MULTI-TIER FOUNTAIN NOZZLE

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ABSTRACT

An ornamental fountain nozzle has no moving parts and includes a hollow body defining an internal chamber having a liquid inlet at one end thereof and an outlet opening at its opposite end. The communication between the chamber and the outlet end of the body is via grooves formed in a plug disposed across the outlet end of the body and having substantial length between its opposite end surfaces. The net area available for water flow out of the nozzle through the grooves is less than the area of the liquid inlet to the chamber.

33 Claims, 15 Drawing Figures
MULTI-TER FOUNTAIN NOZZLE

CROSS-REFERENCE TO RELATED APPLICATIONS


BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention pertains to liquid handling and, more particularly, to nozzles for discharging water in a predetermined pattern for use in an ornamental fountain. More specifically, this invention relates to an ornamental fountain at least a portion of the discharge of which is of the non-aerating type.

2. Description of the Prior Art

Ornamental fountain arrangements fall into two broad categories, namely, the sculpture fountain in which water is used either to attract the eye to or to carry out the theme of an underlying sculpture which forms an integral part of the fountain arrangement, and the non-sculptural fountain in which the basic and often the entire aesthetic appeal of the fountain is provided by the patterns of water discharged from one or more fountain nozzles. Sculptural fountain arrangements are exemplified by the Renaissance fountains of Europe and their modern counterparts. Non-sculptural fountains now known, in turn, are either generally of the aerating type or the non-aerating type and are usually installed in situations where the fountain is to be viewed during the day without illumination by artificial light, as well as at night when illuminated by artificial light.

In order that aerating and non-aerating fountains may be effective to provide appealing displays in daylight or under illumination by artificial light, aerating and non-aerating fountain nozzles are subject to radically different design considerations. That is, if an aerating fountain is to be effective under daylight and artificial light conditions, it is desired that the water discharged from the fountain nozzles be aerated as fully as possible in order that the water discharge pattern may be readily visible in daylight, and also when subject to artificial illumination, by reason of reflecting incident light to the observer. On the other hand, the discharge patterns produced by non-aerating fountains should be as free of aeration as possible since such fountains produce their greatest appeal by reason of light refraction in both daylight and artificial light conditions. Non-aerating fountains are particularly effective when illuminated by artificial light since the water streams associated with such fountains function as in a multitude of prisms to refract white or colored artificial light to a viewer. As a general rule, the ability of an artificially illuminated non-aerating fountain to produce an aesthetic and appealing display is inversely proportional to the amount of aeration of the water discharged by such fountains.

The production of a non-aerating water fountain nozzle which is acceptable in terms of its performance in both daylight and artificial light conditions has long been a troublesome problem for those engaged in the design and manufacture of ornamental fountain arrangements. Because of the prior inability to produce a non-aerating fountain capable of producing a discharge pattern which has the same aesthetic appeal during daylight and artificial light conditions as an aerating fountain, the majority of fountains now in private, public and commercial installations are of the aerating type. The principal hurdle to be overcome in producing an acceptable non-aerating fountain nozzle lies in the elimination of aeration in the water discharge pattern, as well as the elimination of mist or fog associated with the discharge pattern.

Henceforth it has not been known to provide a fountain nozzle having a portion of the discharge pattern defined by un aerated water and another portion of the fountain discharge pattern produced by aerated water.

SUMMARY OF THE INVENTION

This invention produces a simple, effective and reliable fountain nozzle which, in use, produces a liquid discharge pattern a substantial portion of which is defined by non-aerated liquid and is characterized by an absence of mist or fog. The discharge pattern may also include a portion defined by aerated liquid distinct from the non-aerated portion of the pattern to provide an aesthetic contrast in the total discharge pattern. The discharge pattern produced by the present nozzle is considered by many to be more appealing under daylight and artificial light conditions than the discharge pattern produced from good quality aerating nozzles operating under the same conditions.

Generally speaking, this invention provides an ornamental fountain nozzle for discharging water generally upwardly therefrom and includes an elongate body which defines an internal cylindrical chamber. A water inlet opening is provided to the lower portion of the chamber and an upper water outlet opening is located at the opposite end of the chamber. A plug, which has substantial length between its opposite ends relative to the mean transverse dimension of the chamber, is disposed across the chamber outlet opening. A plurality of grooves are formed in the circumferential surface of the plug at regular intervals around the periphery of the plug. The grooves all extend parallel to the length of the plug from lower ends, which communicate with the chamber at the lower end of the plug, to upper ends which communicate with the exterior of the nozzle above the outlet end of the nozzle body. The surfaces of the grooves opposite the peripheral surfaces of the plug are inclined outwardly from the length of the plug. The surface of the plug at the outlet end of each groove is arranged with the intersecting walls of the adjacent grooves to define a sharp corner in cooperation with the walls of the grooves. The grooves collectively have a net water flow area which is substantially less than the
cross-sectional area of the inlet opening to the chamber. The plug between the grooves within the body is engaged in surface-to-surface contact with adjacent surfaces of the body.

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 perspective view of the water discharge pattern produced by a nozzle according to this invention;

FIG. 2 is an elevation view, with parts broken away, of an ornamental fountain nozzle which functions to produce the discharge pattern shown in FIG. 1;

FIG. 3 is a cross-sectional view taken along line 3—3 in FIG. 2;

FIG. 4 is a cross-sectional elevation view of another ornamental fountain nozzle according to this invention;

FIG. 5 is a cross-sectional view taken along line 5—5 in FIG. 4;

FIG. 6 is a view taken along line 6—6 in FIG. 4;

FIG. 7 is a view taken along line 7—7 in FIG. 4;

FIG. 8 is an elevation view of the discharge pattern produced by the nozzle shown in FIG. 4;

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

FIG. 10 is a view taken along line 10—10 in FIG. 9;

FIG. 11 is an elevation view of the ornamental discharge pattern produced by the nozzle shown in FIG. 9;

FIG. 12 is a top plan view of the lower tier of the discharge pattern shown in FIG. 11;

FIG. 13 is a fragmentary cross-sectional elevation view of another form of baffle ring useful in a nozzle of the type shown in FIG. 9;

FIG. 14 is a fragmentary cross-sectional elevation view of still another form of baffle ring useful in a nozzle of the type shown in FIG. 9; and

FIG. 15 is a fragmentary cross-sectional elevation view of yet another baffle ring which may be used to advantage in a nozzle of the type shown in FIG. 9.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Ornamental fountain nozzle 10, as shown in FIG. 2, includes an elongate, hollow, tubular body 11 which defines an elongate, straight, circularly cylindrical duct 12. The duct extends from a lower water inlet opening 13 at a lower end 14 of the body to an upper water outlet opening 15 at the upper end 16 of the body. The body, adjacent its lower end, defines external threads 17 which adapt the body to be securely connected to a suitably sized, preferably vertically disposed, water discharge pipe or the like (commonly known as a riser pipe) through which water at suitable pressure is applied to the nozzle for discharge by the nozzle of a characteristic ornamental discharge pattern 18, shown in FIG. 1. Alternatively, the nozzle body may be connected to a base submerged in the fountain pool. The cylinder defined by wall 19 of duct 12 is open across its entire extent at the upper end of the body.

In nozzle 10 as in the other nozzles described below, a plug 20, having substantial length between its opposite ends 21 and 22 relative to the diameter of duct 12, is disposed across the duct at body upper end 16 so that plug upper surface 22 is disposed outwardly of duct 12 from the upper end of the body. If desired, however, plug 20 may be disposed so that its surface 22 is flush with tube end 16, and similarly with plugs 65 and 105 in tubes 63 and 97, respectively.

The presence of the plug across the outlet end of body 11 produces a chamber 26 within the body below the plug and to which inlet opening 13 communicates. Preferably, as shown, the opposite end surfaces of the plug are parallel to each other at least around the periphery of the plug and are normal to the length of duct 12. The plug shown in FIG. 2 has its end surfaces flat and parallel across the entire extent of the plug. The plug has a right circular cylindrical peripheral surface 23 which either has the same diameter as duct 12 or is slightly larger in diameter than the duct with the result that the plug, when disposed in the duct as shown in FIG. 2, has its peripheral surface snugly and intimately engaged in contact with duct walls 19 around the entire surface of the plug except where the plug is recessed to define a plurality of grooves 24. The plug is held securely in position axially of body 11 by a plurality of pins 25 cooperating between the body and the plug.

It is preferred that the distance between the plug end surfaces 21 and 22, at least adjacent to the circumference of the plug in those portions of the plug through which grooves 24 extend, be at least one-quarter of the diameter of duct 12. Since this invention contemplates a nozzle which may have a duct having a cross-sectional configuration other than a circle, it is preferred that the thickness of the plug axially of the duct through those portions of the plug in which the grooves are defined be at least one-quarter of the mean transverse dimension of the duct at the location of the plug in the duct. Preferably the duct is straight between its opposite ends through the body of a nozzle according to this invention. In instances, however, where the duct is other than straight between its opposite ends, it is preferred that the duct for a substantial distance from the plug toward the inlet end of the body be straight and of the same cross-sectional area.

As noted above, a plurality of grooves 24 are formed in plug circumferential surface 23 and extend from plug lower end surface 21 toward plug upper end surface 22 into communication with the exterior of nozzle 10 above body upper end 16. It is desired that the upper ends of the grooves open to the exterior of the nozzle at least in part through the plug circumferential surface. Grooves 24, shown in FIG. 2, also open through the upper end surface of plug 20; grooves 67, shown in FIG. 4, open only through the peripheral surface of the plug. As seen best in FIG. 3, grooves 24 are spaced uniformly apart from each other around the entire circumference of plug 20; the regularly spaced grooves need not, if desired, be distributed around the entire circumference of the plug, as where it is intended that the fountain nozzle be located against a wall. The grooves, because they open to the plug circumferential surface, cooperate with duct wall 19 to define a corresponding plurality of water discharge passages which
provide the sole communication between duct 12 below the plug and the exterior of the nozzle above the plug.

As shown in FIG. 2, the grooves are tapered to have a greater cross-sectional area at their lower ends than at their upper ends. Preferably the taper of the grooves is uniform along the entire length of the plug. Accordingly, each groove has an inner wall surface 28 which is inclined outwardly of the length of the plug proceeding upwardly along the groove. As shown best in FIG. 3, groove surfaces 28 preferably are of semicircular configuration and are concave toward plug circumferential surface 23. Also, each groove has parallel sidewalls 29 which extend from surface 28 essentially radially outwardly of the plug to intersect the plug circumferential surface at essentially right angles. The grooves are parallel to the length of the plug, as opposed to being inclined in a helical manner to the length of the plug.

The spacing between the grooves circumferentially of the plug is sufficient that the plug adjacent its circumferential surface defines a plurality of essentially square-ended ribs 30, each of which has substantial thickness circumferentially of the plug relative to the width (i.e. the dimension of the groove circumferentially of the plug) of the adjacent grooves. In the nozzle shown in the drawings, each rib has a thickness which is approximately equal to the width of each of the adjacent grooves. As noted above, the plug circumferential surface 23, between each adjacent pair of grooves, is engaged intimately in surface-to-surface contact with duct wall 19 along the entire extent of the body traversed by plug 20. This relationship between the configuration of the grooves and the intimate cooperation of the plug with the body assures that water discharge pattern 18 is as devoid as possible of any mist or spray when the nozzle is operated to produce fountain discharge pattern 18. That is, a substantially right angle intersection between groove walls 29 and duct wall 19 eliminates, in discharge pattern 18, the production of thin sheets of water as would be encountered if duct walls 29 were merged smoothly or furred into substantial tangency with duct wall 19 at least adjacent the portions of the nozzle where grooves 24 open to the exterior of the nozzle. The presence of thin sheets of water in the discharge from nozzle 10 and the other nozzles described below is to be avoided since such sheets rapidly break up, even in the absence of wind, into fine spray or mist.

As shown best in FIG. 3, it is preferred, in nozzle 10, that the taper of grooves 24 be such that the configuration of the intersection line of the groove with plug upper surface 22 is substantially a semicircle.

As shown in FIG. 2, which illustrates a presently preferred nozzle single-tier according to this invention, the exterior surfaces of the nozzle which border and define the several water discharge passage openings of the nozzle are substantially normal to the length of the adjacent grooves. That is, it is preferred that body upper end surface 16 adjacent each of grooves 24 and the surfaces of the plug to which the grooves open be disposed to make a distinct angle with the adjacent groove walls; this is desired in nozzle 10 and in the corresponding elements of the other nozzles described below. Preferably, the angle of taper of grooves 24 is on the order of approximately 15°. Accordingly, when plug end surface 22 is flat and is perpendicular to the length of duct 12, it is apparent that surface 22 adjacent the opening of each of grooves 24 is substantially normal to the length of each groove. Thus, the exterior surfaces of the nozzle which bound the outlet opening from each of the grooves define a sharp corner with the surfaces defining the walls of the water outlet passages below the passage outlet openings. Because water emerging from grooves 24 during operation of nozzle 10 passes a sharp corner in emerging from the nozzle, such water separates cleanly from the nozzle and does not tend to follow along any of the surfaces bordering the outlet openings from the grooves. The result is that water discharge pattern 18, and the corresponding portion of the other discharge patterns described, are essentially free of fine spray or mist. In order that they may be used to advantage in populated areas, 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. Also, mist, fog or fine spray tends to mask the basic fountain discharge pattern and thus detracts from the aesthetic effect desired from the fountain discharge pattern.

Aeration in the discharge pattern produced by a fountain nozzle is usually the result of turbulence generated in water passing through the nozzle. Fountain nozzle 10 is arranged to produce minimum turbulence in the water discharged from such nozzle in use. Avoidance of turbulence follows from several factors, a principal one of which is the net waterflow area provided by grooves 24 in proportion to the waterflow area afforded by duct 12 below plug 20. That is, the net flow area afforded by grooves 24 in cooperation with body 11 is substantially less than the waterflow area afforded by duct 12 below plug 20. Also, the net flow area afforded by grooves 24 is less than the area of the inlet opening to the chamber provided by duct 12 below plug 20. Thus, when nozzle 10 is in use, duct 12 below the plug serves as a reservoir of pressurized, relatively undisturbed water available for flow through grooves 24. Because of the relationship between the configuration of grooves 24 and the walls of duct 12, the water which actually emerges from nozzle 10 flows primarily along the smooth walls of the duct and is given direction by the taper of the grooves such that water discharge pattern 18 is composed of a plurality of discrete non-aerated water streams 35. Streams 35 diverge from each other as they rise from nozzle 10 to a uniform height, and then fall back into a fountain pool 36 at equal distances radially from nozzle 10. The nozzle preferably is located in the pool so that only a small portion of the length of the nozzle below end 16 is above the surface of the pool.

Avoidance of turbulence in the water discharge pattern produced by nozzle 10 is also assured by making the grooves of substantial length relative to their net waterflow cross-sectional area, i.e. the area of the grooves at body upper end 16. The grooves are at least twice as long as their average cross-sectional dimension at the upper end of the plug; from an inspection of FIG. 2, it is apparent that grooves 24 in the nozzle shown have a length which is several times that of the depth of the groove at body upper end 16. Thus the water that
emerges from grooves 24 during use of nozzle 10 moves with laminar flow, rather than turbulent flow, as it emerges from the nozzle, with the result that the emerging water streams 35 do not tend to entrain air within themselves nor do such water streams tend to break up into droplets or spray in their passage upwardly and then downwardly relative to the nozzle.

Turbulence in water streams 35 is also reduced by assuring that the walls forming the boundaries of the groove water discharge passages are smooth, by the elimination of any burrs or the like at ends or along the lengths of the grooves. Preferably body 11 is fabricated of polyvinyl chloride which is easily worked to a smooth surface, and plug 20 preferably is made of Delrin or cast epoxy for the same reason. Also, such materials are preferred as the materials from which the nozzle is fabricated because such materials do not readily erode or corrode in use, with the result that optimum performance of the nozzle is maintained over a long period.

In describing plug 20 of nozzle 10, reference has been made to the other nozzles described herein, all of which include components similar to plug 20 for use in producing identical or similar portions of an overall fountain discharge pattern. It will be apparent that the features and characteristics of the described plug are also found in the corresponding components of the other nozzles described below for the reasons already set forth.

Certain dimensional relationships were mentioned above in the description of the nozzle 10. An exemplary nozzle of the type shown in Figs. 2 and 3 includes a body fabricated from a 12 inch long section of 6 inch nominal diameter, high impact, Schedule 80 polyvinyl chloride pipe. This nozzle includes a 3 inch long plug defined of Delrin acetal resin (E. I. DuPont de Nemours & Co.) and having a diameter sufficient to mate snugly with the interior of the pipe body. The 36 grooves in this exemplary nozzle have a 1 1/4" taper angle and were machined into the plug by use of a one-quart perch ball end mill; the grooves have a depth of approximately 0.20 inch at the upper end of the plug. The plug is located in the body so that the upper surface of the plug is spaced one-half inch outwardly from the upper end of the pipe body. In operation, this nozzle produces 36 discrete streams of crystal clear water which is essentially devoid of any aeration. The water discharge pattern of this nozzle has been found to be as appealing when viewed in daylight as when viewed under white or colored artificial light at night.

As shown in FIG. 1, nozzle 10 operates in use to provide a fountain discharge pattern constituted of a single tier of un aerated discrete streams which cooperate to form an inverted conical array. Another fountain nozzle 40 according to this invention, shown in Figs. 4-8, operates in use to provide a two-tier fountain pattern 43 the upper tier 41 of which is similar to that produced by nozzle 10. Nozzle 40 includes structures similar to that of nozzle 10, as already noted, in addition to other structure which provides the aerated inverted cone lower tier 42 of fountain pattern 43 shown in FIG. 8.

Nozzle 40 includes an elongate straight tubular body 44 having opposite liquid inlet and liquid outlet ends 45 and 46, respectively. The body, between its opposite open ends, defines a water flow duct 47 along its length, the duct being of circular cross-sectional configuration and of constant diameter. The body, adjacent its lower liquid inlet end, is externally threaded as at 48 to adapt nozzle 40 to be secured to a suitable fountain base or water riser pipe, for example.

An insert plug 49 having substantial length between its opposite ends 50 and 51 relative to the diameter of the duct is disposed across duct 47 intermediate the ends of the duct. Preferably, plug 48 is approximately "square" in that its length along the duct is approximately equal to or greater than the diameter of the duct. Preferably plug end surfaces 50 and 51 are parallel to each other and are normal to the axis of duct 47.

A plurality of grooves 52 are defined in the side walls of the plug at locations spaced uniformly about the circumference of the plug. As shown by Figs. 4 and 5 grooves 52 extend radially of the plug and are of increasing radial depth proceeding upwardly from lower end surface 50 to upper end surface 51. Also, as shown in FIG. 5, grooves 52 are not parallel to the axis of the duct, but rather are inclined a roughly helical manner to the axis of the duct.

When nozzle 40 is secured to a suitable fountain base or water riser pipe, and water at appropriate pressure is supplied to the nozzle, a portion of the water entering the liquid inlet end of the nozzle flows through grooves 52 and out the open upper end of the body. This water, because of the attitude of grooves 52 relative to the axis of duct 47 spirals around the interior of the body as it flows from the grooves toward the outlet end of the body. This spiral flow of this portion of the water discharged by nozzle 40, due to the centrifugal effect of such water flow, flares outwardly and upwardly from the nozzle upon emerging from outlet opening 46. Thus, the water which passes through grooves 52 defines the relatively translucent and only slightly aerated inverted cone of water which constitutes lower tier 42 of fountain pattern 43.

As shown in FIG. 5 grooves 52 have side walls 53 which extend substantially radially of the plug to the inner walls of body tube 44. The groove side walls, even considering the fact that the grooves are helically disposed relative to the axis of the duct, make a substantial angle (approaching 90°) with the inner walls of the body tube. Between the grooves the circumferential surface of the plug is intimately engaged with the inner walls of the body. Thus, the water emerging from body tube outlet opening 46 passes the plug only through grooves 52. Because of the configuration of the grooves relative to the inner walls of the duct and due to the intimate engagement of the plug with the body tube between the grooves, the presence of fine spray or mist in the lower tier of the fountain pattern 43 is avoided.

Preferably, body tube 44 and plug 49 are fabricated of polyvinyl chloride and the plug is fixed in the tube either by a force fit or by solvent welding of the plug to the tube, it being understood that other procedures for fixing plug 49 within the interior of body tube 44 intermediate the ends of the body tube may be used.

An elongate, hollow, open-ended center tube 55 of circular cross section is disposed within body tube 44 coaxially of duct 47. Tube 55 is carried in fixed relation to body tube 44 by plug 49 and is received in an axial bore 56 through the plug. Tube 55 has an external diameter which is substantially less than the internal
diameter of body tube 44. The outer diameter of tube 55 is less than the minimum diametral dimension across plug 49 between opposed ones of grooves 52, as shown in FIG. 5. Tube 55 has an open lower end 57 disposed below the lower surface 50 of plug 49; the tube also has an open upper end 58 disposed above end 46 of the body tube. An elongate water flow passage 59 is defined by tube 55.

A collar 60 is secured to the center tube 59 just below its upper end and is fixed to the tube. The collar has a lower surface 61 which is of conical configuration and flares outwardly and upwardly from the center tube. Collar 60 is a portion of a nozzle assembly 62 which is carried by the upper end of center tube 55 and which, in use of nozzle 40, functions to define the upper tier 41 of discharge pattern 43 shown in FIG. 8. As shown by FIG. 8, the upper tier of fountain pattern 43 is of canopy-like configuration; therefore, for the purposes of reference in this description, nozzle assembly 62 is referred to as a “canopy” nozzle.

Canopy nozzle 62 includes a body tube 63 which is aligned coaxially with the axis of tube 55 and is carried by collar 61. Tube 63 extends upwardly from its lower end at collar 61 to an upper end 64 disposed above the upper end of tube 55. Tube 63 is of circular cross-sectional configuration and has an outer diameter which is less than, but roughly approximates the inner diameter of body tube 44. A plug 65, similar to plug 20 of nozzle 10, is carried by the upper end of tube 63 in much the same manner as plug 20 is carried by body tube 11 of nozzle 10. Plug 65 has a lower surface 66 disposed within the length of tube 63 in spaced relation to the upper end of central tube 55.

Like plug 20 of nozzle 10, plug 65 of nozzle 40 defines a plurality of grooves 67 in its peripheral surface 68. There are approximately the same number of grooves 67 in plug 65 as there are grooves 24 in plug 20, and grooves 67 are configured to be very similar to grooves 24. As shown in FIG. 4, however, grooves 67 have their upper ends disposed within the circumferential surface 68 of plug 65, i.e., between plug lower surface 68 and a top surface 69 of the plug. Thus, the outlet openings from grooves 67 are defined through the side walls of plug 65 above the upper end of tube 63, rather than through both the side walls and the top surface of the plug as is the case with grooves 24 of plug 20.

In view of the foregoing discussion concerning nozzle 10, it is apparent that when nozzle 40 is secured to a suitable fountain base or water riser pipe and liquid is supplied to the nozzle at appropriate pressure, the nozzle functions to generate the two-tier fountain pattern shown in FIG. 8. During such operation the canopy nozzle assembly 62 of fountain nozzle 40 functions in the same manner as nozzle 10 functions to produce fountain pattern 18, and the nature of the discharge from assembly 62 of nozzle 40 is the same as the nature of the discharge obtained from nozzle 10.

Fountain pattern 43 is characterized by the presence, in the total pattern, of two different water textures in the upper and lower tiers thereof respectively. That is, the upper tier 41 of fountain pattern 43 is defined by discrete streams of essentially crystal clear unaerated water which rise to a common height and fall back gracefully toward the pool within which fountain nozzle 40 is disposed. Lower tier 42, on the other hand, is defined by an inverted cone of relatively unaerated translucent water which rises in such a manner as to be basically continuous, as opposed to being constituted of discrete rising streams. As the water defining the lower tier fountain pattern 43 reaches its maximum height it separates into randomly located discrete water streams which fall back to the surface of the pool. Also, it is desired that the overall diameter of lower tier 42 be substantially less than the overall diameter of the upper tier of the fountain pattern. It has been found that these dimensional proportions and textural or aesthetic differences between the upper and lower tiers of fountain pattern 43 are best provided, over the widest possible range of water pressures applied to nozzle 40, when certain flow controlling structural arrangements are provided in nozzle 40.

As noted above, the upper tier of fountain pattern 43 is defined by essentially crystal clear discrete streams of water. The generation of such water streams can be accomplished quite readily in fountain pattern 18, using nozzle 10, merely by regulating the pressure and rate of water flow to the nozzle. In the case of nozzle 40, however, the presence of two fountain tiers of differing character requires that water be supplied at higher pressures and at greater rates to nozzle 40 than to nozzle 10 of approximately the same nominal size. The higher pressures and gallogenae associated with nozzle 40 tends to produce turbulence in the water discharged from the nozzle. The presence of such turbulence is not too troublesome in the case of lower tier 42, but does tend to produce aeration, in water defining the upper tier of the fountain pattern, particularly when an overall fountain pattern of height comparable to that associated with an equivalent size nozzle 10 is desired. Accordingly, those portions of the structure of nozzle 40 illustrated in FIG. 4, for example, but not here before described, are present in the nozzle for the purposes of controlling the turbulence in the water defining upper tier 41, and also for the purposes of controlling the relative rates of flow in the nozzle of the water which defines the upper and lower tiers of pattern 43, respectively.

A collar 71 is carried by central tube 55 immediately adjacent its lower end 57. The collar extends circumferentially of the tube and extends radially outwardly of the tube in proximity with the inner walls of body tube 44. This collar functions as a choke or throttle on water flowing from body inlet opening 45 toward the grooves 52, thereby to regulate the quantity of water passing through the grooves relative to the quantity of water flowing along passage 59. Collar 71 also serves to control the velocity of the water entering the grooves. Lastly, collar 71 serves as a support for a velocity reducing strainer screen 72 which is provided in a cylindrical form and has its upper end disposed in a circular groove 73 formed in the inner surface of the collar concentric to center tube 55. Strainer screen 72 has a diameter greater than that of central tube 55 but less than that of collar 71. A circular plate 75, having a diameter equal to the outer diameter of annular collar 71, is carried by the lower end of screen 72 by disposing the lower end of the screen in an upwardly open circular recess 76 formed in plate 75 concentric to its center. The presence of solid plate 75 across the lower
end of the strainer screen causes water to flow from duct 47 below the plug radially inwardly through the screen into passage 59.

A stream straightening baffle assembly 79, which functions to reduce turbulence in water moving from passage 59 into a chamber 80 located between collar 60 and plug 65 within tube 63, is disposed in the upper portion of center tube 55. As shown best in FIG. 6, baffle assembly 79 is preferably constituted by a pair of flat plates disposed at right angles to each other diametrically of tube 55 and aligned with the axis of the tube. Baffle plates 81 and 82 act upon water passing them to assure that water entering chamber 80 from passage 59 has as little turbulence present therein as possible.

A pair of perforated metal screens 84 and 85 are disposed across chamber 80 between the upper end of center tube 55 and the lower surface of plug 65. Screens 84 and 85 are spaced from each other; the spacing between screen 85 and the lower surface of plug 65 preferably is greater than the spacing between screens 84 and 85. The desired spacing of the screens in chamber 80 is provided by a pair of spacer collars 86 and 87 located concentric to a bolt 88 which is coaxially threaded into the lower portion of plug 65 to fix the screens relative to the plug. While two screens 84 and 85 are shown in FIG. 4, it has been found that, in many instances, only a single screen may be required to produce the desired turbulence and flow velocity control within nozzle 40. Screens 84 and 85 are desirable because the increase in flow passage area from passage 59 to chamber 80 generates turbulence in the water which would otherwise enter grooves 67. As noted above, however, turbulence in the water flowing through grooves 67 leads to the production of an opaque characteristic to the water constituting the several streams defining upper tier 41 of fountain pattern 43. Perforated screens 84 and 85 minimize turbulence encountered in the water entering grooves 67.

Annular collar 71, screen cylinder 72, plate 75 and screens 84 and 85, in combination with the other structure previously described in nozzle 40, provide a mechanism for adjusting the resistance to water flow into and through passage 59 relative to that into and through grooves 52 of plug 49. That is, these structural elements of nozzle 40 provide a mechanism for regulating the relative quantities of water emerging from the upper end of body tube 44, on the one hand, and grooves 67 of plug 65, on the other hand. Thus, these aspects of nozzle 40 provide control over the proportions of the upper and lower tiers of fountain pattern 43 and make it possible for the nozzle to be operated over a wide range of applied water pressures to produce a water discharge pattern of relatively unvarying appearance and proportions.

Where nozzle 40 is to be used with a fountain base adapted for such purpose, rather than with a riser pipe, the length of body tube 44 may be reduced to place its lower inlet end 45 intermediate plug 49 and collar 71 so that cylindrical strainer screen 72 is disposed within a chamber of the fountain base.

An exceptionally attractive fountain pattern of the type illustrated in FIG. 8 has been obtained by use of a nominal 6-inch nozzle in accordance with the foregoing description. The exemplary nozzle included a body tube defined by an 18 inch length of 6-inch schedule 80 polyvinyl chloride pipe. The center tube of the exemplary nozzle was defined by a length of 3 \(\frac{1}{2}\) inch o.d. brass tube. The body of the canopy nozzle assembly was defined by a length of 5-inch o.d. brass tube approximately 8 inches in length. Circular strainer screen 72 was defined by a piece of perforated metal having 3/32-inch-diameter holes formed through it. Similarly, screens 84 and 85 were defined by pieces of perforated metal having holes three thirty-seconds inch in diameter, and having a thickness of approximately one thirty-second inch.

It has been found that double tier fountain nozzles of the type represented by nozzle 40 are particularly effective when used in artificially lit fountains in which the illuminating lamps are disposed beneath the surface of the fountain pool closely adjacent to the fountain nozzle. The presence of lower tier 42, having the characteristics described above, diffuses the light emanating from a single submerged lamp sufficiently that the entire fountain pattern 43, including both the upper and lower tiers thereof, are essentially uniformly illuminated, even where the lamp is of relatively low wattage. It has been found that a fountain nozzle 10 of the same nominal size as a fountain nozzle 40 requires two 200 watt lamps disposed on opposite sides of the nozzle to produce the same uniformity and brightness of illumination of fountain pattern 18 as is produced by the use of a single 200 watt lamp upon fountain pattern 43 when the two nozzles are operated to produce discharge patterns of essentially equal height. It is apparent, therefore, that in addition to the exceptionally attractive discharge pattern produced by fountain nozzle 40 such nozzle has particular advantage when used in artificially illuminated fountains in which different colored lamps are sequentially used to illuminate the fountain pattern. Because of the lens effect associated with the lower tier of fountain pattern 43, it is possible to use fewer lamps, or the same number of lamps with more colors, to effectively illuminate the discharge pattern than is the case with the discharge pattern from nozzle 10.

Another fountain nozzle 90 according to this invention is illustrated in FIGS. 9 and 10 and is operative to produce fountain pattern 91, shown in FIG. 11, when connected to a suitable fountain base or water riser pipe and supplied with water at appropriate pressure. Fountain pattern 91 is a two-tier fountain pattern in which the upper tier 92 is composed of a plurality of discrete streams 93 of crystal clear unaerated water. In view of the foregoing description, it is apparent that the upper tier 92 of fountain pattern 91 is similar to fountain pattern 18 and to the upper tier of fountain pattern 43, and that, as with fountain patterns 18 and 43, each discrete stream in tier 92 of pattern 91 is attributable to a corresponding groove in the plug disposed across the upper end of the body tube of the fountain nozzle.

The lower tier 94 of fountain pattern 91, as illustrated more clearly in FIG. 12, is of substantially smaller overall diameter than upper tier 92 and is composed by a plurality of discrete water streams 95 which extend radially from fountain nozzle 90 at regularly spaced intervals around the circumference of the nozzle to form the dominant aspects of tier 92. The spaces between adjacent ones of radial streams 95 are filled by fine water streams which lend continuity to the ap-
pearance of the tier to provide the illusion of webs in an umbrella-like skirt or support pedestal for the canopy-like upper tier of fountain pattern 91. The fine water streams which occur in lower tier 94 between streams 95 are not so profuse or massive as to mask streams 95. Streams 95 are discernible in the composite array of tier 94 as radial fingers of water which radiate outwardly from the nozzle and appear to be supporting the upwardly rising water streams in the upper tier of the pattern.

As shown in FIG. 9, nozzle 90 includes an elongate tubular body 97 having an open lower inlet end 98 and an open upper outlet end 99. A straight duct 100 of circular cross-section is defined within the body between the opposite open ends of the body. In nozzle 90, it is preferred that body 97 be defined by a length of relatively thin-walled brass tubing rather than by a length of polyvinyl chloride pipe, because of the reduced wall thickness of brass tubing relative to polyvinyl chloride pipe. A circumferential collar 101 is affixed to the body tube adjacent its lower end and defines external threads 102 to adapt nozzle 90 to be connected to a suitable fountain base or water riser pipe, either directly or indirectly via a pipe union, for example.

An insert plug 105 is disposed in the upper end of body tube 97 and, like insert plugs 20 and 65 of nozzles 10 and 40, respectively, is of substantial length relative to the diameter of duct 100. Like plugs 20 and 65, plug 105 has a plurality of grooves 106 formed in its circumferential surface at intervals spaced regularly along the circumference of the plug. Grooves 106 have the same basic configuration as grooves 24 and 67 previously described and, as shown, open through the lower end 107 of the plug into communication with the duct and through the side walls of the plug above tube upper end 97 to the exterior of the nozzle. As noted above, however, the grooves of an insert plug for nozzle 90 may be defined to open to the upper surface 108 of the plug in the manner described and shown concerning plug 20 of nozzle 10, if desired. Plug 20 is similar to plug 105 or, for the purposes of brevity of description at this point, reference is made to the foregoing description of plug 20, its proportions, the groove configurations, and the nature of installation of the plug in the nozzle body tube.

A plurality of holes 110 are formed through body tube 97 at regularly spaced locations along a line circumferentially of the body tube below insert plug 105, but substantially closer to the insert plug than to the lower end of the body tube. Holes 110 are elongated along the length of the body tube, and preferably are of oval configuration. The thin-walled characteristic of body tube 97 is desired because of the presence of holes 110.

An axially bored, adjustable collar 112 is disposed within body tube 97 adjacent the lower ends of holes 110. The axial bore 113 of collar 112 has a diameter which is a major fraction of the diameter of duct 100, and preferably is as large as possible relative to the diameter of duct 100 consistent with the function which collar 112 serves in nozzle 90. As shown in FIG. 9, the lower extent of bore 113 is chamfered as at 114, the angle of chamfer to the axis of duct 100 preferably being as small an angle as possible to facilitate the smooth flow of water from duct 100 below collar 112 through the collar to grooves 106. The outer surface of the collar adjacent the upper end of the collar is recessed, as at 115. The recess has a total length along the collar which is approximately equal to or slightly greater than the overall length of holes 110. Recess 115 has a major portion of its length defined by a surface 116 parallel to the axis of duct 100, and a minor surface 117 which is inclined at the lower end of the recess downwardly and outwardly to the maximum diameter of the collar. The maximum diameter of the collar is sized so that the collar makes a sliding fit with the inner walls of body tube 97, whereby the position of the collar axially of the body tube relative to holes 100 may be adjusted. The position of the collar axially of the body tube determines the angle at which streams 95 emerge from holes 110. The axial position of the collar in the nozzle also determines the extent to which fine streams 95 are present between larger streams 95 in lower tier 94 of fountain pattern 91. That is, the closer the top of collar 112 is positioned to the top of holes 110, the more pronounced will be the presence of fine streams 96 relative to more massive streams 95. Thus, the position of the collar within the body tube is used to regulate the "weight" of the lower tier of the fountain pattern, and also to regulate the angle of the generally conical lower tier of the fountain pattern.

The exact position of collar 112 in body tube 97 is fixed by biasing a set screw 120 against collar 112 to jam the collar in the desired position in the body tube. Set screw 120 is carried by a sleeve 121 extending around the outside of the body tube below holes 110. The head of the set screw is accessible from the outside of the nozzle. Engagement of the head of the set screw with collar 112 is facilitated by a hole 122 formed in the body below holes 110 intermediate the length of sleeve 121 and of collar 112.

The adjustability of collar 112 in body tube 97 makes it possible for the exact characteristics of discharge pattern 91 to be adjusted at the time of installation of the fountain nozzle. Adjustment of the precise characteristic of the discharge pattern at the time of nozzle installation is desired since the surroundings and environment of one particular fountain using nozzle 90, for best aesthetic effect, may require a setting of collar 112 somewhat different from the setting of the same collar in another nozzle 90 in a different fountain installation.

FIGS. 13, 14 and 15 show other adjustable collars 125, 130 and 133 which may be used to advantage in nozzle 90, as desired, to produce different control capabilities over the characteristics of the lower tier of discharge pattern 91. While such is not shown in FIGS. 13, 14 and 15, these collars are fixed in the desired position axially of body tube 97 by a set screw arranged and functioning like set screw 120 described above.

Collar 125, shown in FIG. 13, has the same configuration as collar 112 at its lower end, but has a recess 126 around its upper circumferential extent of configuration different from that of recess 115. Recess 126 is provided by relieving the upper outer extent of collar 125 so that the recess is bounded by a conical surface 127 of the collar. That is, in longitudinal cross-section, the wall of collar 125 has a shape which generally resembles a parallelogram. Collar 130, shown in FIG. 14 has no recess defined at its upper end; instead, the upper end of surface 131 of the collar is normal to the
axis of body tube 97. Collar 133, shown in FIG. 15, is substantially the reverse of collar 125 in that this collar has its inner wall surface 134 relieved radially upwardly and outwardly, as at 135, so that in longitudinal cross-section the wall of collar 133 has a configuration resembling that of a truncated pyramid. Collars 130 and 133, because their outer surfaces are not relieved adjacent the upper end of the collar, may be used to regulate the volume of water emerging from holes 110; collar 125 has the same capability, although to a lesser extent. The different attitudes of the upper surfaces of collars 125, 130 and 133 impart directional control to the water flowing through holes 110. By proper selection from between collars 112, 125 130 and 133, and by suitable adjustment of the selected collar, a fountain pattern 91 having any desired lower tier 94 can be provided. This versatility in the nature and aesthetic appearance of the fountain pattern is obtained with the use of a fountain nozzle which is essentially uniform from fountain to fountain, only a minor component of the fountain nozzle structure being varied.

Accordingly, in view of the foregoing, those skilled in the art to which this invention pertains will readily appreciate that the fountain patterns of the general type described herein may be produced by nozzles having structures different from the precise structures described and illustrated, but which are consistent with the foregoing description. For this reason, the foregoing description, which has been presented for the purposes of illustration and example in furtherance of an exposition of preferred embodiments of this invention, should not be regarded as limiting the scope of this invention.

What is claimed is:

1. An ornamental fountain nozzle for discharging water upwardly therefrom comprising an elongate body defining therein an internal chamber having a lower water inlet opening thereto and an upper water outlet opening therefrom, a plug having substantial length between opposite ends thereof relative to the mean transverse dimension of the chamber fixedly disposed across the chamber at the outlet opening with a portion of the length of the plug disposed within a portion of the chamber which has walls defining a cylinder of constant diameter extending from the outlet opening along the chamber for a distance greater than the extent of said plug portion, a plurality of essentially identical grooves formed in the circumferential surface of the plug at regular intervals along the periphery of the plug with a substantial portion of their length disposed within the body, the grooves all extending parallel to the length of the plug from lower ends communicating with the chamber at the lower end of the plug to upper ends communicating with the exterior of the nozzle, the surfaces of the grooves opposite from the peripheral surface of the plug being inclined outwardly from the length of the plug, the surfaces of the nozzle at the outlet end of each groove being arranged to define a definite corner edge with the intersecting walls of the groove, the grooves collectively having a net water flow area which is substantially less than the cross-sectional area of the chamber and of the inlet opening, the plug between the grooves throughout the length of the plug within the body being engaged in surface-to-surface contact with the chamber walls.
A nozzle according to claim 14, including screen means disposed across the chamber intermediate the plug and the upper end of the second tube.

16. A nozzle according to claim 14, including an elongate open-ended third tube having an inner diameter substantially greater than the outer diameter of the second tube disposed concentric to the second tube, the third tube having its upper end spaced along the second tube from the lower end of the first tube and from the means coupling the first and second tubes, the open lower end of the third tube defining a water inlet opening to the nozzle.

17. A nozzle according to claim 16, including an annular plug disposed across the interior of the third tube intermediate the ends thereof and journaling the second tube in the axial bore thereof for coupling together the second and third tubes, the annular plug being a second plug as to the plug disposed across the upper end of the first tube, the second plug having substantial length along the third tube relative to its diameter, and a plurality of inclined liquid flow passages defined through the second plug adjacent the circumferential surface of the second plug at regularly spaced locations around the periphery of the second plug, the inclined liquid flow passages being inclined to the length of the second plug and opening at their opposite ends to the interior of the third tube above and below the second plug.

18. A nozzle according to claim 17, wherein the liquid flow passages are comprised of a plurality of grooves formed in the circumferential surface of the second plug and cooperating with the inner walls of the third tube.

19. A nozzle according to claim 18, wherein the circumference of the second plug between the inclined grooves is snugly mated to the inner walls of the third tube.

20. A nozzle according to claim 18, wherein the inclined liquid flow passages change in cross-sectional area along the length of the second plug.

21. A nozzle according to claim 20, wherein the inclined liquid flow passages increase in area from their lower ends to their upper ends.

22. A nozzle according to claim 18, wherein the net water flow area of the inclined liquid flow passages and of the second tube is less than area of the water flow opening to the nozzle.

23. A nozzle according to claim 18, wherein the lower end of the second tube is spaced below the second plug, and including a foraminous cylindrical element having a diameter greater than that of the second tube and less than that of the third tube disposed concentric to the second tube below the second plug, and means mounting the foraminous element to the lower end of the second tube.

24. A nozzle according to claim 23, including means closing the lower end of the foraminous element in spaced relation below the lower end of the second tube.

25. A nozzle according to claim 24, wherein the foraminous element is disposed between the second plug and the lower end of the third tube, and the means mounting the foraminous element to the second tube comprises a collar circumferentially of the second tube, the collar being spaced at all locations around its circumference from the inner walls of the third tube.

26. A nozzle according to claim 14, including water streamline straightening baffle means in the second tube.

27. An ornamental fountain nozzle for discharging water upwardly therefrom comprising an elongate body defining therein an internal chamber having a lower water inlet opening thereto and an upper water outlet opening therefrom, a plug having substantial length between opposite ends thereof relative to the mean transverse dimension of the chamber fixedly disposed across the chamber at the outlet opening with a portion of the length of the plug disposed within the body, a plurality of grooves formed in the circumferential surface of the plug at regular intervals along the periphery of the plug, the grooves all extending parallel to the length of the plug from lower ends communicating with the chamber at the lower end of the plug to upper ends communicating with the exterior of the nozzle, the surfaces of the grooves opposite from the peripheral surface of the plug being inclined outwardly from the length of the plug, the surfaces of the nozzle at the outlet end of each groove being arranged to define a definite corner edge with the intersecting walls of the groove, the grooves collectively having a net water flow area which is substantially less than the cross-sectional area of the chamber and of the inlet opening, the plug between the grooves within the body being engaged in surface-to-surface contact with the chamber walls, and a plurality of water outlet holes defined through the body from the chamber to the exterior of the body at a location between the water inlet opening and the lower extent of the plug more proximate to the plug than to the water inlet opening, the holes being uniformly spaced along the body from the plug and spaced regularly along the circumferential extent of the body.

28. A nozzle according to claim 27, wherein the holes are elongated in the direction of the length of the body.

29. A nozzle according to claim 27, including an annular collar engaged with the chamber walls adjacent the holes for modulating the flow of water from the chamber through the holes.

30. A nozzle according to claim 29, wherein the collar is disposed toward the chamber inlet opening from the holes.

31. A nozzle according to claim 30, wherein the collar is movable along the chamber walls, and means operable from the exterior of the body for fixing the collar in a desired position in the chamber relative to the holes.

32. An ornamental fountain nozzle comprising an elongate tubular body defining therein an internal
chamber having a water inlet opening thereto at the lower end of the chamber, a plug fixedly disposed across the chamber at the upper end of the chamber in spaced relation to the water inlet opening, water outlet means from the chamber to the exterior of the nozzle, the water outlet means comprising a plurality of water outlet holes defined through the body for discharging water radially laterally from the nozzle, the holes being defined at a location between the water inlet opening and the plug more proximate to the plug than to the water inlet opening, the holes being uniformly spaced along the body from the plug and spaced regularly along the circumferential extent of the body, and an annular collar circumferentially intimately engaged with the body proximate the holes for modulating the flow of water from the chamber through the holes, the effective area of the water inlet opening to the chamber being greater than the effective water flow area of the water outlet means from the chamber.

33. An ornamental fountain nozzle according to claim 32, wherein the collar is engaged with the inner walls of the body adjacent the lower extent of the holes.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,690,554 Dated September 12, 1972

Inventor(s) John O. Hruby, Jr.

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 8, line 22, after "inclined" insert --in--

Column 16, line 22, change "claim 8" to --claim 7--

Signed and sealed this 20th day of February 1973.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR. ROBERT GOTTSCALK
Attesting Officer Commissioner of Patents