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[45] Patented Aug. 31, 1971
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# [54] LIQUID DISCHARGE NOZZLE

10 Claims, 3 Drawing Figs.

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[51] Int. Cl. ..... B05b 7/06
[50] Field of Search ..... 239/424, 424.5, 425.5, 17–23, 552, 553, 553.3, 419.5

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**ABSTRACT:** A liquid discharge nozzle having no moving parts, includes a hollow body defining a liquid inlet at one end and an outlet opening at the other end. The body has an internal chamber arranged in communication with both the inlet and outlet ends of the body. A plug, having substantial length between opposite end surfaces, is disposed across the chamber inwardly of the body-outlet end and grooves in the sidewalls of the plug define constricted liquid-outlet means from the body. An air duct extends through the plug from adjacent the body outlet to the exterior of the body between the plug and inlet end of the body.

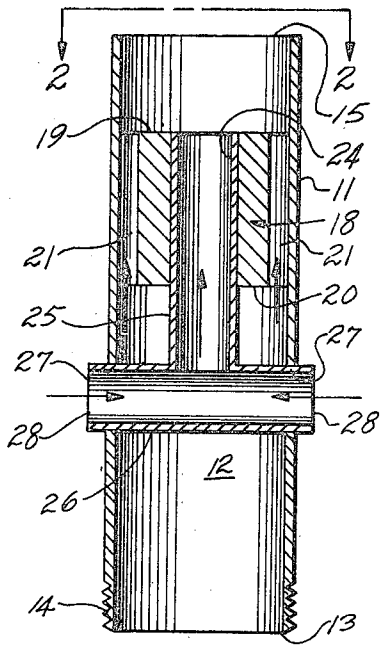

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FIG. 1

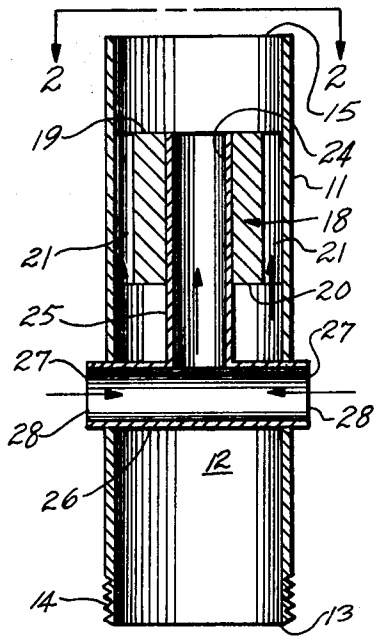



FIG. 3

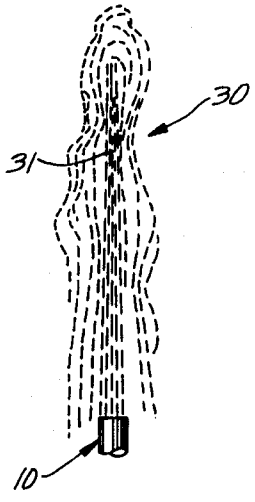
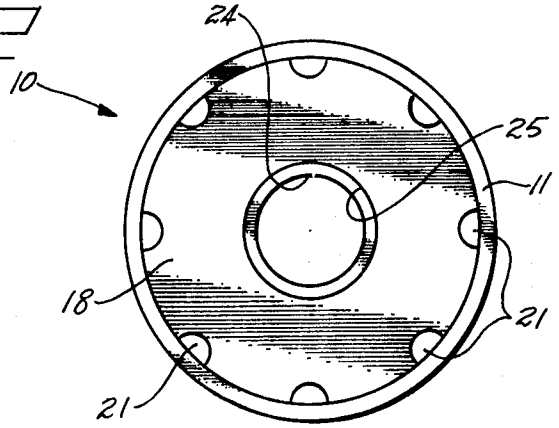



FIG. 2

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# LIQUID DISCHARGE NOZZLE

## CROSS-REFERENCE TO RELATED APPLICATION

This application is a division of copending U.S. application Ser. No. 784,541 filed Dec. 9, 1968 now U.S. Pat. No. 3,558,053, as a continuation-in-part of U.S. application Ser. No. 691,111 filed Dec. 8, 1967, now abandoned, as a continuation-in-part of U.S. Ser. No. 492,389 filed Oct. 4, 1965, now abandoned.

## BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to liquid handling and, more particularly, to nozzles for discharging aerated liquid in a predetermined pattern as in an ornamental fountain. Nozzles according to this invention are characterized by the absence of moving parts in the liquid stream.

2. Description of the Prior Art

In ornamental fountain arrangements which are to be viewed during the day without illumination by artificial light, it is desired that the discharged water be aerated as fully as possible in order that the water discharge pattern may be readily visible. Aerating fountain heads or nozzles are known. Many existing aerating fountainheads do not produce sufficient aeration of the water discharged from them. Moreover, existing aerating nozzles require critical clearances in the nozzle openings to produce the desired aeration; these clearances either become worn by erosion as the nozzle is operated, or clogged by foreign particles in the liquid passing through the nozzle head, thus adversely affecting the nozzle-aerating efficiency.

For efficiency of operation, an aerating fountain nozzle should produce the appearance of discharging a massive stream of water even though the quantity of water actually passed through the nozzle is relatively moderate. When this desired condition is obtained, a small pump may be used, thus resulting in a fountain which is economical to operate. Also, in order that they may be used in populated areas, aerating fountain nozzles should produce as little mist or fine spray as possible; mist is readily transported by slight breeze out of the fountain area to locations where viewers may be positioned. Mist also tends to mask the basic fountain discharge pattern and thus detracts from the aesthetic effect desired in the fountain.

The design of aerating liquid nozzles is often more an art than a science, especially where it is desired that the aerated liquid discharged from the nozzle follow a predetermined path from the nozzle throughout a relatively wide range of liquid pressures applied to the nozzle, and where the discharge is to be used to produce an ornamental effect. The use of techniques and principles which are effective in gas-mixing nozzles, wherein two or more gases are mixed in the nozzle structure and are discharged as a mixture, is practical in only random situations in aerating liquid nozzles because of the widely different physical properties between gases and liquids.

## SUMMARY OF THE INVENTION

This invention provides a simple, rugged, effective and efficient aerating nozzle which is particularly useful in ornamental fountain arrangements. The nozzle contains no moving parts which may wear as the nozzle is operated. Moreover, no critically sized apertures are provided in the nozzle, and thus water erosion and the presence of foreign particles in the water passed through the nozzle have little effect, if any, upon the aerating efficiency of the nozzle. The nozzle produces the appearance of a massive discharge stream even though the actual volume of water passed therethrough is moderate. Moreover, nozzles according to this invention provide liquid discharge patterns which are essentially free of objectionable mist or fine spray and which are readily visible because of the high degree of aeration of the nozzle discharge and freedom from mist.



Generally speaking, this invention provides an aerating liquid discharge nozzle which includes an elongate body defining a duct between a liquid inlet and a liquid outlet opening located at opposite ends of the body. A plug, having substantial length between its opposite end surfaces relative to the diameter of the duct, is disposed across the duct adjacent the duct outlet opening. The plug defines liquid-passage means through it, such passage means being comprised of a plurality of grooves formed in the plug sidewalls at spaced locations around the circumference of the plug. Each groove communicates between the opposite ends of the plug. The passage means has a cross-sectional area, at least adjacent the outlet end of the body, which is substantially less than the cross-sectional area of the duct through the portion of the duct in which the plug is disposed. The grooves are configured so that the boundary surfaces thereof defined by the plug intersect at a substantial angle the groove boundary surfaces defined by the walls of the duct. The plug sidewalls between adjacent grooves are engaged with the duct walls. The surface of the plug adjacent to the outlet end of the body around the opening of each of the grooves to such surface is substantially normal to the length of the plug so as to make a sharp corner with the walls of each groove. Air duct means communicate through the plug from the exterior of the body to the end of the plug adjacent the outlet end of the body for mixture of air passed through the air duct with liquid discharged from the nozzle.

## BRIEF DESCRIPTION OF THE DRAWINGS

The above-mentioned and other features of the present invention are more fully set forth in the following detailed description of the invention, the description being presented in conjunction with the accompanying drawings, wherein:

FIG. 1 is a cross-sectional elevation view of an aerating liquid discharge nozzle according to this invention;

FIG. 2 is a top plan view taken along lines 2—2 of FIG. 1; and

FIG. 3 is an elevation view of the liquid discharge pattern produced by the nozzle shown in FIG. 1.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

An aerating nozzle **10**, shown in FIG. 1, includes an elongate hollow body **11** defining a circularly cylindrical inner chamber **12** which preferably is of uniform internal diameter along its length. The lower end **13** of body **11** is open and is externally threaded **14** to define a liquid-inlet opening to chamber **12** and to adapt the body for connection to he upper end of a vertically disposed water-supply riser pipe through which water at suitable pressure is supplied to the nozzle. The chamber opens to the exterior of the nozzle across its entire diameter at an upper end **15** of the body. The upper end of body **11** should form a sharply defined shoulder with the inner walls of the body so that the generation of mist or fog in the discharge of the nozzle is avoided at this location of the nozzle structure; as shown, it is preferred that the surface-defining body upper end **15** be normal to the length of the body.

A plug **18**, having a length between parallel opposite end surfaces **19** and **20** at least equal to one-half the diameter of the chamber, is fixedly disposed across chamber **12** between the inner walls of the body at a location spaced below the open upper end of the body. Preferably, the plug is spaced below the upper end of the body a distance at least equal to one-half the maximum transverse dimension of the chamber, i.e., a distance at least equal to one-half the diameter of the chamber. The circumferential walls of the plug are engaged in surface-to-surface contact with the inner walls of the body between a plurality of grooves **21** which are formed in the sidewalls of the plug. The grooves extend between and open to the opposite ends of the plug. The grooves form water-outlet passages from the portion of the chamber between the plug and the liquid-inlet opening to the chamber. The passages are bounded in part by the inner walls of the body. The length-to-depth ratios of the grooves should have a value of at least about 2.

Grooves 21 are spaced apart from each other at regular intervals around the circumference of the plug. In nozzle 10, the grooves are aligned parallel to the axis of the chamber. Thus, the upper ends of grooves 21 define essentially the same pattern in the upper surface of the plug as the lower ends of the grooves define in the lower surface of the plug. Stated in another way, if the peripheral surface of the plug were developed onto a planar surface, it would be found that grooves 21 lie parallel to each other. Also, the grooves preferably have equal cross-sectional areas at all points along their lengths, although it is within the scope of the invention that grooves 21 may be of nonuniform cross-sectional area (as by tapering) along their lengths. The total cross-sectional area provided by the grooves is substantially less than the cross-sectional area of the chamber between the plug and the open upper end of the body.

As shown in FIG. 2, grooves 21 are of generally semicircular configuration and are closed substantially across their diameters by the inner walls of the body so that the walls of the grooves as defined by plug 18 make a substantial angle (approximately 90° in the case of the structure shown in FIG. 2) with the inner walls of the body. That is, the grooves may be as shown in FIG. 2 in which the open cross-sectional configuration of the groove is slightly less than an exact half circle and the diameter of each groove is substantially less than the diameter of body 11. On the other hand, the grooves may be deeper radially of the plug than they are wide circumferentially of the plug; in such event the inner ends of the grooves are semicircular and the walls of the grooves adjacent the circumference of the plug are parallel. In either case, the walls of the grooves intersect the circumferential surface of the plug at a substantial angle having a value of 90° or thereabouts, and adjacent grooves have their proximate walls spaced apart a distance at least equal to the width of one of the grooves circumferentially of the plug. The existence of a substantial angle between the plug-defined groove walls and the body-defined groove walls prevent the generation of mist producing thin sheets of water in the discharge pattern of the nozzle.

The upper surface 19 of the plug is substantially normal to the lengths of the plug and the grooves about the upper end of each groove and makes a sharp corner with the groove walls as defined by the plug. Thus, the water stream emerging from each groove separates cleanly, without the generation of mist, fog or fine spray from the plug.

As shown in FIG. 1, the inner walls of the body between the plug and the open upper end of the body are straight.

A bore 24 is formed axially through the plug. A hollow tube 25 is fitted into the lower end of the bore sufficiently tightly that water supplied under pressure to the chamber below the plug cannot pass through the bore between the plug and the tube. Preferably, as shown in FIG. 1, the tube has an open upper end lying in the plane of the upper end of the plug. The tube extends downwardly from the plug into chamber 12 to a T-joint where the tube branches into oppositely extending lateral extensions 26. The lateral extensions of the tube pass through diametrically opposed apertures 27 in the body below the plug. The extensions terminate in open outer ends 28 exteriorly of the body. The apertures form a liquid-tight seal with the outer surfaces of the tube extensions.

When water is supplied under pressure to vertically oriented nozzle 10 through the lower end of the nozzle, the nozzle operates to produce an aerated column or plume 30 of water as shown in FIG. 3. Column 30 has a converging rising portion 31. In other words, the several jets of water which issue from grooves 21 converge upon each other above the open upper end of the nozzle. Nozzle 10, because of the convergence or tapering of the rising column of aerated water which issues from it, is especially useful in fountains which must be operated in wind because the discharge column produced by this nozzle retains its character quite well in wind.

Tube 25 may be extended above the surface of plug 18, if desired, without adversely affecting the performance of the nozzle and without departing from the scope of this invention.

An aerating nozzle like that shown in FIG. 1 has been operated successfully over a wide range of supply water pressures to produce the water discharge pattern shown in FIG. 3. This nozzle has a body fabricated of polyvinyl chloride pipe having an inner diameter of 2 5/16 inches. A polyvinyl chloride plug 2 inches thick is mounted in the body 1¼ inches below the upper end of the body. Eight semicircular vertical grooves each having a radius of ¼ inch and a uniform depth of ¼ inch, are provided at regular intervals around the circumference of the plug. A length of ¾-inch thin-walled brass tubing extends from the top of the plug axially through the plug to lateral extensions communicating to the exterior of the body below the plug; the tube extensions are also fabricated of ¾-inch thin-walled brass tube. The nozzle has a back pressure of 30 pounds per square inch when passing 110 gallons of water per minute. The column defined by the discharge from the nozzle reaches a height of approximately 30 feet and falls back to earth within a circle 10 feet in diameter.

From the foregoing, it is apparent that this invention provides a novel, highly useful water discharge nozzle. These nozzles are particularly useful in ornamental fountain arrangements, but may be used in other applications as desired. For example, nozzle 10 may be used as a fire nozzle if desired. The nozzle described above produces a high degree of aeration in the liquid passing through it without relying upon any moving parts or critically sized openings to accomplish this aeration. Preferably, the nozzle is fabricated entirely from polyvinyl chloride or some similar plastic; thus this nozzle is highly resistant to he effects of water erosion and has long life expectancy under adverse conditions. The nozzle has the feature that the water discharge pattern produced by the nozzle is remarkably free of mist, fog, or fine spray.

In the foregoing description, specific geometrical arrangements and dimensional relationships, and even specific dimensions, have been set forth merely for the purposes of example and explanation of this invention; only in certain instances have specified features of the nozzle been stated to be critical. Accordingly, it will be apparent to those skilled in the art that modifications and alterations in the above-described nozzle may be made without departing from the scope of this invention.

What is claimed is:

1. An aerating liquid-discharge nozzle comprising an elongate body having opposite open ends defining a duct therethrough between a liquid inlet opening defined by one of said open ends of the body and the other of said open ends of the body; a plug having substantial length between opposite ends thereof relative to the diameter of the duct disposed across the duct adjacent the other open end of the body and secured from movement along the length of the body; the plug being engaged around its periphery with the inner walls of the duct; the plug having liquid flow passage means therethrough comprised by a plurality of grooves formed in the sidewalls of the plug and communicating between the opposite ends of the plug; the grooves and the inner walls of the body cooperating to define a corresponding plurality of liquid outlet passages; the liquid-flow passage means having an aggregate cross-sectional area, at least adjacent the other end of the body, substantially less than the cross-sectional area of the duct at the location of the plug in the duct; the surface of the plug adjacent the other end of the body being substantially normal to the elongate extent of the plug peripherally of the opening of each groove to said surface; and air duct means communicating through the plug from the exterior of the body to the end of the plug adjacent the other end of the body for mixture of air passed therethrough with liquid discharged from the nozzle.

2. A nozzle according to claim 1 wherein the plug is spaced along the duct toward the one end of the body from the other end of the body.

3. A nozzle according to claim 1 wherein the ends of the grooves at opposite ends of the plug are arranged in substantially identical patterns.

4. A nozzle according to claim 3 wherein the grooves are parallel to each other and to the length of the duct.

5. A nozzle according to claim 1 wherein the grooves have sidewalls which intersect the plug sidewalls and the walls of the duct at a substantial angle.

6. A nozzle according to claim 5 wherein the proximate walls of adjacent grooves at the periphery of the plug are spaced apart along said periphery a distance at least equal to substantially the width of one of the grooves.

7. A nozzle according to claim 1 wherein the grooves are spaced uniformly around the circumference of the plug.

8. A nozzle according to claim 1 wherein the grooves provide the only flow path of liquid from the liquid inlet opening to the exterior of the body.

9. A nozzle according to claim 1 wherein the air duct means comprises an air duct at one end thereof communicating with the exterior of the body at a location between the plug and the inlet end of the body and at the other end thereof opening axially of the body through the end of the plug adjacent the outlet end of the body.

10. A nozzle according to claim 9 wherein the air duct extends from said one end coaxially of the plug to a location between the plug and the inlet end of the body where the air duct branches laterally into communication with the exterior of the body.