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FLUID DISTRIBUTOR

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My invention relates to a fluid distribution system and, more particularly, to a fluid distribution nozzle particularly adapted for discharging a thin sheet of fluid.

It is often desirable to jet a high-velocity, peripherally-continuous stream of fluid into a space. For example, it is sometimes desirable to discharge a thin outwardly-flowing sheet of liquid into the interior of a tank. If this tank contains a body of liquid, the incoming liquid will be jetted thereinto to establish desirable circulation paths within the tank-contained liquid, this circulation being aided, if desired, by suitable baffles.

In many instances, it is desirable to support a fluid distribution nozzle at the upper end of a riser pipe within the tank, the liquid being forced under pressure along the riser pipe and the nozzle deflecting the liquid to form the outwardly-discharging sheet. In this connection, if large volumes of liquid are to be discharged and if the outward velocity is to be high, the fluid distribution nozzle must provide an annular orifice only a small fraction of an inch in width but being several feet in circumferential dimension. The present invention can be satisfactorily employed even in those extreme instances in which the width of the annular discharge orifice is only a few thousandths of an inch, yet in which the distance across the annular discharge orifice, measured diametrically, is up to or more than eighteen inches.

It is desirable to form such a nozzle by employment of a stationary tubular member and a movable head member, these members providing outwardly-extending annular surfaces cooperating in defining the annular discharge orifice. It is also desirable to urge the head member resiliently toward the stationary tubular member. At the same time, it is very desirable that there be no tipping of the head member nor any sidewise displacement thereof; otherwise, the annular discharge orifice will be wider at one peripheral position than at a diametrically opposed position, thus tending to prevent equal discharge at all peripheral sections. Furthermore, unless the head member is properly centered and prevented from sidewise displacement, any particles of foreign matter accumulating in the discharge orifice will cause the head member to tip when this member is urged toward orifice-closing position.

It is an object of the present invention to provide a novel fluid distribution nozzle for discharging a thin outwardly-flowing sheet or stream of

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fluid, and to provide a novel nozzle construction including a head structure which is not subject to sidewise displacement or tipping.

A further important object of the invention is to provide a centering support for the head structure at a position near the annular discharge orifice and, more particularly, to provide a movable head structure which is slidably journaled at a position near this annular discharge orifice to prevent sidewise movement of the head structure or any tipping thereof.

Another object of the invention is to provide a novel hollow head structure for a fluid distributor, and to provide a bearing therefor within the hollow structure. In this connection, it is another object of the invention to extend a tubular support member upward in the outer tubular member of a distributor, and to employ a novel head structure movably telescoping with the upper end of the support member.

In the preferred embodiment of the invention, the fluid moves along a distributor passage of progressively decreasing cross-sectional area so that the stream is gradually accelerated toward the annular discharge orifice. It is an object of the invention to provide a fluid distributor of novel construction and having one or more tapered surfaces for forming such a passage of progressively decreasing cross-sectional area.

Further objects and advantages of the invention will be evident to those skilled in the art from the following description of an exemplary embodiment.

Referring to the drawing:

Figure 1 is a vertical cross-sectional view of a spherical tank embodying a nozzle of the invention;

Figure 2 is an enlarged vertical sectional view of the fluid distributor; and

Figure 3 is a horizontal sectional view, taken along the line 3—3 of Figure 2.

Referring particularly to Figure 1, the invention is well adapted to the substantially-radial discharge of a high-velocity stream of liquid into a tank 10, shown, by way of example, of spherical form and supported above the ground by any suitable means, not shown. It should be understood, however, that this environment of the invention is merely exemplary and that discharge into tanks of other shape or into other zones or spaces can take place without departing from the spirit of the invention. In general, the invention will be exemplified with relation to the problem of jetting an incoming stream of liquid into a body of liquid 11 in the tank 10.

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As suggested in Figure 1, a pump 12 forces a high-pressure stream of liquid along a horizontal pipe 13 connected by a pipe T 14 with a riser pipe or conduit 15, which extends upward from the bottom of the tank 10 and is suitably braced by means not shown. The fluid distributor of the invention is indicated, in general, by the numeral 18 and discharges an outwardly-flowing sheet of liquid, as indicated by the arrows 19. This outward discharge is preferably substantially equal at all peripheral points to form, in effect, a thin sheet of liquid discharging substantially radially with respect to vertical axis A—A of the distributor and in a substantially horizontal plane. If this outward discharge is intermediate upper and lower annular plates 20 and 21, suitably mounted in the tank 10 by means not shown, desirable toroidal-shaped circulations are set up. For example, the outwardly-jetted stream tends to aspirate liquid from above the upper plate 20 through the central opening thereof and from below the lower plate 21 through the central opening thereof to establish upper and lower closed circulation paths through which tank-contained liquid will circulate, the upper and lower paths being indicated, respectively, by the arrows 22 and 23.

Referring particularly to Figure 2, the invention includes a stationary structure, indicated generally by the numeral 25, and a movable head structure, indicated generally by the numeral 26. The stationary structure 25 includes an outer fluid-guiding member 28 carrying at its lower end a flange 29 adapted to be bolted to a mating flange 30 at the upper end of the conduit 15, as shown in Figure 1. This outer fluid-guiding member is of tubular form and may be substantially cylindrical throughout its length. However, in the preferred embodiment, the lower end thereof comprises a cylindrical section to which is welded, as indicated at 31, a section flaring upwardly and outwardly. At the extreme upper end of the outer member 28 is an annular surface 32 which, if the discharge is to be in a horizontal direction, represents a narrow horizontally-disposed annular surface. If the discharge is to be slightly inclined from the horizontal, as is sometimes desirable, the annular surface 32 will be correspondingly inclined.

The stationary structure 25 includes, also, a tubular support member 35 retained rigidly in properly centered position by arms 36 extending across an annular space 37 between the outer periphery of the support member 35 and the inner surface of the outer fluid-guiding member 28. The lower end of the support member 35 preferably terminates a slight distance below the arms 36 to extend a slight distance into the upper end of the conduit 15. The uppermost end of the support member 35 terminates near the annular surface 32, i. e., at a position near the plane containing the annular surface and a distance slightly therebeneath, as shown in Figure 2.

The movable head structure includes a plate 40 providing an annular surface 42 opposite and usually parallel to the annular surface 32. The annular surfaces 32 and 42 cooperate in defining an annular discharge orifice 43 when these annular surfaces are spaced a slight distance from each other. Preferably, the head structure 26 is hollow to telescope with the upper end of the support member 35. It is also preferable to design the head structure so that it provides a tapered portion spreading the rising stream of

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liquid. Figure 2 shows a structure thus designed. Here, the movable head structure 26 includes a tapered section 45 in the form of an inverted skirt providing a surface 46 flaring upwardly and outwardly from a position adjacent the outer periphery of the support member 35 to an aligned surface 47 of the plate 40, which flares upwardly and outwardly to the annular surface 42. The interior of the tapered section 45 provides a chamber 48, and the extreme upper end of this tapered section is preferably welded to the bottom of the plate 40, as indicated at 49. The lower end of the tapered section 45 provides an opening 50 slightly larger than the outer dimension of the support member 35 to provide a sliding fit and permit a small amount of liquid from the annular space 37 to enter the chamber 48.

A small bead 51 may be built up by welding around the periphery of the support member 35 just below the lowermost end of the tapered section 45, this welded portion being subsequently machined to tapered form, with its uppermost surface radial and disposed a short distance below the end of the tapered section 45 to provide a slight clearance even when the annular surfaces 32 and 42 are in engagement. This small bead guides the liquid to the surface 46 and forms, in effect, a continuation thereof.

Depending from the movable head structure 26 is an element such as a mounting member or rod 55 providing a tapered portion 56 fitting snugly into a correspondingly-tapered opening in the plate 40. A nut 57 is threaded to the extreme upper end of the rod 55. By tightening this nut against a lock washer 58, the rod 55 is rigidified and centralized with respect to the head structure 26. A short externally-threaded flange 59 can be welded to the plate 40 to receive an internally-threaded cap 60, which encloses the nut 57 after it has been tightened.

The invention comprehends the provision of a centering support for the head structure immediately adjacent the plate 40 or, in other words, at a position adjacent the plane of the annular discharge orifice 43. Any suitable mating engagement between the upper end of the support member 35 and the upper portion of the movable head structure 26 can be employed so long as this prevents sidewise displacement and tipping of the head structure. In the preferred construction, the rod 55 extends downward completely through the tubular support member 35 and is slidably journaled with respect thereto in at least two spaced positions, one of which is at the upper end of the support member. For this purpose, the extreme upper end of the support member 35 is counterbored to receive a bearing 62 suitably held in place, as by one or more set screws 63. Similarly, the lower end of the support member 35 is counterbored to receive a bearing 64 held in place by one or more set screws 65.

Below the lowermost bearing 64 is a plug member 67 providing an opening 68 slightly larger than the rod 55 so that the latter may slide easily therein. This plug member provides an externally-threaded neck 69 which is threaded into the lowermost end of the support member 35, holes 70 being provided for reception of a suitable tool for tightening the plug member. This plug member 67 is disposed in the conduit 15 and preferably provides an outer surface 71 curving outward and upward from a position adjacent the periphery of the rod 55 to the external surface of the support member 35.

It is desirable to apply to the head structure 26 a resilient biasing force urging the same toward orifice-closing position. Referring particularly to Figures 1 and 2, this can be accomplished by extending the rod 55 downward through the conduit 15 to a position exterior of the tank 10, the junction of the tank and the lowermost end of the conduit 15 providing a stuffing box or sealing means 75 through which the lowermost end of the rod slidably extends in fluid-tight relationship. As shown, the extreme lower end of the rod carries a nut 76 threaded thereto and a spring 77 is compressed between the nut and the sealing means 75. This portion of the structure is shown only diagrammatically but will suffice to indicate the positioning of the spring 77 which urges the head structure 26 resiliently downward. It illustrates also a manner in which the spring bias can be adjusted, namely, by turning the nut 76 with respect to the lower end of the rod 55.

The annular surfaces 32 and 42 are accurately ground to contact each other at all peripheral positions when no liquid is pumped through the conduit 15. When the pump 12 is started, the pressure of the liquid will exert an upward orifice-opening force on the movable head structure 26 and will displace this structure upward to separate the annular surfaces 32 and 42 to provide the narrow annular discharge orifice 43. In fact, the width of this discharge orifice will be dependent upon the amount of liquid pumped through the conduit 15, the liquid pressure overcoming the bias applied by the spring 77.

It will be readily apparent that the stream of liquid moving upward through the conduit 15 is spread first by the surface 71 of the plug member 67 so as to form an annular stream in the annular space 37. This stream is further spread by the upwardly-diverging surface 46 and flows to the annular discharge orifice 43, from whence it is jetted radially outward at high velocity. This is true irrespective of whether the outer fluid-guiding member 28 is cylindrical or whether it flares upwardly and outwardly, as suggested. In either instance, the distributor desirably provides a tapered passage of progressively decreasing cross-sectional area toward the annular discharge orifice 43 to spread the stream gradually to the position where it enters this discharge orifice.

The head structure is always maintained exactly centered with respect to the stationary structure 25 by the spaced bearings 62 and 64. The bearing 62 near the upper end of the distributor is particularly important in this regard as it prevents any sidewise movement or tipping of the head structure. It will be recognized that even a minute tipping would cause unequal peripheral discharge, and the positioning of the bearing 62 adjacent the plate 40 is important in preventing this.

While the invention has been particularly exemplified with reference to the high velocity discharge of liquids, it should be clear that it is not limited thereto and can be used for discharging various fluids into various environments.

Various changes and modifications can be made without departing from the spirit of the invention as defined in the appended claims.

I claim as my invention:

1. A massive fluid distribution nozzle adapted for connection to a biasing means and for receiving a large-volume pressured stream of liquid and discharging an extremely thin outwardly-flowing sheet thereof into a tank containing a

body of liquid and into a member-bounded liquid-filled annular space disposed around the nozzle, said nozzle including: an open-ended tubular member adapted to receive said pressured stream and providing a first large-diameter annular surface; a movable head means comprising a plate extending across the open end of said tubular member and providing a second large-diameter annular surface adjacent said first large-diameter annular surface and cooperating therewith in defining an annular peripherally-continuous discharge orifice directed outwardly into said liquid-filled annular space, said plate having a central flat surface within said tubular member; mounting means for connecting said movable head means to said biasing means to close said discharge orifice upon stoppage of said pressured stream, said discharge orifice opening against the action of said biasing means by pressure exerted on said head means by said pressured stream to open said discharge orifice and thus project a high-velocity sheet of liquid outwardly into said annular space disposed around said nozzle, said mounting means including a rod secured rigidly to said plate and extending from said flat surface of said plate centrally along said tubular member; a plurality of arms secured to and extending inwardly from said tubular member at a position spaced from said open end thereof, said arms providing inner ends; and a centering support for said head means for preventing sidewise movement thereof and tipping thereof relative to said tubular member, said centering support comprising a massive tubular support member rigidly secured to said inner ends of said arms and extending toward said plate in surrounding relationship with said rod, said tubular support member having an end adjacent said central flat surface, said centering support comprising a bearing means at said end of said tubular support member and immediately adjacent the junction of said rod and said central flat surface of said plate but spaced a minute distance from said plate when said discharge orifice is closed, said bearing means slidably receiving and longitudinally journaling said rod.

2. A massive fluid distribution nozzle adapted for connection to a biasing means and for receiving a large-volume pressured stream of liquid to discharge a thin outwardly-flowing sheet of the liquid into a tank containing a body of liquid and into a member-bounded liquid-filled annular space disposed around the nozzle, said nozzle including: an open-ended tubular member adapted to receive said pressured stream and providing a first large-diameter annular surface; a movable head means comprising a plate extending across the open end of said tubular member and providing a second large-diameter annular surface adjacent said first large-diameter annular surface and cooperating therewith in defining an annular peripherally-continuous discharge orifice directed outwardly into said liquid-filled annular space, said head means having a hollow tapered portion extending into the interior of said tubular member in an upstream direction, said plate extending across said hollow tapered portion of said head means to a position therebeyond to form said second large-diameter annular surface, said tapered portion spreading said pressured stream and guiding same to said annular discharge orifice; mounting means for connecting said movable head means to said biasing means to close said discharge orifice upon stop-

page of said pressured stream, said discharge orifice opening against the action of said biasing means by pressure exerted on said head means by said pressured stream to open said discharge orifice and project a high-velocity sheet of liquid outwardly into said annular space disposed around said nozzle, said mounting means including a rod secured rigidly to said plate and extending centrally along said tubular member; and a centering support for said head means for preventing sidewise movement thereof and tipping thereof relative to said tubular member, said centering support being rigidly connected to said tubular member and comprising a stationary bearing means immediately adjacent the junction of said rod and said plate but spaced a minute distance from said plate when said discharge orifice is closed, said bearing means slidably receiving and longitudinally journalling said rod, said centering support extending into the interior of said hollow tapered portion to support said stationary bearing means therewithin and immediately adjacent the junction of said rod and said plate.

3. A massive fluid distribution nozzle adapted for connection to a biasing means and for receiving a large-volume pressured stream of liquid to discharge an extremely thin outwardly-flowing sheet thereof into a tank containing a body of liquid and into a member-bounded liquid-filled annular space disposed around the nozzle to establish a circulation of the tank-contained liquid through such space, said nozzle including: an open-ended tubular member adapted to receive said pressured stream and providing a first large-diameter annular surface; a massive tubular support member; arm means at a position spaced from said open end of said tubular member for mounting said tubular support member axially within said tubular member, the upper end of said tubular support member being mounted as a cantilever by said arm means, the extreme upper end of said tubular support member comprising a bearing means and terminating only a short distance below the plane of said first large-diameter annular surface, said tubular support member cooperating with said tubular member in providing an annular space into which said pressured stream of liquid flows from between said arm means; a hollow head means providing a second large-diameter annular surface adjacent said first large-diameter annular surface and cooperating therewith in defining an annular peripherally-continuous discharge orifice directed outwardly into said liquid-filled annular space and having an extensive peripheral length, said hollow head means providing a chamber and providing an opening communicating with said chamber, said opening being only slightly larger in diameter than said tubular support member to receive same and dispose said bearing means in the upper interior of said chamber; and a mounting means connected to said movable head means and adapted for connection to said biasing means for movably mounting said head means to move between a closed-orifice position in which said large-diameter annular surfaces are in contact and an open-orifice position in which said annular surfaces are separated a few thousandths of an inch to project a high-velocity sheet of the pressured liquid of corresponding thickness outwardly into said annular space disposed around said nozzle, said discharge orifice opening against the action of said biasing means by pressure exerted on said

head means by said pressured stream, said mounting means including a rod secured rigidly to said head means and being slidably received and journalled for axial movement by said bearing means, said head means moving along said tubular support member to provide relative movement therebetween at the position where said tubular support member passes through said opening of said head means, said rod providing means for connecting such rod to said biasing means.

4. A combination as defined in claim 3, in which said massive tubular support member is substantially larger in diameter than said rod and comprises an extremely rigid member, said bearing means comprising a bearing member in the upper end of said tubular support member for slidably receiving and journalling said rod for axial movement, and including an additional bearing means at a position spaced below said bearing member for slidably receiving and journalling said rod at such position for such axial movement.

5. A combination as defined in claim 3, in which said opening of said head means terminates at a relatively sharp edge of said head means, this edge being disposed immediately around said tubular support member, said tubular support member including a head immediately beneath said relatively sharp edge when said head member is in closed-orifice position for guiding said pressured stream of liquid in said annular space to flow outside said relatively sharp edge.

6. A combination as defined in claim 3, in which said tubular member flares upwardly and outwardly toward its first large-diameter annular surface, the diameter of said tubular member adjacent said arm means being substantially less than the diameter of such first annular surface, there being a tapering annular space between said tubular member and said head means which progressively decreases in thickness toward said orifice and which openly communicates with said annular space between said tubular member and said tubular support member.

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