disposed at an angle of the order of 60° to the central fluid feed passage measured in the direction of the fluid travel. Preferably a second cavity chamber, forward of the first cavity chamber and parallel thereto is also disposed in the end section, the walls between the chambers having rounded edges to facilitate the passage of the sound forming gas fed through the bulky gas chamber.

While it will be apparent that the embodiment of the invention herein disclosed is well calculated to fulfill the objects of the invention, it will be appreciated that the invention is susceptible to modification, variation and change without departing from the proper scope or fair meaning of the subjoined claims.

I claim:

1. A sonic spray nozzle, comprising in combination, an elongated housing with a fluid delivery end section; a central fluid feed passage through said housing for delivery of a main fluid stream therethrough; a bulky gas chamber surrounding the central fluid feed passage having a tapered opening defined by a wall towards said end section; and, at least one cavity chamber defined by a second wall in said end section said cavity chamber being disposed at an angle to the central fluid feed passage so as to receive therein the fluid discharging from said bulky gas chamber.

2. A sonic spray nozzle as claimed in claim 1, said cavity chamber being disposed at an angle of the order of 60° in the direction of fluid travel.

3. A sonic spray nozzle as claimed in claim 1 having a second cavity chamber forward of the first cavity chamber in the direction of fluid travel said second chamber being parallel to said first chamber and defined by a third wall.

4. A sonic spray nozzle as claimed in claim 3, said cavity chambers forming cylindrical revolutions in a step like arrangement.

5. A sonic spray nozzle as claimed in claim 4, said end section being concave.

6. A sonic spray nozzle as claimed in claim 5, said defining walls having rounded edges between chambers to facilitate passage of the sound forming gas through the bulky gas chamber.

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