July 30, 1929. B. H. COFFEY ET AL 1,722,733

SPRAY NOZZLE

Filed Aug. 30, 1924

Fig. 1.

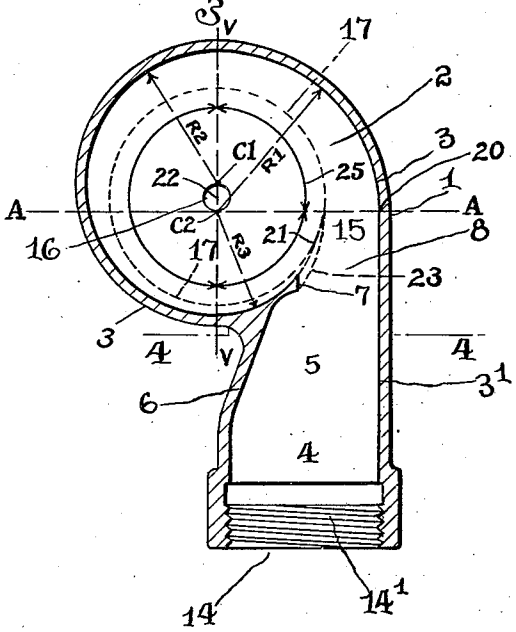


Fig. 2.

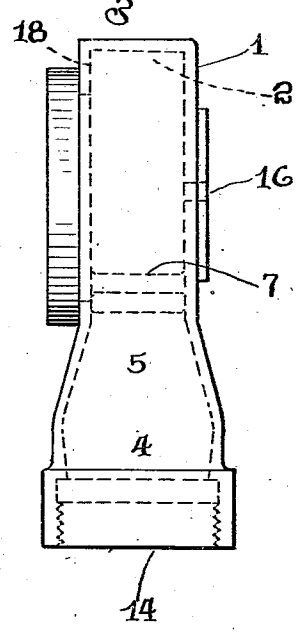


Fig. 3.

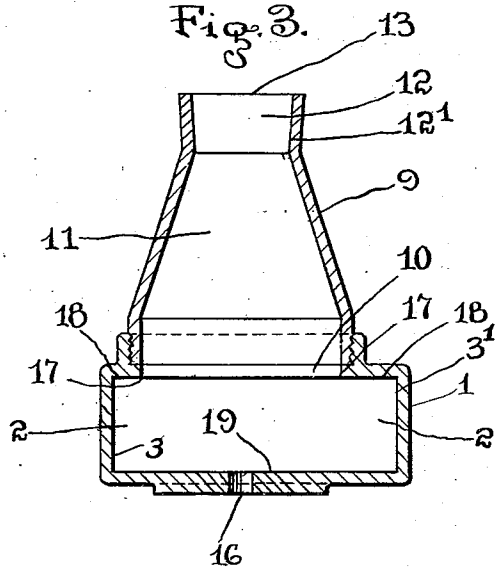


Fig. 4.

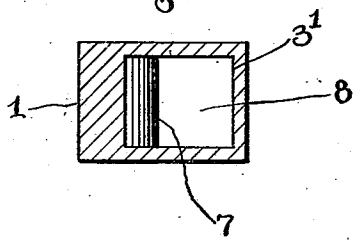
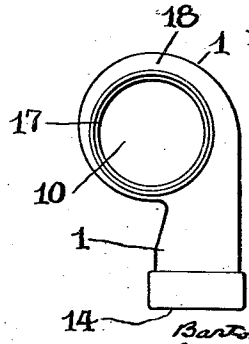


Fig. 5.



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UNITED STATES PATENT OFFICE.

BARTON H. COFFEY, OF ELIZABETH, NEW JERSEY, AND GEORGE S. DAUPHINEE, OF NEW YORK, N. Y., ASSIGNORS TO THE COOLING TOWER CO. INC., OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

SPRAY NOZZLE.

Application filed August 30, 1924. Serial No. 735,117.

Our invention relates to improvements in spray nozzles and particularly to that class of nozzles useful in the art of cooling water by atmospheric action.

This type of nozzle is usually located over ponds or roofs which receive the cooled sprayed water that after being heated again passes through the nozzles and so on indefinitely. Vegetable growths and solid matter in the ponds or on the roofs get into the circulation and clog the nozzles, constituting the most serious trouble encountered in the operation of this type of cooling apparatus.

The chief object of this invention is to greatly minimize this trouble by a large increase in the dimensions and area of the water-way through the nozzle for equal capacities and pressures without decreasing the quality and cooling efficiency of the spray-cloud produced, compared with the existing standards of the contemporary art. As a result of the novel features of our invention we have increased the size of the water-way over the existing art known to us, measured by minimum dimensions, considerably over two hundred per cent and, measured by minimum areas, over one hundred per cent, with improvement in the symmetry, texture and cooling efficiency of the spray-cloud.

A further object of the invention is to produce a novel and efficient spray nozzle; a further object of the invention is to produce a spray nozzle which will discharge a high spray cloud in which the water particles are evenly and uniformly distributed; another object of the invention is to produce a nozzle in which the danger of stoppage and clogging by foreign matter will be reduced to a minimum; a further object of the invention is to provide in a nozzle a water passage of maximum diameter for a given capacity and a further object of the invention is to make a practical application in the nozzle of the principle of a contracted jet.

We accomplish these objects by the device illustrated in the accompanying drawings in which:

Figure 1 is a horizontal section of the device.

Figure 2 is a side elevation with the vortex chamber removed.

Figure 3 is a vertical section of the device.

Figure 4 is a section on the line 4—4 in Figure 1, and

Figure 5 is a plan view of the device with the vortex chamber removed.

Similar characters of reference refer to similar parts throughout the several views.

Our improved nozzle includes a casing 1 in which we form a horizontal peripheral volute channel 2 an inlet passage, means for producing a contracted jet of entering water, an equalizing vortex chamber 11 and a discharge orifice 13.

The vertical spiral surface 3 of the horizontal spiral volute channel 2 is preferably generated from the centers C^1 and C^2, symmetrical with the axis 22. We do not limit ourselves to the form of spiral herein described, however.

Beginning with the radius R^1 and center C^2, the surface 3 of the spiral starts at the tangent point 20. The revolution of R^1 is 90°, ending at the vertical line V, through the axis 22, as indicated by the circle 25, on which arrows indicate angular advance. The angular advance of radius R^2 is 180°, that of R^3 a little short of 90°, ending at the point 21 where a very acute intersection with the circle 17 takes place, practically a tangent. It will be noted that point 21 is nearly on a line A—A, drawn through the center C^1, normal to the vertical through 22 and crossing the tangent point 20.

The boundary of the volute channel 2 is the wall of the three sided rectangular gutter of decreasing vertical transverse section, formed by the interior surfaces of the horizontal parallel walls 18 and 19 and the vertical wall 3, which begins at the tangent point 20, where it joins the wall 3^1 and ends at the tip of the lip 7 at about 315° angular advance. The wall 18, forming the top of the casing 1 is pierced by the circular opening 10 centered on the vertical axis 22 of the spiral, the circumference 17 of the aperture 10 hence forms the edge of the upper wall of the volute channel 2, the lower wall or leg thereof being the surface 19 and the channel itself is the space, measured vertically, between the walls 18 and 19, forming an elongated spiral wedge. The physical volute channel leaves, from its termination, a small intervening distance on its extended curve, shown in dotted line, to the point 21. If the functions of the volute channel did not continue in this distance, such would be immediately reflected by an imperfection in the texture of the issuing

spray cone at the orifice 13, which is extremely sensitive to any irregularities in the waterway or disturbances or interferences in the current. We attribute the absence of any such imperfections, first, to the fact that in this region the residual water in the volute and that in the entering jet are moving in the same direction on parallel lines and at approximately the same velocity so that interference, if any, is negligible, and second, any space between the contracted jet and the volute stream would be kept flooded from the sides and bottom by water under centrifugal pressure. As the volute begins to feed the vortex chamber on the line A—A and tangent 20, it would seem desirable for uniform feed, that the tail end of the volute channel should cease feeding on the same line and, from the appearance of the spray cone, that is what occurs. Any very small irregularities in flow in this region would, however, be smoothed out in the vortex chamber before reaching the orifice 13.

The inlet passage includes a round section 4 which merges into a rectangular section 5.

The inner wall 6 of this inlet passage converges inwardly with reference to wall 3^1, the convergence being mainly in the rectangular section 5, and terminates in a sharp edge contraction lip 7 which projects into the waterway, at a still sharper angle, and forms a side wall of the substantially square orifice 8.

On the casing 1 we provide a cap section 9 communicating with the casing 1 by a circular opening 10 and containing an equalizing vortex chamber 11, a throat 12 and a mouth 13.

The entrance port 14 is preferably provided with threads 14^1 by which the nozzle may be attached to a water main or other suitable source of supply.

The water enters the device at the entrance port 14 with parallel stream lines and on meeting the converging wall 6, the stream lines adjacent thereto are forced to make an angle with the axis of the entering water and at the same time the velocity of the whole mass is increased by reason of the decreased section of the water-way. At the sharp edge contraction lip 7 the stream lines are further bent and make a still greater angle with the axis of the entering water.

At a point 15, beyond the orifice 8 and adjacent to tangents 20 and 21, there is produced in the water a jet of maximum contraction and maximum velocity in accordance with the hydraulic phenomenon of the vena contracta, indicated by the dotted curve 23.

As the volume passing the orifice 8 is equal to that passing the contracted jet section, the velocities at these points are in inverse proportion to the corresponding areas and therefore the velocity at the contracted jet is greater than that at the orifice 8. The contracted jet is thus equivalent to that of a round edge orifice of equal size having practically no contraction, without the serious disadvantage of forming a metallic barrier to the passage of solids through the nozzle. The minimum interior opening is orifice 8, larger than the contracted jet which produces the high velocity called for by the principles of this nozzle. The maximum contraction in the jet occurs at the tangent point 20 beyond the opening 8 where the jet enters the volute 2, continuing onward in the volute under the stress of centrifugal force and encountering a gradually decreasing area, the inner side of the jet is uniformly exposed by the receding edge 17 of the volute. Under a head equal to the unbalanced centrifugal pressure minus the static head from the edge 17 of the volute channel to the mouth 13, a liquid film ascends the wall 9 of the vortex chamber 11 in an inclined direction, the resultant of the horizontal component acquired in the volute channel 2 and the vertical component acquired in leaving the volute channel 2.

The path of each particle is a true helix or inclined straight line on the developed surface of the vortex chamber 11. Centrifugal force, due to the horizontal component, keeps the film in contact with the constraining surface until the particles leave the edge of the mouth 13 at angles of about 45° to the horizontal, in vertical planes tangent to the mouth 13. An infinite number of such issuing streams of particles produce a closely approximate cone with its apex at the mouth 13.

The spray cone is of very fine and uniform texture, perfectly symmetrical and of good height.

As the volute channel 2 cannot be machined conveniently, casting roughness mars the smoothness of the jet therein but these irregularities are smoothed out by the pressure of centrifugal force in the vortex chamber, which is machined, and these irregularities are, therefore, not reflected in the texture of the spray cone.

Disturbance of the entering jet by contact with water in the volute 2 is avoided by making the vortex chamber 11 tangental to the volute channel 2 in close proximity to the point of maximum contraction 20 of the jet.

The inner marginal edge 17 of the top wall 18 of the spiral volute channel 2 is circular and concentric with the origin of the said channel, consequently, the area of the channel 2 constantly and uniformly diminishes, whereby the ribbon of water in the volute channel 2 constantly and uniformly overflows at every point the marginal edge 17 of the channel and is practically exhausted at the tangent point 21, by reason of which the stream lines are not disturbed.

The hole 16 in the bottom wall of the cham-

ber 19 performs a valuable function in freezing weather by draining the nozzle, thus avoiding rupture from ice formation.

It also prevents reduction of air pressure within the nozzle due to the exhausting action of the upward film flow and thus preserves full atmospheric pressure on the water in the volute and on the film in the vortex chamber 11 and throat 12.

In research experiments, we have found that at rated capacities no water flows from the hole 16 and, on further investigation with exploring tubes in this hole 16 we find that the water ascends the walls of the vortex chamber 11 and of the throat 12 in a thin film, the result of high angular velocity and the accompanying high centrifugal pressure, as in centrifugal separator practice. This feature of the invention produces within the whole nozzle, except the volute channel and inlet, practically air conditions and thus enables the sequence of hydraulic phenomena within the nozzle to function without the disturbance, internal friction and interference losses that necessarily occur within a flooded nozzle and, as is well understood, a water jet under water produces results widely different from those of a water jet in air.

By experiment we find that the area of the contracted jet and its orifice 8 are governing factors in varying the capacity and that the throat 12 is secondary in this respect. In practice, we make the throat 12 about equal to the horizontal dimension of the orifice 8. The discharge at the mouth 13 is perfectly free, the water issuing therefrom as a thin hollow cylinder of outside diameter that of the mouth 13 and a thickness that of the film; the cylinder immediately expands into a hollow cone under the stress of the horizontal and vertical components and, as the expansion continues, the film becomes thinner until at a horizontal plane of about one foot above the nozzle mouth, under usual operative conditions of pressure, surface tension fails and the cone rim disintegrates into fine drops which continue along conical elements until gravity exhausts the vertical component.

Having thus described our invention, what we claim is:—

1. In an air filled, film flow, free discharge, centrifugal spray nozzle, the combination of a volute channel, an inlet passage tangental thereto and having a side wall, a rectangular orifice therebetween, the side wall of said inlet passage terminating in a lip which makes a sharp angle with the remaining portion of said side wall and which extends in a direction toward the axis of said passage whereby a contracted jet is produced in the volute channel beyond the orifice.

2. In an air filled, uniform film flow, free discharge, certifugal spray nozzle, the combination of a vortex chamber, a discharge orifice therefor above the vortex chamber, a volute channel below the vortex chamber and open thereto, a tangental inlet passage to the volute channel merging into rectangular form, the side wall of the said inlet passage terminating in a lip having a sharp edge and which makes a sharp angle with the remaining portion of said side wall and extends in a direction toward the axis of said inlet passage and forms a contracted orifice adapted to produce a contracted jet in the volute channel beyond the orifice.

3. In an air filled, uniform film flow, free discharge, centrifugal spray nozzle, the combination of a channel, a gradually diminishing top wall thereon, an inlet passage positioned tangentally to said channel, a side wall of said inlet passage terminating in a lip which makes a sharp angle with the remaining portion of said side wall and which extends in a direction toward the axis of said passage, forming a contracted section, a sharp edge on said lip adapted to produce a contracted jet beyond said inlet, a vortex chamber above the top wall of the channel and a circular opening between the vortex chamber and the channel.

4. In an air filled, uniform film flow, free discharge, centrifugal spray nozzle, the combination of a casing, a horizontal peripheral volute channel therein, an inlet passage positioned tangentially to the channel and having a round section merging into a rectangular section, a side wall of the rectangular section converging at a sharp angle toward the other side wall thereof and having a sharp edge to form a contracted orifice, a cap section on the said casing and communicating therewith by a circular opening, a vortex chamber in said cap section and a discharge port above the vortex chamber.

5. In a spray nozzle, the combination of an inlet passage, an open side volute channel connected with the inlet passage, said inlet passage being tangental to said volute channel, a side wall of said inlet passage terminating in a sharp edge contraction lip which makes a sharp angle with the remaining portion of the said side wall and which extends in a direction toward the axis of said passage and is adapted to produce a contracted jet in the channel, and a discharge orifice from the channel.

6. In a spray nozzle, the combination of an inlet, an open side spiral volute channel opening into said inlet, said inlet being tangental to said volute channel, a side wall of said inlet forming a sharp edge contraction lip adjacent the entrance to the said channel and adapted to produce a contracted jet therein, and a discharge orifice from the channel.

7. In a spray nozzle, the combination of an inlet, a spiral volute channel opening from the inlet, said inlet being tangental to said volute channel, a side wall of said inlet terminating in a lip having a sharp edge and

adapted to form a contracted jet beyond the lip, a vortex chamber opening from the channel and a discharge orifice from the vortex chamber.

8. In a spray nozzle, the combination of a tangential converging inlet adapted to admit a stream of water, a sharp edge contraction lip in the path of the entering stream, a volute channel adapted to receive the stream beyond the said lip, a vortex chamber connected with the said channel and a discharge orifice opening from the vortex chamber.

In testimony whereof, we have signed our names to this specification, this 29 day of August, 1924.

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GEORGE S. DAUPHINEE.