United States Patent

Hruby, Jr.

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[54] MULTITIER ORNAMENTAL FOUNTAIN

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[73] Assignee: **Rain Jet Corp.**, Burbank, Calif.

[22] Filed: **Oct. 5, 1970**

[21] Appl. No.: **78,117**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 784,541, Dec. 9, 1968, Pat. No. 3,558,053, which is a continuation-in-part of Ser. No. 691,111, Dec. 8, 1967, abandoned, which is a continuation-in-part of Ser. No. 492,389, Oct. 4, 1965, abandoned.

[52] **U.S. Cl.** **239/17,** 239/428.5, 239/488

[51] **Int. Cl.** **B05b 17/08**

[58] **Field of Search** 239/17, 428.5, 488, 23, 552, 239/553, 553.3

[56] **References Cited**

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Assistant Examiner—Michael Y. Mar

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[57] **ABSTRACT**

An ornamental fountain nozzle includes an elongate tubular body having a duct formed therethrough between opposite open ends of the body. An elongate plug is disposed across the duct inwardly of the body adjacent its outlet end and has its periphery engaged with the walls of the duct. A plurality of tapered grooves are formed in the sidewalls of the plug at regular intervals around the plug and are inclined in a skew manner to the axis of the duct. A hollow open-ended tube is disposed coaxially of the duct through the plug so that liquid introduced to the inlet end of the body flows through the tapered skew plug grooves to define the lower tier of a fountain discharge pattern and also flows through the central tube to define an upper central tier of the pattern.

28 Claims, 9 Drawing Figures

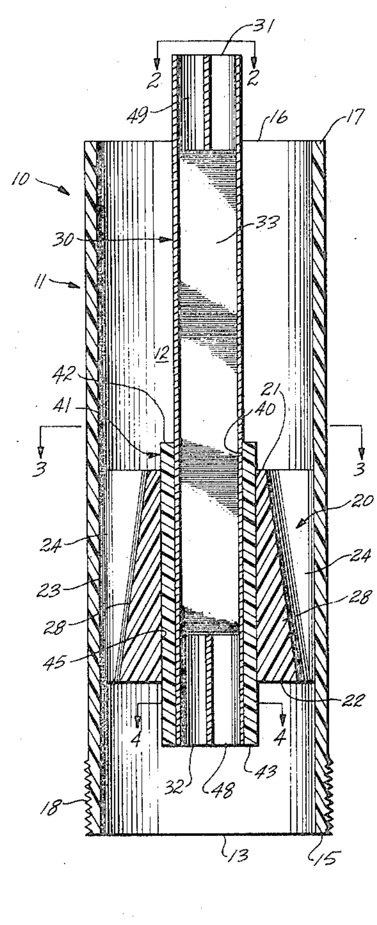

FIG. 1

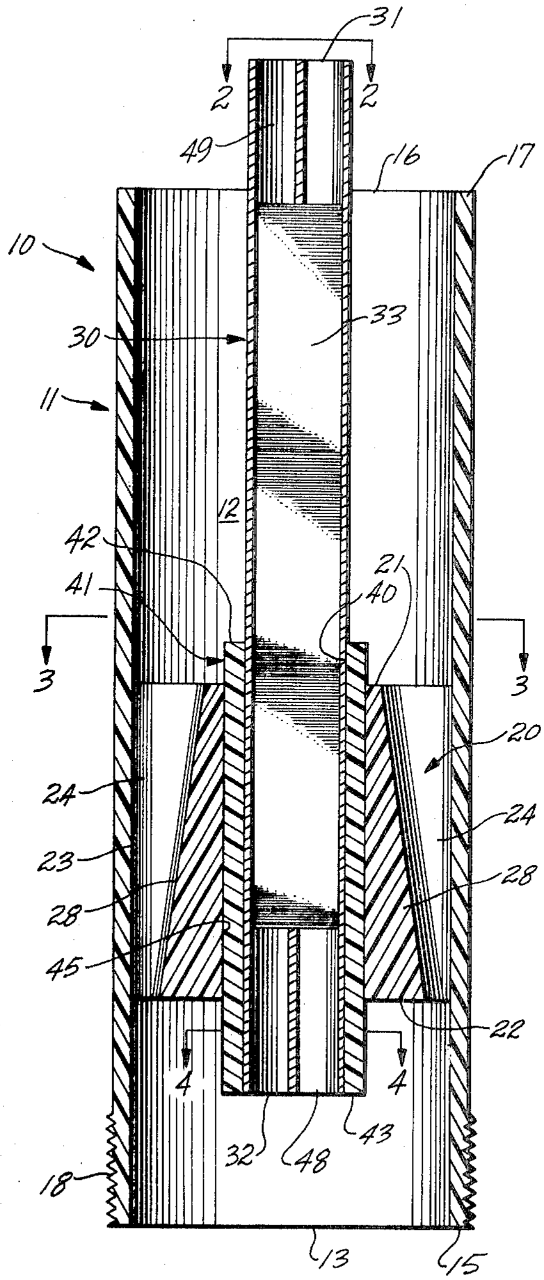

FIG. 3

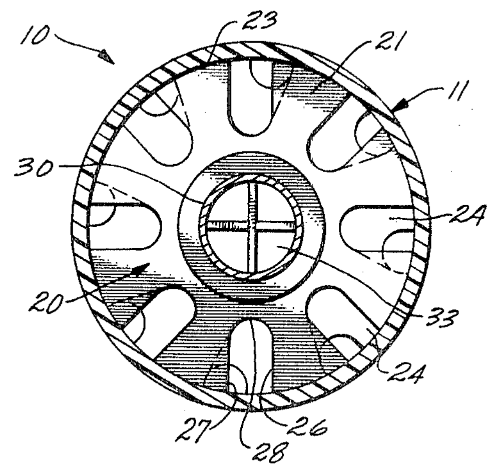

FIG. 7

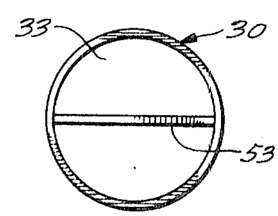

FIG. 2

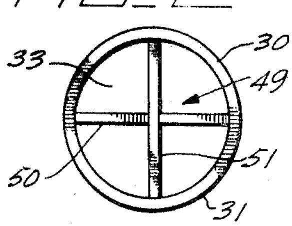

FIG. 4

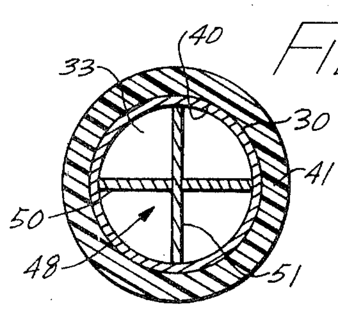

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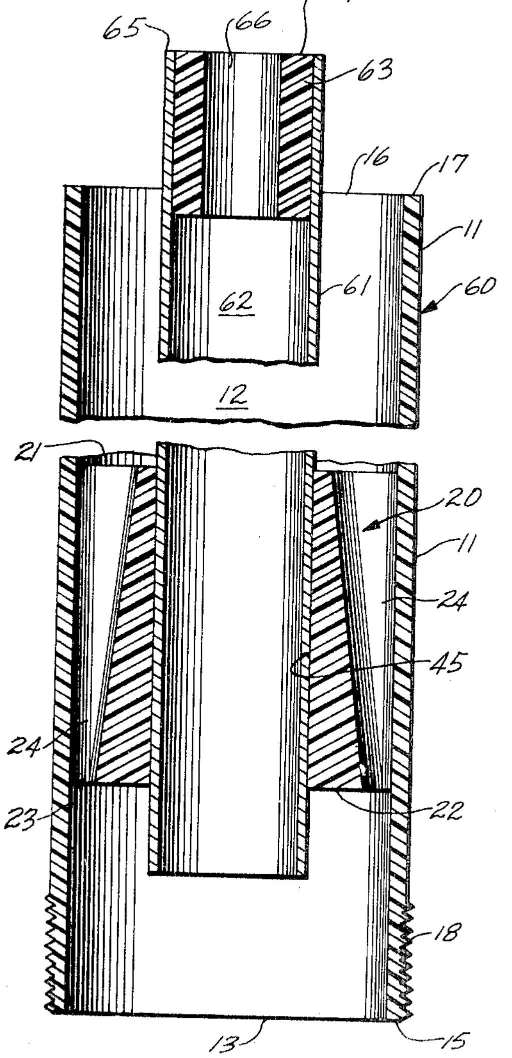
FIG_8



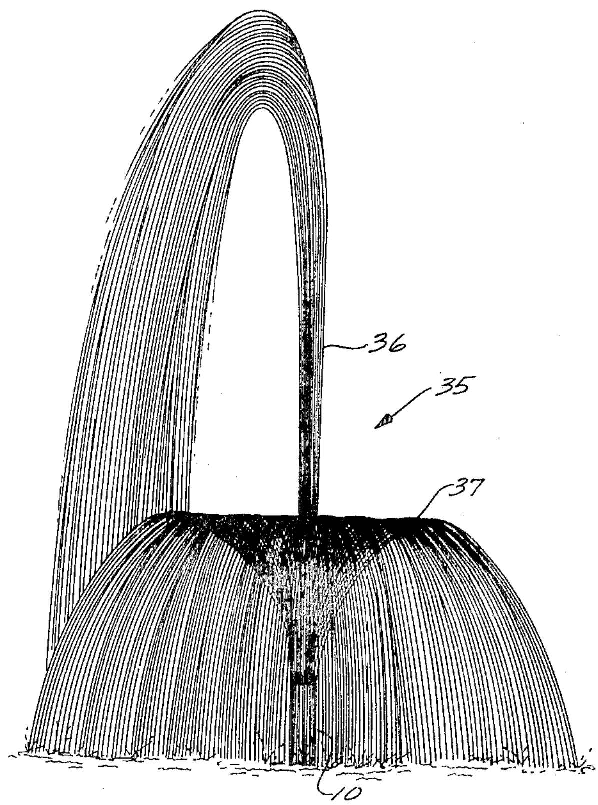


FIG_5

FIG_6

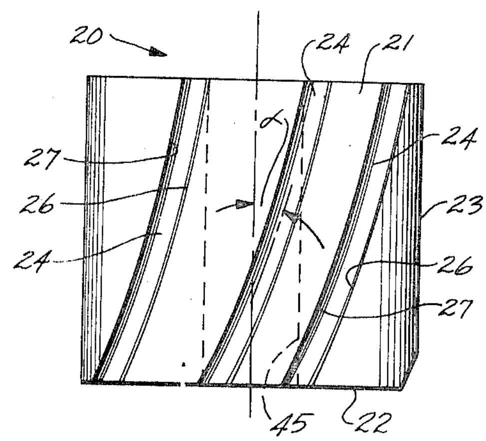
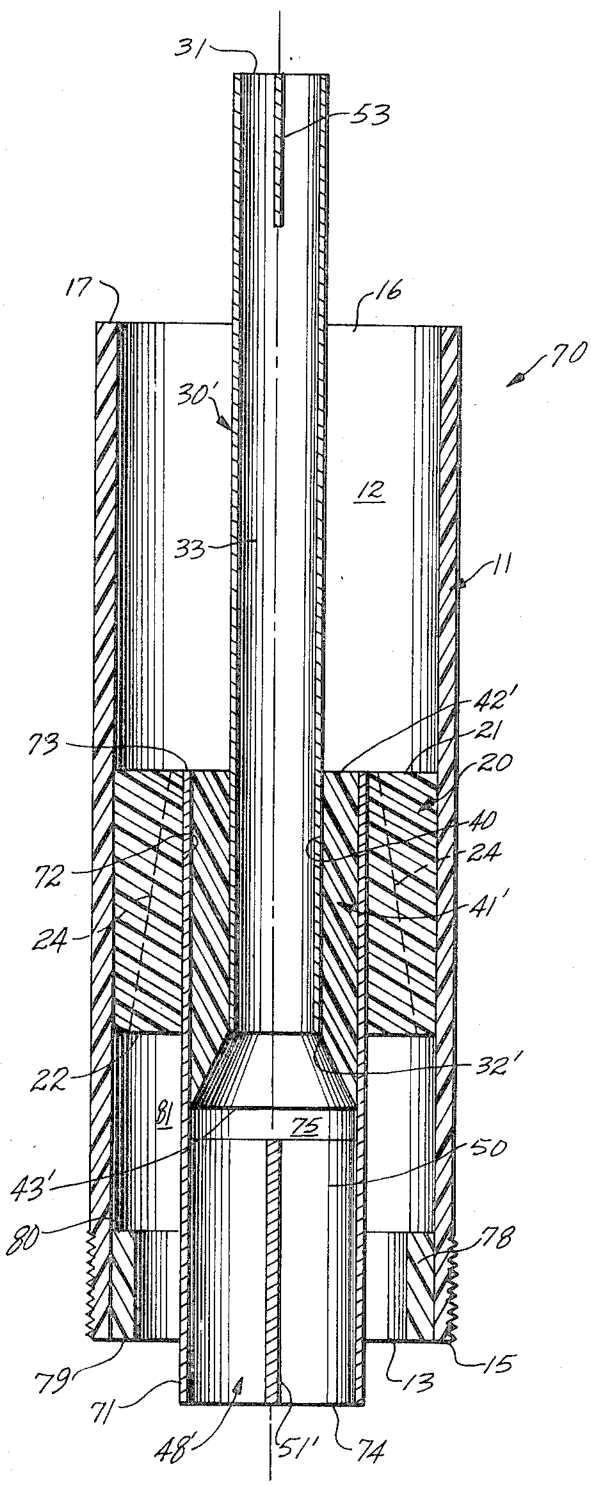


FIG_9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MULTITIER ORNAMENTAL FOUNTAIN

CROSS-REFERENCE TO RELATED APPLICATIONS

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

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to liquid handling and, more particularly, to aerating ornamental fountain nozzles.

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 fountainheads or nozzles are known. Present fountainheads, however, produce only a limited number of water discharge patterns. Many existing fountainheads do not produce sufficient aeration of the water discharged from them. Moreover, many existing aerating nozzles contain moving parts which wear as the nozzle is operated. In other cases, 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, 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 a slight breeze out of the fountain area to locations where viewers may be positioned. Mist also tends to mask the basic discharge pattern, and thus detracts from the aesthetic effect desired in the fountain.

The design of aerating liquid nozzles is often more of 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 supplied to the nozzle, and where the nozzle 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 ornamental fountain nozzle. 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 passing through the nozzle has little, if any, effect upon the aerating efficiency of the nozzle. The nozzle produces the appearance of a relatively massive discharge stream even though the actual volume of water passed through the nozzle is moderate. Nozzles according to this invention provide an exceptionally attractive multitier fountain pattern which is essentially free of objectionable mist or fine spray and which is readily visible because of the high degree of aeration of the nozzle discharge and freedom from mist.

Generally speaking, this invention provides an ornamental fountain nozzle which includes an elongate tubular body defining a duct through its length between liquid inlet and outlet openings defined across opposite open ends of the body. A plug having substantial length relative to the diameter of the duct is disposed across the duct inwardly of the body outlet end and adjacent to such end of the body. The plug is secured from movement along the length of the body. The plug has its periphery engaged with the inner walls of the duct. A plurality of grooves are formed in the sidewalls of the plug and communicate between the opposite ends of the plug. The grooves and the inner walls of the body cooperate to define a corresponding plurality of liquid outlet passages which have an aggregate cross-sectional area at least adjacent the outlet end of the body substantially less than the cross-sectional area of the duct. The surface of the plug adjacent the outlet end of the body, peripherally of the opening of each groove to such surface, defines a sharp corner with those walls of the grooves which are formed by the plug. A hollow tube extends axially of the body from a lower end communicating with the duct on the side of the plug toward the liquid inlet opening through the plug to an upper end spaced toward the outlet end of the body from the plug.

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, which description is presented in conjunction with the accompanying drawings, wherein:

FIG. 1 is a cross-sectional elevation view of an ornamental fountain nozzle according to this invention;

FIG. 2 is a plan view taken along line 2—2 in FIG. 1;

FIG. 3 is a cross-sectional plan view taken along line 3—3 in FIG. 1;

FIG. 4 is a cross-sectional plan view taken along line 4—4 in FIG. 1;

FIG. 5 is a elevation view of the discharge pattern produced by the nozzle shown in FIG. 1;

FIG. 6 is an elevation view of a typical insert plug encountered in a nozzle according to this invention;

FIG. 7 is a view similar to that of FIG. 2 showing another form of structure which may be used in a nozzle according to this invention;

FIG. 8 is a fragmentary cross-sectional elevation view of the upper end of the central tube of another nozzle according to this invention; and

FIG. 9 is a cross-sectional elevation view of another nozzle according to this invention.

DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

An aerating ornamental fountain nozzle **10**, shown in FIG. 1, includes an elongate tubular body **11** which defines an elongate duct **12** therein. The duct extends from an inlet opening **13** defined across an open lower end **15** of the body to an outlet opening **16** defined across an open upper end **17** of the body. Adjacent its lower end, the exterior of the body is threaded, as at **18**, to adapt the body to be connected to the correspondingly threaded upper end of a water supply pipe or the like (not shown) through which water at appropriate pressure is supplied to nozzle **10**. As shown in FIG. 1, it is preferred that duct **12** be of right circular cylindrical configuration and have a constant diameter along its length between the upper and lower ends of the body. Preferably, body **11** is fabricated from a length of polyvinyl chloride pipe, although it is within the scope of this invention that other materials may be used, or that the body may be fabricated of something other than a length of pipe. In any event, duct **12** extends without restriction from the open upper end of the body for a substantial distance along the length of the body, preferably to the liquid inlet opening defined at its lower end.

A plug **20**, also preferably fabricated of polyvinyl chloride, having opposite parallel planar end surfaces **21** and **22** is disposed transversely across the interior of body **11** at a location on the body spaced below its open upper end **17**. The plug has its circumferential surface **23** in surface-to-surface contact with the inner walls of the body. A plurality of grooves **24** (shown best in FIGS. **3** and **6**) are formed in the sidewalls of the plug at regular intervals around the entire circumference of the plug. The grooves extend along the entire length of the plug so that they communicate with duct **12** on opposite sides of the plug. Preferably, the spacing between grooves **24** around the circumference of plug **20** is such that the distance at the periphery of the plug between sidewalls **26** and **27** of adjacent grooves approximates or is greater than the distance between walls **26, 27** of a single groove.

As shown in FIGS. **1** and **3**, the grooves are tapered along their length so that they have their minimum cross-sectional area adjacent body lower end **15** and have their greatest cross-sectional area adjacent body upper end **17**. Preferably, the taper of the grooves is linear, although tapers other than linear tapers may be used if desired. The grooves may be formed in the sidewalls of plug **20** by the use of a ball end mill so that the grooves (see FIG. **3**) have sidewalls **26** and **27** which are parallel to each other essentially radially of the plug outwardly of a semicircularly configured base portion **28** formed along that portion of each groove adjacent the axis of the plug. It has been found to be satisfactory if the grooves, at their lower ends, are approximately half as deep as they are wide and, at their upper ends, are at least as deep as, or deeper than they are wide (see FIG. **3**). Regardless of how the grooves are actually defined in the plug, the groove sidewalls **26** and **27** make a substantial angle, essentially a right angle, with plug circumferential surface **23** notwithstanding the fact that the grooves are skew to the length of the plug as described below. The existence of a substantial angle between groove sidewalls **26** and **27** and the circumferential walls of the plug, in concert with the surface-to-surface engagement of plug surface **23** with the body between grooves **24**, prevents the generation of thin sheets of water in the discharge pattern created during operation of nozzle **10**. Thin sheets of water in the discharge pattern from the nozzle readily degrade, especially in the presence of a breeze, into mist and fine spray which are objectionable for the reasons set forth above.

As shown best in FIG. **6**, plug grooves **24** are formed in the plug to be skew to the length of the plug, the extent of the angle of skew to the grooves being represented by angle α. The angle of skew of the grooves relative to the length of the plug may be as much as about 30° or so, but not more than 45°. Preferably, eight grooves **24** are formed around the circumference of the plug and are uniformly spaced from each other around the plug. As shown in FIG. **3**, the width of each groove, i.e., the dimension of the groove circumferentially of the plug, is substantially less than the diameter of duct **12**, with the result that the walls of the grooves at the point of intersection thereof with the inner walls of body **11** lie at approximately 90° to the inner walls of the body. Because the value of angle α preferably is approximately 30° or so, this nearly right-angle relationship between the inner walls of the body and groove sidewalls **26** and **27** at the periphery of the plug is not significantly modified by the deviation of the length of the grooves out of exact parallelism to the length of the body.

All of the grooves are skew to the axis of the plug in the same sense. That is, the upper ends of the grooves are all displaced in the same direction relative to their lower ends, as shown in FIG. **3**. Stated in another way, if the peripheral surface of the plug were developed onto a planar surface, it would be found that grooves **24** lie parallel to each other.

The combined cross-sectional areas of the grooves at plug upper end surface **21** is substantially less than the cross-sectional area of duct **12** below the plug, and at the liquid inlet opening to nozzle **10**. Preferably, the plug has a thickness axially of the duct which is at least equal to the diameter of duct **12** at the location of the plug across the duct, i.e., the plug is at least square in terms of its length to its diameter. Also, each groove **24** preferably has a length at least twice as long as the mean depth of the groove radially of the plug, and may advantageously have a length several times its mean depth.

The upper surface **21** of the plug, peripherally of the opening of each groove **24** to such surface, is substantially normal to the elongate extent of the plug so that the water stream emerging from each groove separates cleanly from the plug, without generation of mist, fog or fine spray, by passing a relatively sharp corner defined by plug sidewalls **26, 27, 28** and by plug surface **21**. As shown in FIG. **1**, it is also preferred that the body at upper end **17** form a sharp corner with the walls of the duct so that the generation of fine spray, mist or fog in the discharge of the nozzle is avoided at this location of the nozzle structure.

An elongate open-ended tube **30**, defining a liquid flow passage **33** along its length, is disposed coaxially of duct **12** and extends through plug **20**, as shown in FIG. **1**. Tube **30** has an outer diameter which is substantially less than the diameter of duct **12** and preferably is less than the distance diametrically of the plug between base portions **28** of diametrically opposed grooves **24** at the upper end of the plug. Tube **30** has an upper end **31** which is spaced from the plug toward the upper end of the body and preferably, as shown in FIG. **1**, is disposed above body upper end **17**. Tube **30** has a lower end **32** which preferably is spaced from plug lower surface **22** toward body lower end **15** within the length of duct **12**, although it is within the scope of this invention that the lower end of tube **30** may be located at the lower end of plug **20**. In a presently preferred fountain nozzle according to this invention, tube **30** is defined by a length of thin-walled brass tubing. The total effective water flow area through plug **20** via grooves **24** and tube **30** is no greater than, and preferably is substantially less than the area of duct **12** below the plug to and including the area of liquid inlet opening **13** to the nozzle. Accordingly, the extent to which water is aerated by nozzle **10** is determined by the structure of the nozzle itself rather than by other structure, or by a varying aeration characteristic in water presented to the nozzle. Therefore, when nozzle **10** is connected to the upper end of a water supply riser pipe or to a suitable fountain base so as to have a vertical attitude, and water at suitable pressure is supplied to the nozzle, the nozzle operates to form ornamental fountain discharge pattern **35** shown in FIG. **5**. Discharge pattern **35** is comprised of a central vertical aerated column of water **36** and an inverted symmetrical cone **37** of aerated water immediately above the nozzle. The central column of water is provided by water emerging from the nozzle through coaxial tube **30**, while the cone **37** of the pattern is provided by water emerging through skew grooves **24** in plug **20**. As water flowing through the grooves emerges into duct **12** above plug **20**, such water is spiralling upwardly and around the inner walls of body **11**. As such water passes body upper end **17**, the centrifugal force i such water causes the water to move upwardly and outwardly from the axis of the nozzle, thereby to define inverted cone **37**.

Water discharge pattern **35** has been produced over a wide range of applied water pressures by a nozzle having a body defined by a length of polyvinyl chloride pipe having an inner diameter of 3.80 inches. A plug having an axial length of 3 inches is located 6½ inches below the open upper end of the body. Tube **30** is fabricated of 1 inch nominal diameter thin-walled brass tubing and has its upper end located 8¾ inches above the upper surface of the plug. Eight grooves are formed in the circumference of the plug; each groove has a radius of ⅜ inch, and the depth of each groove increases from 0.300 inch at the bottom of the plug to 0.450 inch at the top of the plug. The value of skew angle α for this nozzle is 30°. When passing 328 gallons of water per minute at a nozzle back pressure of 17 pounds per square inch, the discharge pattern produced by the nozzle is approximately 20 feet high, and 25 feet in diameter.

The basic utility and success of a fountain nozzle is inseparably related to the character of discharge pattern produced by the nozzle in operation. The character of the discharge pattern, in the last analysis, is judged by aesthetic considerations which are difficult of definition. The aesthetics of a given fountain pattern cannot be evaluated in the abstract, but rather must be evaluated in the context of the environment within which the fountain is used. That is, a given fountain pattern may be regarded as extremely beautiful in the context of its surroundings in one application, whereas the same pattern produced by the same fountain nozzle may be regarded as considerably less appealing in a different application and setting. For this reason, the physical proportions of fountain pattern 35 should be adjustable to the specific environment and setting within which nozzle 10 is used; this suggests that fountain nozzles 10 must be custom-built for specific usages. Custom-built nozzles, however, are expensive since the final structure of a custom-built fountain nozzle can be defined only by an extensive trial and error procedure in the intended setting. To enable control over the proportions of fountain patterns 35 and to minimize the extent to which nozzles of the type illustrated by nozzle 10 are subject to custom-manufacturing requirements, nozzle 10 includes certain structural features in addition to those already discussed above.

As shown in FIG. 1, axial tube 30 of nozzle 10 is disposed within an axial bore 40 formed through a concentric sleeve 41 disposed coaxially of plug 20 in an axial bore 45 through the plug. Sleeve 41 has an upper end 42 which, as shown, is disposed a short distance above plug upper surface 21 or which may be disposed at or below plug top surface 21, as desired. The sleeve also has a lower end 43 which is disposed below plug lower surface 22 preferably in the plane of tube lower end 32. The diameter of plug bore 45 is less than the distance, measured at the upper end of plug 20, between the most proximate portions of diametrically opposed pairs of grooves 24. Preferably sleeve 41, like plug 20, is fabricated of polyvinyl chloride so that, once the appropriate position of the sleeve axially relative to tube 30 and plug 20 has been determined, the sleeve may be secured in place in the plug by solvent bonding techniques.

The external diameter of sleeve 41 below plug lower surface 22 is variable, at the site at which nozzle 10 is to be installed (if desired), to effectively regulate the volume of water flowing through grooves 24 to define pattern lower tier 37 relative to the volume of water which flows through tube 30 to define central column 36 of the discharge pattern. In effect, the greater the diameter of the sleeve between the lower end of tube 30 and the lower end of plug 20, the greater will be the throttling effect on water entering grooves 24 from the lower end of duct 12. Such throttling effect has a direct effect upon the diameter and height of inverted conical portion 37 of discharge pattern 35 relative to central plume 36. Stated in another way, this throttling effect produced by the size of the lower end of sleeve 41 determines the relative heights of the upper and lower tiers of fountain pattern 35 for a given flow rate of water to nozzle 10. As a practical matter, the portion of sleeve 41 below plug end surface 22 functions as a flow-regulating choke collar around the lower portion of tube 30.

The outer diameter of the lower end of sleeve 41 is readily changed at the site of installation of nozzle 10 since it is preferred that such sleeve be fabricated of polyvinyl chloride, which material is readily worked by simple tools. Once the specific configuration of the lower end of the sleeve has been determined empirically at the site of use of the fountain nozzle, the sleeve is secured into plug 20, preferably by solvent bonding techniques, to fix the position of the sleeve into the plug. Preferably the tube 30 is force-fitted into sleeve bore 40 such that positioning of sleeve 41 relative to plug 20 fixes the position of tube 30 relative to plug 20.

It is desirable that central plume 36 of fountain discharge pattern 35 be as straight and coherent as possible for best aesthetic values and definition of the fountain pattern. To assure that water flowing through tube 30 during use of nozzle 10 is directed upwardly, thereby to define a coherent column 36 of the greatest height possible, stream-straightening baffles 48 and 49 are provided at the lower and upper ends, respectively of tube 30. As shown best by FIGS. 4 and 2, baffles 48 and 49, respectively, are essentially identical and are of cruciform configuration. Each baffle is defined by perpendicularly crossed, vertically disposed thin metal plates 50 and 51 force-fitted or soldered into the adjacent ends of tube 30. As shown in FIG. 7, however, a single flat plate 53 disposed diametrically of the interior of tube 30 may be used as an alternate to stream straighteners 48 and 49. The baffle configuration shown FIGS. 2 and 4, however, is preferred to that shown in FIG. 7 since the structure of baffles 48 and 49 provides more complete control over the flow characteristics of water emerging from tube 30.

Another nozzle 60, which provides much the same benefits of control over the proportions of discharge pattern 35 as nozzle 10, is illustrated in FIG. 8. Nozzle 60 includes a tubular body 11 and a peripherally grooved plug 20 in which grooves 24 are tapered and disposed skew to the length of the plug in accord with the foregoing description; these components of nozzle 60 are identical to those correspondingly numbered components of nozzle 10. Nozzle 60 differs from nozzle 10 in the details of the coaxial tube 61 provided through the nozzle. Tube 61 is open-ended to define a central liquid flow passage 62 through the nozzle from below plug 20 to adjacent the open upper end of body 11. Tube 61 has an outer diameter corresponding to the diameter of axial bore 45 through plug 20. An axially bored bushing 63 is fitted into the upper end of tube 61 to have its upper end 64 coextensive with upper end 65 of tube 61. Bushing 63 has an axial bore 66 which has a diameter essentially equal to the inner diameter of tube 30. Preferably, bushing 63 is configured so that bore 66 is at least as long as and preferably is longer than the diameter of such bore. Bushing 63 is secured from axial movement along tube 61 as by force-fitting the bushing into the tube.

The presence of bushing 63 in tube 61 determines the effective waterflow area of passage 62 and therefore, in the context of the overall structure of nozzle 60, is significant in determining the volume of water which flows through tube 61 relative to the volume of water which flows through plug grooves 24.

Another nozzle 70 according to this invention is shown in FIG. 9. Nozzle 70 includes some components which are identical to the components of nozzles 10 and 60; therefore the same part numbers are used with respect to these components. Other components of nozzle 70 are very similar to components of nozzles 10 and 60 and thus are given primed reference numbers to signify the similarity. Thus, nozzle 70 includes an elongate tubular body 11 defining an elongate duct 12 through its length. The duct has a liquid inlet opening 13 defined across a lower end 15 of the body, and a liquid outlet opening 16 defined across the upper end 17 of the body. A plug 20, in accord with the foregoing description, is disposed across duct 12 adjacent the outlet end of the duct in the manner described above. Thus, plug 20 has upper and lower parallel end surfaces 21 and 22 which preferably are perpendicular to the length of duct 12 and a plurality of skew-tapered grooves 24 formed in the sidewalls of the plug.

A tube 71, preferably a thin-walled brass tubing and having a diameter similar to the diameter of tube 61 of nozzle 60, is intimately engaged in a circular bore 72 formed coaxially through plug 20. Tube 74 preferably has its upper end 73 located in the plane of plug upper end surface 21 and preferably has its lower end 74 located below lower end 15 of body tube 11. A chamber 75 is provided inside tube 71 below plug 20. A cruciform stream straightening baffle assembly 48′ is disposed in tube 71 adjacent its lower end and is composed of a pair of perpendicular plates 50′ and 51′. Baffle plates 50′ and 51′ preferably are defined of sheets of polyvinyl chloride rather than metal as is the case with plates 50 and 51 of baffle 48 encountered in nozzle 10.

A central liquid discharge tube 30′ extends coaxially of nozzle 70 from a lower end 32′, preferably coextensive with the lower end surface 22 of plug 20. Tube 30′ has its upper end 31 disposed outwardly of nozzle body 11 as shown in FIG. 9. A liquid flow passage 33 is defined within tube 30′ coaxially of body 11 and preferably has a single stream-straightening baffle 53 disposed diametrically thereacross at its upper end as shown in FIG. 9 in a manner consistent with the illustration of

FIG. 7. Adjacent its lower end, tube 30' has its outer surface intimately engaged within a coaxial bore 40 formed through an annular sleeve 41'. The outer surface of annular sleeve 41' is intimately engaged with the inner surface of tube 71 adjacent the upper end of such tube. Thus, as shown in FIG. 1, sleeve 41' has a length which is a small amount greater than the length of plug 20 and is so disposed relative to the plug that its upper end surface 42' is coplanar with plug end surface 21 and its lower surface 43' is below plug lower end surface 22. In this manner, chamber 75, having a diameter greater than the diameter of passage 33 through tube 30', is defined within tube 71 below tube 30'.

It has been found that stream-straightening baffle 48' functions best when it operates upon liquid flowing past it at a relatively low velocity. Accordingly, tube 71 has a diameter which is substantially greater than the diameter of coaxial liquid discharge tube 30'. The liquid which flows through tube 71, when the externally threaded lower end of body 11 is engaged with a suitable fountain base or riser pipe, moves with a velocity which is substantially less than the velocity of the liquid flowing through passage 33. Thus, stream-straightening baffle assembly 48' operates efficiently upon liquid flowing through chamber 75 to effectively control and enhance the aesthetic characteristics of central plume 36 of fountain discharge pattern 35. To facilitate the smooth transfer of fluid from chamber 75 to coaxial discharge passage 33, the lower end of bore 40 through sleeve 41' is flared outwardly, as shown in FIG. 9, to fair the boundaries of chamber 75 into passage 33.

The enlarged diameter of tube 71 relative to the diameter of tube 30' provides some measure of control over the relative quantities of liquid used to define central plume 36 and inverted cone 37 of discharge pattern 35. That is, an annular chamber 81 is defined in nozzle 70 below plug 20 around the exterior of tube 71. Only liquid present in this chamber may enter grooves 24 for discharge from the nozzle as inverted cone 37. The enlarged diameter of tube 71 relative to that of tube 30' provides that chamber 81 has relatively small volume. Further control over the quantity of liquid-defining lower tier 37 of fountain pattern 35, relative to the quantity of water-defining central plume 36, is further provided by a throttling ring 78. Throttling ring 78 cooperates with the inner surface of duct 12 immediately adjacent lower end 15 of body 11. Thus, when nozzle 70 is secured to a suitable fountain base or riser pipe, throttling ring 78 cooperates with the exterior of tube 71 to provide a restricted annular inlet opening to chamber 81 and grooves 24.

Preferably, throttling ring 78 and sleeve 41' of nozzle 70 are fabricated of polyvinyl chloride. The throttling ring is suitably secured to body 11 by solvent or ultrasonic bonding techniques, as desired. Sleeve 41' is secured between tubes 71 and 30' by interference fits, which securing mechanism is also relied upon to fix tube 71 in plug 20.

Preferably water is supplied to nozzles 10, 60 and 70 at relatively high-pressure, such pressure being required to define the central plume 36 of discharge pattern 35 at the desired height. Some of the mechanisms relied upon to control the height of inverted cone 37 relative to central plume 36 have already been described. The relative height of cone 37 to plume 36 is also determined in substantial part by the taper of grooves 24. The total quantity of water which emerges from nozzles 10, 60 and 70 to define inverted cones 37 is principally dependent upon the aggregate cross-sectional area of grooves 24 at their lower ends. The extent to which the cross-sectional area of the grooves increases along the length of plug 20 is pertinent to the velocity with which such water emerges from the nozzle; the velocity of such water as it emerges from the nozzle in turn controls the height and spread of inverted cone 37. Specifically, the velocity of water entering grooves 24 is reduced by an amount related to the difference in the cross-sectional area of the grooves between their lower and upper ends, such area change being determined in principal part by the taper of grooves 24. In view of what has been described above, therefore, it is apparent that subtle changes in the effective waterflow area of grooves 24 and of the taper of such grooves will have significant effects upon the aesthetic properties of discharge pattern 35.

In the foregoing description, certain specific structures and structural relationships have been set forth for the purposes of example and illustration. Workers skilled in the art to which this invention pertains will readily appreciate that changes in the described structure may be made without departing from the scope of the invention. Accordingly, the foregoing description should not be regarded as limiting the scope of this invention.

What is claimed is:

1. An ornamental fountain nozzle comprising an elongate tubular body defining a duct therethrough between opposite open liquid inlet and outlet ends of the body, a plug having substantial length relative to the diameter of the duct disposed across the duct inwardly of the body outlet end adjacent thereto and secured from movement along the length of the body, the plug being engaged around its periphery with the duct walls, a plurality of grooves formed in the plug sidewalls and communicating between the opposite ends of the plug, the surface of the plug adjacent the body outlet end being substantially normal to the elongate extent of the plug peripherally of the opening of each groove to said surface and defining sharp corners with those walls of the grooves which are defined by the plug, and an open-ended tube extending axially of the body from a lower end communicating with the duct on the side of the plug toward the body inlet end through the plug to an end spaced toward the body outlet end from the plug.

2. Apparatus according to claim 1 wherein a line between the opposite ends of each groove is skew to the length of the plug by an amount within the range of from 0° to about 30°.

3. Apparatus according to claim 2 wherein all of the grooves have the same angle of skew relative to the length of the plug.

4. Apparatus according to claim 3 wherein the opposite ends of the grooves are arranged in substantially identical patterns in the opposite ends of the plug.

5. Apparatus according to claim 2 wherein the grooves are tapered along their length.

6. Apparatus according to claim 5 wherein the taper of each groove is regular along the length thereof.

7. Apparatus according to claim 6 wherein the taper of each groove is arranged so that the groove has its maximum cross-sectional area in a plane normal to the length of the groove at the end thereof adjacent the body outlet end.

8. Apparatus according to claim 1 wherein the grooves and the duct walls cooperate to define a corresponding plurality of liquid flow passages through the plug which have an aggregate cross-sectional area at least adjacent the body outlet end which is substantially less than the cross-sectional area of the duct.

9. Apparatus according to claim 1 wherein the spacing between adjacent ones of the grooves circumferentially of the plug is at least approximately the width of one of the grooves circumferentially of the plug.

10. Apparatus according to claim 1 wherein the tube has a diameter which is substantially less than the diameter of the duct.

11. Apparatus according to claim 10 wherein the tube defines a passage therealong, and the cross-sectional area of the passage in combination with the minimum aggregate cross-sectional area of the grooves is substantially less than the area of the duct.

12. Apparatus according to claim 10 wherein said end of the tube is disposed outwardly of the duct.

13. Apparatus according to claim 10 wherein the other end of the tube is spaced from the plug toward the body inlet end.

14. Apparatus according to claim 13 wherein the other end of the tube is disposed within the length of the duct.

15. Apparatus according to claim 10 including means associated with the tube for regulating the relative quantities of liquid flowing through the tube and the grooves in use of the nozzle.

16. Apparatus according to claim 15 wherein the regulating means includes an axially bored bushing disposed in the tube.

17. Apparatus according to claim 16 wherein the bushing is disposed in the tube adjacent said end thereof.

18. Apparatus according to claim 15 wherein the tube has an opposite end spaced from the plug toward the body inlet end and disposed in the duct, and the regulating means includes a collar circumferentially of the tube between the plug and the body inlet end.

19. Apparatus according to claim 1 including stream-straightening baffle means in the tube.

20. An ornamental fountain nozzle comprising an elongate tubular body defining a duct therethrough between opposite open liquid inlet and outlet ends of the body, a plug having substantial length relative to the diameter of the duct disposed across the duct inwardly of and adjacent to the body outlet end, a plurality of grooves formed in the plug sidewalls at regular intervals around the circumference of the plug each communicating between the opposite ends of the plug, each groove being tapered along its length to have its greatest cross-sectional area adjacent the body outlet end and having sidewalls which intersect the plug sidewalls at a substantial angle, the grooves having their elongate extent disposed skew to the length of the plug, the surface of the plug adjacent the body outlet end around the opening of each groove thereto defining a sharp corner in cooperation with the walls of the groove, and an elongate hollow open-ended tube disposed through the plug coaxially of the duct.

21. Apparatus according to claim 15 wherein the regulating means includes a liquid flow-throttling collar secured to the body circumferentially of the duct adjacent the liquid inlet end of the body.

22. Apparatus according to claim 21 including extension means for the tube extending the passage through the tube to a location spaced from the plug in the direction of the liquid inlet opening to the body.

23. Apparatus according to claim 22 wherein the tube extension means has an inlet end disposed outwardly of the body from the body liquid inlet opening.

24. Apparatus according to claim 10 wherein the tube has an end opposite to said end, the tube opposite end is disposed within the length of the duct, and including a second tube having a diameter substantially greater than that of the first tube and less than that of the duct, the second tube being concentric to the first tube and extending from the plug to an end spaced from the plug in the direction of the body liquid inlet opening.

25. Apparatus according to claim 24 including means fairing the passage through the first tube into the inner diameter of the second tube.

26. Apparatus according to claim 24 including stream-straightening baffle means in the second tube adjacent said end thereof.

27. Apparatus according to claim 24 wherein the end of the second tube is disposed outwardly of the body.

28. Apparatus according to claim 27 including a liquid flow-throttling collar circumferentially of the duct and carried by the body adjacent the liquid inlet end thereof.

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