

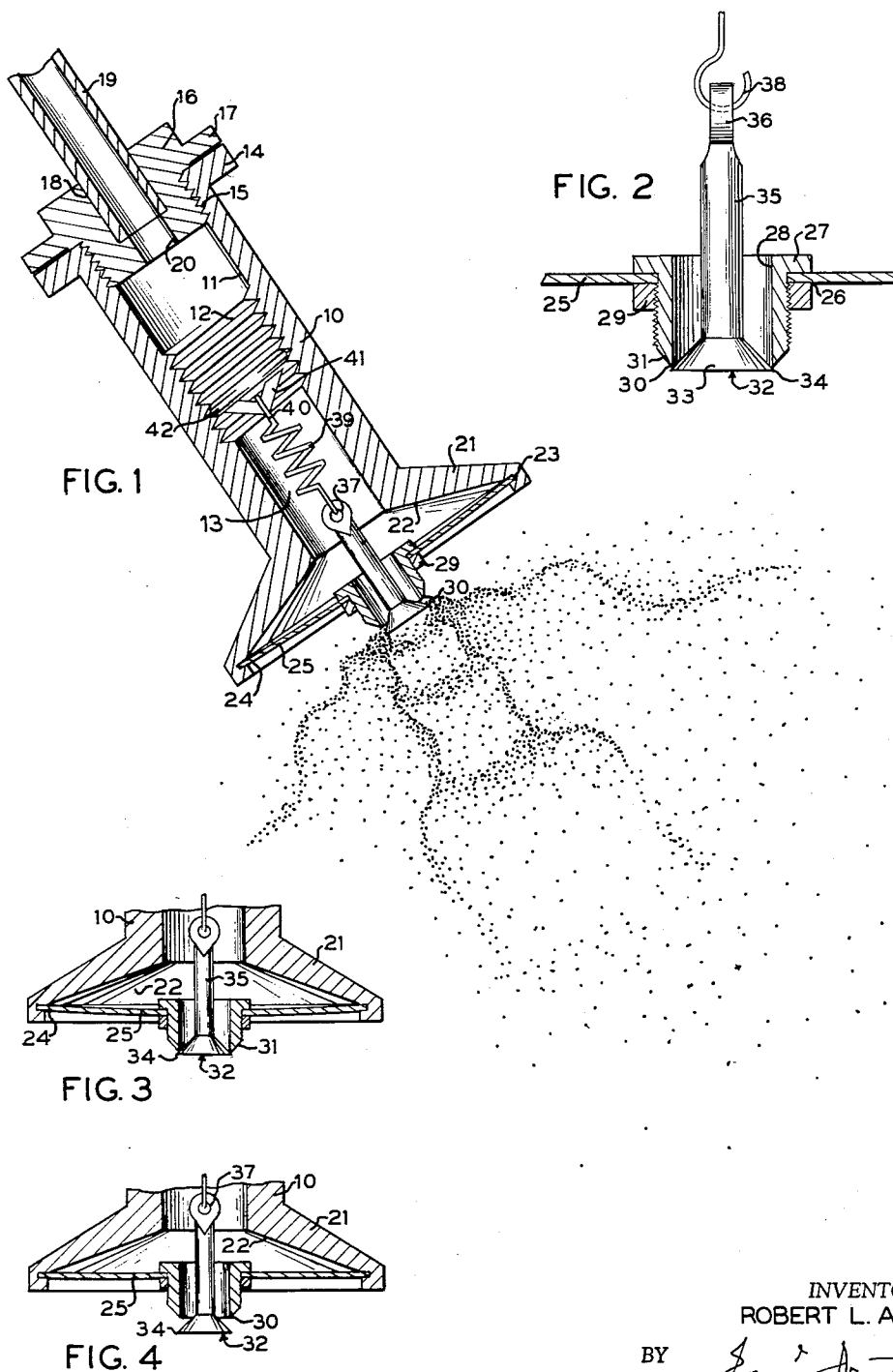
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SPRAY NOZZLE WITH VIBRATORY HEAD AND SEAT

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SPRAY NOZZLE WITH VIBRATORY HEAD AND SEAT

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This invention relates to vibratory spray nozzles, and is particularly concerned with a nozzle having a vibratory head and seat to produce a vibratory fluctuation of the area of the discharge opening so as to produce a flutter in the discharge pattern to enhance the miscible characteristic of the discharge.

One of the outstanding objectives in the design and construction of spray nozzles for substantially all purposes is the perfection of a discharge pattern wherein the liquid particles are so dispersed in the gaseous medium of the receiving atmosphere as to be most effectively and efficiently utilized for the purpose intended. It is of course obvious that in the discharge of liquid particles, no matter how finely divided, if successive particles follow a given trajectory in the receiving atmosphere their contact and absorption in such atmosphere will be limited to the area of such trajectory. It follows that should successive particles be dispersed in varying trajectories, a greater area of atmosphere will be contacted by such particles and a proportionally higher degree of dispersion will be achieved.

Heretofore, a variation in the direction of particle discharge has been achieved by such means as bodily movement of a nozzle itself to alter the direction of discharge, means to intercept the discharge from stationary nozzles to successively deflect particles from the direction of their original trajectory, or means to impart a rotary or swirling movement to the fluid itself prior to discharge. The present invention achieves a continually varying discharge pattern by which successive liquid particles are discharged in dissimilar trajectories without either of these prior art procedures. In the present invention, a vibrating hollow conical discharge pattern is achieved which is characterized by progressive radial undulations formed by a continuously changing angularity of particle trajectory with respect to the central axis of the fluid flow in the body of the nozzle. Such discharge pattern is accomplished in the present invention by the provision of automatic pressure responsive means producing relative vibration of the nozzle orifice with respect to a dispersion head, the result of which is to continuously vary the area of an annular discharge opening thus to continuously vary not only the volume of discharge but the angular trajectory of at least the peripheral particles of the hollow conical pattern of discharge.

The structure of the present form of the invention may be broadly defined as providing a pressure responsive diaphragm defining an axially movable orifice in combination with the pressure responsive mounting of a dispersion head, preferably centrally of the orifice and extending therethrough and independently supported for free floating movement. The dispersion head is resiliently and yieldably urged toward the orifice so as to seal the orifice in the absence of flow pressure. Upon the application of pressure, the diaphragm will flex outwardly as the dispersion head is unseated from the orifice by pres-

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sure to permit fluid flow. As the fluid is emitted from the orifice by displacement of the dispersion head from the seat the internal pressure will subside and the diaphragm will relax to increase the space between the orifice and the dispersion head to increase fluid flow and to change the angle of dispersion. Such movement will, however, further decrease the internal pressure and tend to return the diaphragm and dispersion head to a position diminishing fluid flow, and hence pressures will again increase. Such responsive reactions will provide a hunting action whereby the diaphragm will be vibrated as well as the dispersion head to provide the vibratory conical discharge flow materially enhancing the miscible characteristics of the spray pattern.

It is, of course, recognized that a highly miscible diffusion of liquid immediately following its discharge from a nozzle is not in all cases required or desirable and that such dispersion may be achieved only at the sacrifice of an elongate and consolidated discharge which in some cases is preferable. However, the type of discharge here achieved is admirably suited for the rapid diffusion and atomization of liquid closely adjacent the discharge port of the nozzle, and is hence well adjusted to the many uses where rapid diffusion is desired. While the invention is in no way limited to any specific use, it is here suggested that the nozzle of the present invention finds successful adaptation in the spraying, sprinkling, diffusion and atomization of fuels and in particular in the injection of fuel into the combustion supporting gases of high speed, spark ignition type, internal combustion engines.

It is therefore among the primary objects of the present invention to provide a novel and improved nozzle for the discharge of liquid into a gaseous environment in a highly miscible state.

It is another general object of the present invention to provide a nozzle of the character set forth which is simple in construction and operation, involves few working parts, is rugged and durable and yet well suited to meet the demands of economic manufacture.

More specifically, it is an object of the present invention to provide a fluid discharge nozzle including cooperating vibratory means for effecting a continuously varying spray pattern whereby the individual particles will be more widely dispersed and more evenly distributed.

Another object of the invention is to provide in a spray nozzle for the cooperation of a vibrating nozzle orifice with a vibrating dispersion head, both of which are pressure responsive, whereby continuous fluctuation of their relative position will produce a responsive continuously fluctuating spray pattern.

It is also an object of the present invention to provide a spray nozzle including a discharge orifice defined by the center of a pressure responsive diaphragm whereby in combination with a centrally disposed free floating dispersion head there is produced a hollow conical vibratory discharge pattern of highly miscible character.

Numerous other objects, features and advantages of the present invention will be apparent from consideration of the following specification taken in conjunction with the accompanying drawing, in which:

FIG. 1 is a central longitudinal cross section of one form of the present invention indicating the type of undulating discharge pattern emanating therefrom.

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FIG. 2 is a detail vertical cross section on an enlarged scale illustrating the dispersion head mounting in its relation to the flexibly mounted orifice when no pressure is applied through the body.

FIG. 3 is a detail cross sectional view illustrating the nozzle with the orifice closed but under fluid pressure.

FIG. 4 is a view similar to FIG. 3 illustrating the orifice open, and the pressure on the diaphragm relieved.

In the drawings illustrating one embodiment of the invention, the nozzle is disclosed as comprising a central generally cylindrical hollow body 10, the internal bore of which defines an upper fluid reception chamber 11, a central internally threaded section 12 and a terminal straight concentric flow section 13. At the upper end of the body 10 a mounting shoulder 14 is provided. The outer end of the reception chamber 11 is threaded as at 15 to receive a closure plug 16 formed with a mounting shoulder 17 conforming with the shoulder 14 and with a counterbore 18 to receive a fluid supply tube 19. A port 20 communicates with the tube 19 to deliver fluid therefrom to the chamber 11 and thence through the valve for discharge.

In the present form of the invention, the lower portion of the body 10 is formed with an externally frustoconical annular head 21 defining therein a discharge pressure chamber 22. The peripheral edge of the head 21 is formed with a terminal head defining an internal annular recess 23 which receives and retains the peripheral edge 24 of a circular diaphragm 25. As more clearly shown in FIG. 2, the inner edges 26 of the diaphragm 25 define a central opening which receives therethrough a discharge port plug having an upper flange 27 bearing against the inner surface of the inner edge 26 of the diaphragm and defining a central circular discharge port 28. The plug is secured by a threaded retaining ring 29 engaging the outer surface and the inner edge 26 to secure the plug in centrally located position. The lower outer terminus of the port 28 is defined by a sharp annular edge 30 formed between the inner cylindrical walls of the port 28 and the receding frusto-conical surface 31 of the outer end of the plug. While the material of the body, diaphragm and plug are not critical, it will be understood that should the device be used for the discharge of combustible fluid such materials will be heat resistant and of suitable material and strength as the particular type of installation may dictate. However, it will be also understood that the diaphragm 25 is of such material as to be relatively flexible and so mounted as to yield under pressure to flex outwardly, as indicated in FIG. 2, or to return to a substantially converse position as indicated in FIG. 4 when pressure is relieved.

For cooperation with the sharp annular edge 30 of the orifice of the plug, there is provided a diffusion head 32 having an inwardly facing frusto-conical surface 33 terminating in a sharp annular edge 34 of substantially the same diameter as that of the edge 30, so that when the head is seated against the plug there is a line contact therebetween effectively sealing the orifice, but such that when the diffusion head and orifice are separated there is a minimum of liquid travel over the surface 33 beyond the orifice. By this construction there is an immediate pressure drop as the liquid is discharged from the orifice and hence an immediate diffusion of liquid particles with minimum drag on the liquid as it is discharged. It will further be noted that the frusto-conical surface 33 inhibits the clinging of liquid particles, and thus when the nozzle is used in the discharge of pulses of fuel, as in the ejection of fuel to an internal combustion engine, the entire fuel increment will be fully discharged without loss by adhesion of fluid to the nozzle parts.

The diffusion head 32 is formed as an integral terminal portion of a shank 35 which extends through the port 28, terminating in an internal perforate end 36, the eye 37 of which loosely receives the lower hook end 38 of a spring 39. The upper hook end 40 of the spring 39 is loosely

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received over the generally V-shaped transverse bar 41 of an annular mounting ring 42 which is threadedly received in the threads 12 for vertical adjustment in order to vary the tension applied by the spring 39 to the diffusion head. By this construction it will be seen that the diffusion head is yieldably mounted in contact with the orifice and that the head is freely suspended for pivotal movement by its eye 37 while the spring itself is freely suspended for pivotal movement on the bar 41. Thus the diffusion head when disengaged from the orifice is free for lateral motion in response to any type of flow characteristics tending to urge such lateral displacement as well as for axial movement under pressure to open the orifice. It will further be noted that the frusto-conical surface 32 not only directs the flow outwardly at an angle corresponding to the relative position of the diffusion head with respect to the orifice, but also acts to guide the diffusion head toward seating position with uniform line contact on the sharp edge 30 of the orifice.

In considering the operation of the present device, it will be understood that when no fluid pressure is applied to the nozzle the diaphragm will be in a relatively transverse position as indicated in FIG. 3 and the spring 38 will urge the diffusion head inwardly in sealing line contact of its edge 34 against the edge 30 of the orifice. When fluid is admitted under pressure through the tube 19 thence through the body 10, the diaphragm will be urged to flex outwardly first moving therewith the diffusion head from its contact between the edges 34 and 30 and increasing the tension on the spring 39. Further increase of pressure, however, beyond that producing the limit of outward flexing of the diaphragm 25 will cause the diffusion head to be moved outwardly from its seat on the orifice and against the tension of the spring 39 to permit the discharge of fluid in the annular space formed between the edges 34 and 30, thus initiating a hollow conical pattern of fluid discharge. Since the fluid pressure immediately diminishes as the fluid passes between the orifice and the diffusion head, the internal pressure within the chamber 22 will be diminished and the diaphragm will tend to return to its normal transverse position thus tending to increase the opening between the diffusion head and the orifice; however, such decrease in pressure and such increased opening will also permit the spring 39 to tend to return the diffusion head toward seating position and there will thus follow a successive decrease in the space between the edges 34 and 30, followed in turn by a successive build up of pressure tending to again increase such opening. It will therefore be seen that in the operation of the nozzle, whether the flow be constant or in pulsations, there will be a fluttering and a vibration between the orifice and the diffusion head to produce a constantly varying discharge space; and since the angle of discharge is responsive to such spacing there will be a constantly varying angularity of discharge as well as volume so that there will ensue a discharge pattern characterized as a hollow conical flow of radial undulations of increasing magnitude and decreasing frequency as the conical flow moves outwardly from the orifice.

It will of course be understood that varying strengths and rigidities of the diaphragm 25 and varying tensions on the spring 39 will produce characteristically varying amplitudes and frequencies of vibration, and hence the character of the pattern may be adjusted accordingly. In the present form of the invention with the diaphragm of fixed characteristic, one such adjustment can be achieved by rotation of the annulus 42 in the threads 12 to move the annulus axially of the valve body to vary the tension applied by the spring 39 on the diffusion head 33. It will further be understood that the present invention is not limited to the structural details herein presented, and in the practice of the invention numerous changes, modifications and the full use of equivalents may be resorted to without departure from the spirit or scope of the invention as defined by the appended claims.

I claim:

1. A fluid discharge nozzle including a hollow fluid conducting body, a discharge orifice defining member, means mounting said discharge orifice defining member at one end of said body for fluid pressure responsive movement with respect thereto, a diffusion element cooperating with the discharge orifice of said discharge orifice defining member, and spring means independent of the mounting of said discharge orifice defining member mounting said element on said body for outwardly opening fluid pressure responsive movement with respect to said body and independent of movement of said orifice defining member toward said body.

2. A fluid discharge nozzle including a hollow fluid conducting body, a discharge orifice defining member, means mounting said discharge orifice defining member at one end of said body for fluid pressure responsive vibratory movement with respect thereto, a diffusion element cooperating with the discharge orifice of said discharge orifice defining member, and spring means independent of the mounting of said orifice defining member mounting said element on said body for outwardly opening fluid pressure responsive vibratory movements with respect to said element both axially and laterally relative to said orifice defining member.

3. In a spray nozzle, the combination with a flexible vibratory diaphragm having a central opening of a discharge plug within said central opening and defining a discharge orifice and an outwardly opening diffusion head flexibly mounted for vibratory movement with respect to said orifice to open and close the same.

4. In a spray nozzle, the combination with a flexible vibratory diaphragm defining a discharge orifice, a flexibly mounted vibratory outwardly opening frusto-conical diffusion head, together with means suspending said head for free vibratory movement axially and laterally of the orifice of said diaphragm.

5. In a spray nozzle, the combination with a rigid hollow nozzle body formed for the passage of fluid therethrough having an open discharge end, a flexible vibratory diaphragm defining a discharge orifice across said end, and a spring pressed vibratory outwardly opening frusto-conical diffusion head flexibly mounted on said body and cooperating with the discharge orifice of said diaphragm.

6. In a spray nozzle, the combination with a rigid hollow nozzle body formed for the passage of fluid therethrough having an open discharge end, a flexible pressure responsive vibratory diaphragm defining a discharge orifice across said end, a flexibly mounted vibratory outwardly opening frusto-conical diffusion head cooperating with the discharge orifice of said diaphragm, and spring pressed means supporting said head from within said body for yieldable pressure responsive movement in the same direction as said diaphragm in response to internal pressure.

7. In a spray nozzle, the combination with a rigid hollow nozzle body formed for the passage of fluid therethrough and having an open discharge end, a flexible pressure responsive vibratory diaphragm defining a discharge orifice across said end, a flexibly mounted vibratory outwardly opening frusto-conical diffusion head cooperating with the discharge orifice of said diaphragm, and means supporting head from within said body and through said discharge orifice of said diaphragm for yieldable pressure responsive vibratory movement in the same direction as said diaphragm in response to internal pressure.

8. Means for discharging a hollow conical vibratory spray characterized by progressive annular undulations which includes a hollow spray nozzle body, yieldably mounted means on said body defining a vibratory discharge orifice movable in the direction of the orifice axis, and an outwardly opening frusto-conical diffusion head resiliently mounted on said body for fluid pressure responsive movement in the direction of said orifice axis

and spring means urging said diffusion head to a closed position.

9. Means for discharging a hollow conical vibratory spray characterized by progressive annular undulations which includes a hollow spray nozzle body, yieldably mounted means on said body defining a vibratory discharge circular orifice movable in the direction of the orifice axis, and an outwardly opening frusto-conical diffusion head spring mounted on said body for pressure responsive movement in the direction of said orifice axis, the spring mounting thereof providing for the seating of said head against said orifice to close the same in the absence of predetermined internal fluid pressure.

10. Means for discharging a hollow conical vibratory spray characterized by progressive annular undulations which includes a hollow spray nozzle body, a diaphragm carried by said body, a plug carried by said diaphragm and defining a vibratory discharge orifice, said plug being movable in the direction of said orifice axis, and an outwardly opening frusto-conical diffusion head resiliently mounted on said body for pressure responsive movement in the direction of said orifice axis, spring means urging said head against said plug, the diameter of said head being at least equal to the diameter of said orifice, said spring providing for the seating of said head against said orifice to close the same in the absence of predetermined internal pressure and to permit both axial and lateral displacement of said head with respect to said orifice in response to internal pressure.

11. Means for discharging a hollow conical vibratory spray characterized by progressive annular undulations which includes a hollow spray nozzle body, yieldably mounted means on said body defining a vibratory discharge orifice movable in the direction of the orifice axis in response to internal fluid pressure to flutter as fluid passes therethrough, and an outwardly opening frusto-conical diffusion head spring mounted on said body for pressure responsive fluttering movement both laterally and in the direction of said orifice axis.

12. A spray nozzle comprising a rigid hollow body having a discharge opening at one end thereof, a flexible diaphragm across said discharge opening, means defining a central discharge orifice in said diaphragm axially movable with the flexing of said diaphragm and characterized by an externally frusto-conical surface terminating in a sharp annular orifice edge, a diffusion head spring mounted on said body and having an inwardly directed frusto-conical surface adapted when closed to contact the sharp annular edge of the orifice to close the same.

13. A spray nozzle comprising a rigid hollow body having a discharge opening at one end thereof, a flexible diaphragm across said discharge opening, means defining a central discharge orifice in said diaphragm axially movable with the flexing of said diaphragm and characterized by an externally frusto-conical surface terminating in a sharp annular orifice edge, a diffusion head spring mounted on said body and having an inwardly directed frusto-conical surface adapted when closed to contact the sharp annular edge of the orifice to close the same, the maximum diameter of said head closely conforming to the internal diameter of said annular edge.

14. A spray nozzle comprising a rigid hollow body having a discharge opening at one end thereof, a flexible diaphragm across said discharge opening, means defining a central discharge orifice in said diaphragm axially movable with the flexing of said diaphragm and characterized by an externally frusto-conical surface terminating in a sharp annular orifice edge, a diffusion head spring mounted on said body and having an inwardly directed frusto-conical surface adapted when closed to contact the sharp annular edge of the orifice to close the same, the maximum diameter of said head closely conforming to the internal diameter of said annular edge and presenting a sharp annular edge cooperating with the sharp annular edge of said orifice to provide rapid pressure drop of

fluid passing between said orifice and said head with minimum external surface to which fluid may adhere.

15. A spray nozzle comprising a rigid hollow body having a discharge opening at one end thereof, a flexible diaphragm across said discharge opening, means defining a central discharge orifice in said diaphragm axially movable with the flexing of said diaphragm and characterized by an externally frusto-conical surface terminating in a sharp annular orifice edge, a spring mounted diffusion head suspended from within said body for axial and lateral vibratory movement, said head having an inwardly directed frusto-conical surface adapted when closed to contact the sharp annular edge of the orifice to close the same.

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