Feb. 14, 1961 F. W. WAHLIN 2,971,250

SPRAY NOZZLE WITH CONTOURED ORIFICE AND METHOD OF CONTOURING THE ORIFICE

Filed Dec. 19, 1952 2 Sheets-Sheet 1

Fig. 1

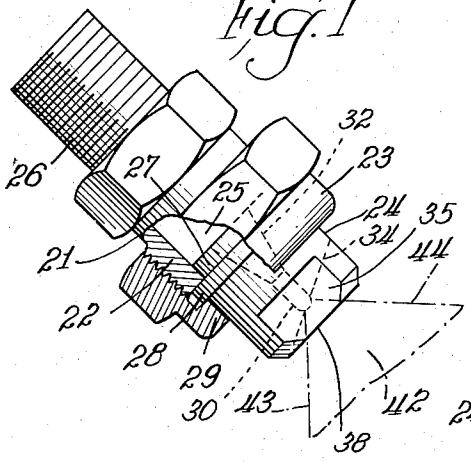
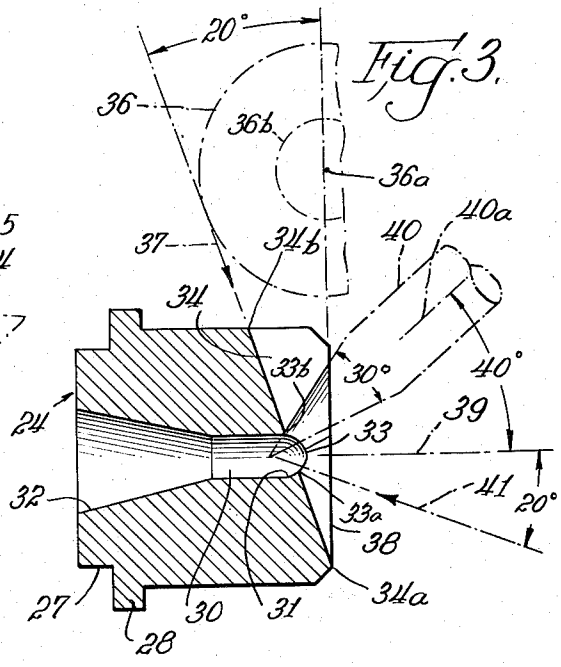


Fig. 3.



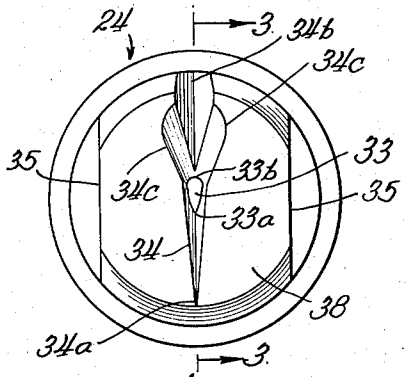


Fig. 2.

Fig. 4

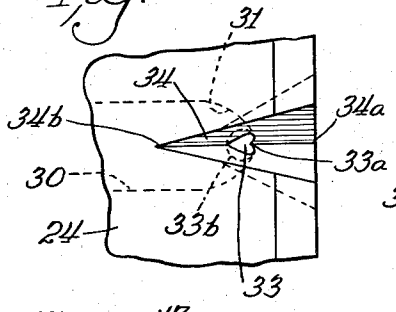


Fig. 5

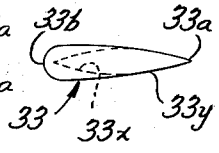


Fig. 6

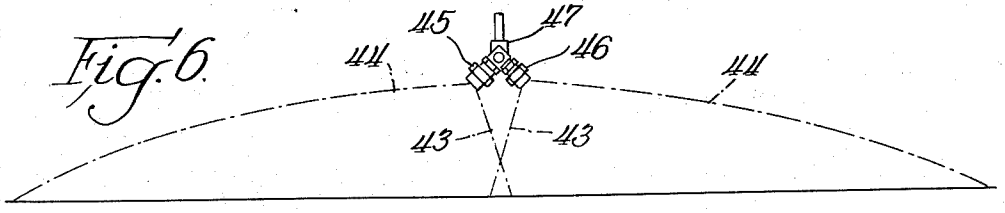
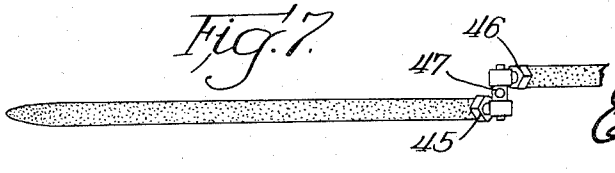


Fig. 7



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SPRAY NOZZLE WITH CONTOURED ORIFICE AND METHOD OF CONTOURING THE ORIFICE

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Fig. 8.

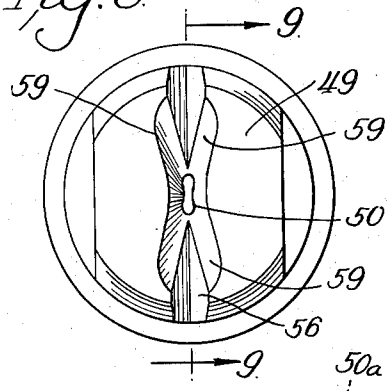
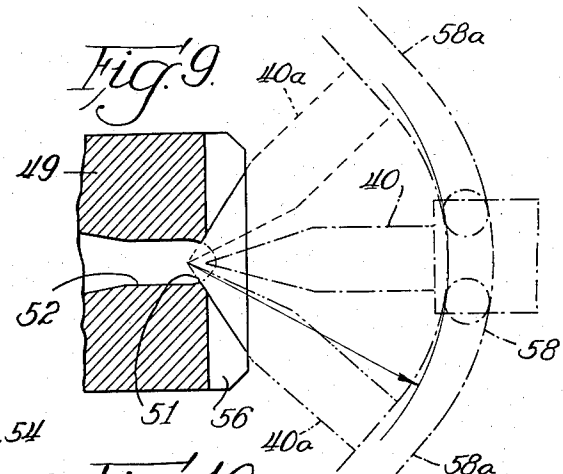


Fig. 9.



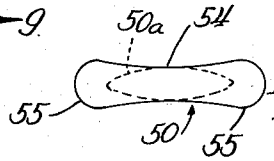


Fig. 10.

Fig. 11.

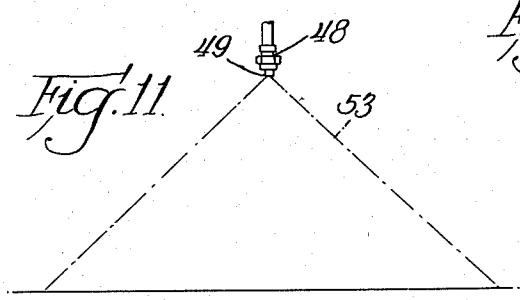
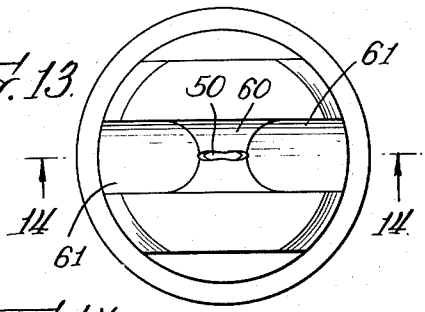


Fig. 13.



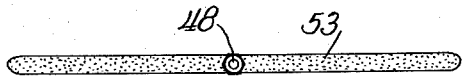


Fig. 12.

Fig. 14.

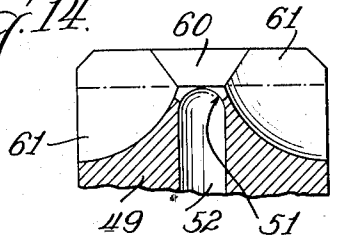


Fig. 15.

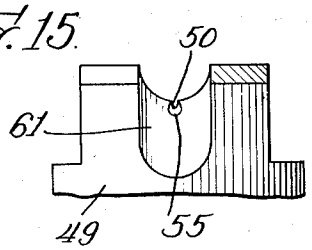


Fig. 16.

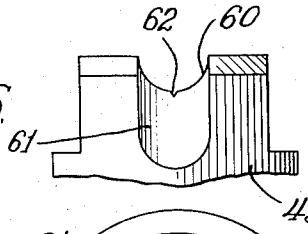
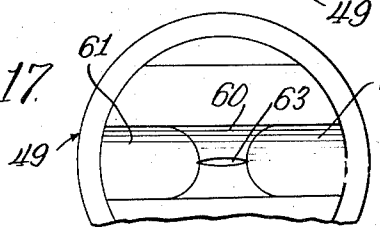


Fig. 17.



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2,971,250

SPRAY NOZZLE WITH CONTOURED ORIFICE AND METHOD OF CONTOURING THE ORIFICE

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Filed Dec. 19, 1952, Ser. No. 326,866

10 Claims. (Cl. 29—157)

This invention relates to spray nozzles which have an orifice of elongated relatively narrow shape for producing a fan shaped spray, and has reference more particularly to a nozzle wherein the width of the orifice is varied throughout the orifice length according to the volume of discharge required for uniformity of spray deposit. The invention also relates to the method of shaping or contouring the orifice according to such differential volume requirement.

In many spraying operations it is customary to employ a nozzle having an orifice which is of a narrow elongated shape or contour and produces a thin fan shaped spray of wide fanwise expanse so as to deposit the spray in a long narrow pattern and apply or deposit the spray across a wide expanse in the spraying operation.

Generally, in such spraying operations it is desirable that the spray be distributed uniformly throughout the wide expanse of spray deposit and it is accordingly important that the volume of spray discharge throughout the length of the orifice be properly proportioned to insure such uniform distribution.

Such nozzles are commonly used, for example, in field spraying, or in spraying along the sides of a roadway, railway or stream, or for similar spraying purposes, wherein the spraying equipment is carried by a conveyance which travels across the field or along the roadway, railway or stream and projects the spray across a wide expanse crosswise of the direction of travel of the conveyance as it moves across the field or along the roadway, railway or stream.

In such spraying operations, the nozzle is generally tilted sidewise in the plane of the orifice length and in the direction of desired wide expanse so that the discharge from one end of the elongated orifice, hereinafter referred to as the inner end, is directed substantially downwardly from the nozzle and the discharge from the other end of the elongated orifice, hereinafter referred to as the outer end, is directed sidewise to a far flung distance from the nozzle. Such nozzles may be advantageously mounted in pairs and oppositely inclined, for field spraying, so that the downwardly discharging inner edge of the fan shaped spray from each nozzle meets or slightly overlaps the downwardly discharging inner edge of the fan shaped spray from the other nozzle, and the sidewise discharge from each nozzle is in the opposite direction to the sidewise discharge from the other nozzle, so that the two nozzles conjointly cover a continuous expanse of double the range of a single nozzle.

In roadside spraying or in spraying along a railroad or along the side of a stream, however, a single nozzle may be employed for each side of the roadway, railway or stream, and tilted sidewise to throw the spray over a wide expanse along the side of the roadway, railway or stream along which the conveyance moves which carries the spraying equipment.

With the nozzles thus inclined, the discharge from the inner end portion of the elongated orifice, which is

directed substantially downwardly from the nozzle, is distributed over a much shorter length of the spray range than the far flung discharge from the outer end portion of the elongated orifice, and as the discharge from each succeeding portion of the orifice, from the inner end to the outer end thereof, is distributed over an increasingly greater length of the spray range, it is essential for uniform spray coverage that the volume of spray discharge from the inner end portion of the orifice be relatively small and that the volume discharge from the outer end portion be relatively large and that the volume increase progressively from the inner end of the orifice to the outer end thereof in accordance with the increasingly greater length of spray range accommodated thereby, and that the width of the orifice be varied accordingly from end to end thereof to provide the appropriate volume of spray for uniform spray coverage throughout the spray range.

Also, in some spraying operations, it is desirable that the nozzle be located midway or at some other place between the extremities of the fanwise expanse of spray deposit, in which event it is essential for uniform spray distribution that the least amount of spray discharge from the orifice be at the place between the orifice ends where the discharge is directly toward the surface upon which the spray is deposited, and that the volume of discharge increase from that place to each end of the orifice where the spray therefrom is outflung to the extremities of the fanwise expanse of spray deposit.

For such spraying operations it is necessary, for uniform spray distribution, that the elongated orifice be shaped or contoured so that it is of the least width at the place where the discharge therefrom is directly toward the surface on which the spray is deposited and that the width thereof be progressively increased from this place of least width to each opposite end of the orifice according to the distance that the spray is far-flung fanwise at each side of the place of discharge directly toward the surface.

Heretofore sidewise discharge fan shaped spray nozzles for field and roadside spraying and the like, have been made with one end of the elongated orifice enlarged and of rounded end contour and with the other orifice end tapered to a V-shape, as shown in my copending application Serial No. 104,672 which was filed on July 14, 1949, now Patent 2,683,626, by forming one end portion of the orifice with a rotary cutter having a rounded peripheral cutting edge and by forming the other end portion of the orifice with a similar rotary cutter but having a V-shaped peripheral cutting edge, and continuing the rounded edge and V-shaped cuts toward one another so that they meet between the ends of and form a continuous orifice opening, and fan shaped spray nozzles have also been made, as shown in my copending application Serial No. 292,798 which was filed on June 11, 1952, now Patent 2,774,631, by opposed cuts, with a V-edged rotary cutter, which are arranged to produce an elongated V-ended orifice which is narrowed at a place between the ends and increases in width at each side of that place of narrow width, but such orifices of said applications, while they approximate the required shape or contour of the orifice for uniform spray distribution and provide greater uniformity of spray distribution than nozzles of those types which were made previously, do not conform sufficiently to the necessary shape to insure complete uniformity of spray distribution throughout the fanwise expanse of spray deposit.

The principal objects of my invention are to provide a spray nozzle with an elongated fan shaped spray producing orifice which is contoured throughout its length so as to provide appropriate variations in orifice width for uniform spray distribution throughout the expanse

of spray deposit; to permit such nozzles to be made readily with the place of least width at one end of the orifice end or midway between the ends or at any selected place between the ends; and to provide a simple and convenient method of contouring elongated orifices of spray nozzles to provide desired variations of width thereof, these and other objects being accomplished as pointed out more particularly hereinafter and as shown in the accompanying drawing, in which:

Fig. 1 is a side view of a spray nozzle constructed in accordance with the present invention;

Fig. 2 is an enlarged view of the outer end of the nozzle tip of the spray nozzle of Fig. 1;

Fig. 3 is a sectional view of the nozzle tip of Fig. 2 taken on the line 3—3 of Fig. 2, and showing the method of making the orifice thereof;

Fig. 4 is an enlarged view of a fragmentary portion of the nozzle tip looking at the large open end of the groove which extends across the end of the nozzle tip;

Fig. 5 is a developed or planar view of the orifice of the nozzle;

Fig. 6 is a side view of a twin nozzle assembly comprising two nozzles made in accordance with the present invention and showing the spray streams produced thereby;

Fig. 7 is a top view of the nozzle assembly and spray streams of Fig. 6, part of one of the spray streams being broken away;

Fig. 8 is an end view of a nozzle tip showing another form of orifice made in accordance with the present invention;

Fig. 9 is a sectional view of the nozzle tip of Fig. 8, taken on the line 9—9 thereof and showing the method of making the orifice thereof;

Fig. 10 is a developed or planar view of the orifice of the nozzle tip of Figs. 8 and 9;

Fig. 11 is a side view of a nozzle having a spray orifice like that of Figs. 8, 9 and 10 and showing the spray stream produced thereby;

Fig. 12 is a top view of the nozzle and spray stream of Fig. 11;

Fig. 13 is an end view of a nozzle tip showing a modified form of nozzle tip end;

Fig. 14 is a sectional view taken on the line 14—14 of Fig. 13;

Fig. 15 is a side view of the nozzle tip end of Fig. 14 looking at the end of the cross groove thereof;

Fig. 16 is a view similar to Fig. 15 but showing the orifice at an intermediate stage of the making thereof; and

Fig. 17 is an enlarged fragmentary end view of the nozzle tip at the intermediate stage of orifice making shown in Fig. 16.

The nozzle illustrated in Fig. 1 is of a conventional form, except for the nozzle tip and orifice construction, and comprises a hollow body 21 with externally threaded outer end 22 engaged by an internally threaded clamping ring 23 by which a nozzle tip 24 is secured to the outer end of the nozzle body.

This nozzle body 21 has an opening 25 therethrough which leads to the nozzle tip end thereof and at its other end, the body 21 is provided with appropriate facilities for securing the nozzle to a pipe or fitting through which liquid is supplied to the nozzle.

As representative of such facilities, the nozzle body 21 is shown in Fig. 1 with external threading 26 at the inner end thereof remote from the nozzle tip 24, although it is to be understood that other facilities may be employed instead, such, for example as those indicated in Figs. 6 and 7, which, as hereinafter explained, show a twin nozzle assembly like that described in detail in my copending application Serial No. 104,672 which was filed on July 14, 1949, now Patent 2,683,626.

The nozzle tip 24, as illustrated herein, has a portion 27 which projects into the outer end of the nozzle body opening 25, and said tip is provided with an annular flange 28 which is clamped in leak proof manner against the outer end of the nozzle body 21 by the clamping ring 23 which has an inturned flange 29 at the outer end to engage against the flange 28 for that purpose.

This nozzle tip 24 has a bored out central passage 30 leading outwardly therein from the nozzle body opening 25 and terminating in a rounded or dome shaped outer end 31, and the inner end of this passage 30 is preferably flared as indicated at 32 to provide a somewhat funnel shaped entrance from the nozzle body opening 25 to the passage 30.

The dome shaped end 31 of the passage 30 is concentric with the passage 30 and preferably hemispherical or approximately hemispherical, that of the illustrated nozzle being of a slightly pointed arch form with the opposite sides of the arch having a radius of curvature which is two thirds the diameter of the passage 30. The diameter of the passage 30 depends upon the purpose for which the nozzle is employed and the material that is to be sprayed, but I have found that a diameter of approximately one sixth of an inch is satisfactory for many field and roadside spraying operations.

At the outer end of the passage 30 a spray orifice 33 leads outwardly therefrom at the bottom of a narrow V-shaped groove 34 which extends centrally across the end of the nozzle tip 24 at an inclination to the axis of the passage 30 from the point 34*a* at the end of the nozzle tip to the point 34*b* of considerable depth down one side of the nozzle tip, as indicated particularly in Fig. 3, and this orifice 33, which is central of the width of the groove 34, is elongated in the direction of the length of the groove 34 and in the direction of its length is off center with respect to the axis of the passage 30 so that the orifice end 33*a*, which is nearest the end 34*a* of the groove 34, is at one side of and near the apex or summit of the dome shaped end 31 of the passage 30 and the other orifice end 33*b*, which is nearest the deep end 34*b* of the groove 34, is quite remote from the apex or summit of the dome shaped end 31, so that the orifice 33 extends a considerable distance down the side of the dome shaped end 31 at one side of the summit thereof and at the opposite side of the summit extends only a short distance down the side of the dome shaped end.

The end 33*a* of the orifice 33 is of a narrow angled V-shape corresponding substantially to the narrow V-shape of the groove 34, whereas the opposite orifice end 33*b* is rounded and of considerable width and the orifice is of progressively increasing width from the V-shaped end 33*a* thereof to the rounded end 33*b* thereof, as indicated in Fig. 5, so that the volume of spray discharge from the orifice 33 is relatively small at the V-shaped end 33*a* thereof and progressively increases from that end 33*a* to the rounded end 33*b* where the spray discharge is relatively large and of maximum volume.

In the particular manner of contouring the nozzle orifice 33, as hereinafter explained, with the progressively increasing width from the end 33*a* to the end 33*b* thereof, the V-shaped groove 34 is increased in width between the orifice 33 and the deep end 34*a* of the groove 34 as indicated at 34*c*, and this widening corresponds substantially to the increased thickness of the spray stream projected outwardly from the orifice through the groove 34 at that place.

The outer end portion of the nozzle tip is preferably provided with two opposed flat sides 35, as indicated in Figs. 1 and 2 which not only are convenient for wrench engagement but are also convenient for indexing the nozzle tip in a holder or jig for machining operations on the tip, and the groove 34 and orifice 33 are arranged centrally between and parallel with these flat sides.

For making the above described nozzle with the orifice 33 located and contoured as above described, the narrow V-shaped groove 34 is first cut across the end of the nozzle tip, as indicated in Fig. 3, so as to cut through

into the dome shaped end 31 of the passage 30, but only to a sufficient depth to form the V-shaped orifice end 33*a* at the desired place down the side of the dome shaped end 31.

This may be accomplished by employing a rotary milling cutter 36 of conventional type which rotates about the axis 36*a* and has a peripheral series of V-shaped cutters or cutter formation of sufficient depth of cut, such as indicated at 36*b*, to provide a groove 34 of the required depth and V-shape, and moving the rotating cutter along the line 37 across the end of the nozzle tip 24.

The groove 34 is of 30° angle V-shape and the cutters or cutter formations of the cutter 36 are accordingly of corresponding 30° angle V-shape and the cutter 36 is moved in a straight line, as indicated at 37, across the end of the nozzle tip 24 and at an angle of 20°, as indicated in Fig. 3 of the drawing, to the outer end face 38 of the nozzle tip, which said face is perpendicular to the longitudinal axis 39 of the passage 30, and in this operation a narrow elongated off center initial orifice is formed which is composed of corresponding or substantially similar end halves 33*x* and 33*y*, as indicated in Fig. 5, and is of similar V-shape at each end, and one end of which constitutes the V-shaped end 33*a* of the eventual orifice 33.

After this initial orifice is formed, with the similar V-shaped ends, another rotary cutter 40 of end mill type having an acute angled conical cutting end and rotating about a longitudinal axis 40*a* which coincides with the axis of the cone shaped cutting end thereof, is moved in a direction toward the nozzle tip end along a line 41, as indicated in Fig. 3, so that the point of the rotating conical milling cutter 40 enters the already formed initial orifice 33*x*, 33*y*, near to that end thereof which constitutes the eventual orifice end 33*a*, and the movement of the conical milling cutter 40 is continued to a position, such as indicated in Fig. 3, which is at or slightly beyond the other end of the initial orifice 33*x*, 33*y*, after which the cutter 40 is withdrawn from the orifice.

In this above described movement of the conical milling cutter 40, the pointed end thereof is projected to a progressively increasing depth into the dome shaped end 31 of the passage 30, but does not contact the nozzle tip stock and begin its cutting operation until it is at or approximately at the junction of the two halves 33*x* and 33*y* of the initial orifice opening, after which said cutter 40, in the continued movement progressively increases the width of the initial orifice opening from the place at which it begins its cutting operation, as aforementioned, to its eventual or final cutting position in which it is shown at 40 in Fig. 3, and thus contours the half 33*x* of the initial orifice 33*x*, 33*y* to the eventual widened shape with rounded end 33*b* as shown in full lines in Fig. 5.

Preferably the conical end of the end mill cutter 40 is of the same 30° V-shaped angle as that of the cutters or cutter formations of the cutter 36 so that the taper thereof corresponds to the taper of the V-groove 34, and this cutter 40 is positioned with the axis 40*a* thereof at an angle of 40°, as shown in Fig. 3, to the axis 39 of the nozzle tip passage 30 and is moved in a plane coinciding with the longitudinal axis of the initial orifice opening 33*x*, 33*y* and of the V-groove 34, so that the point of the conical cutter moves along a line 41 at a 20° angle to the longitudinal axis 39 of the nozzle passage 39 all as indicated in Fig. 3.

Thus the advancing front of the concical cutting end of the end mill cutter 40 is arranged at an included angle of 75° to the line of movement 41 and has sufficient pitch to compensate for the lifting tendency of the conical cutter as it advances into the nozzle tip stock.

Obviously the extent of progressive increase in the width of the final orifice 33 and the width attained at he rounded end thereof depends upon the taper of the milling

cutter 10 and the particular line along which the cutter is moved and the rate at which it is moved and the rate at which it is progressively projected to an increasingly greater depth into the dome shaped end 31 of the nozzle tip passage 30.

Also the shape or contour of the orifice 33, and especially the portion thereof which is produced by the cutter 36, depends upon the particular V-shape or angularity of the cutter 36, and moreover the shape of the orifice 33 depends upon the particular place where the conical end of the end mill cutter 40 begins its cutting operation in the initial orifice opening 33*x*, 33*y*, and it is to be understood that while I have, for purposes of illustration, shown and described the above nozzle as made in a particular manner, the shape or contour of the eventual orifice 33 may be varied to provide uniform spray distribution for the particular purpose for or manner in which the nozzle is to be used, by varying any of the above mentioned factors on which the shape of the orifice depends.

In using the above described nozzle for field and roadside spraying and the like, it is generally tilted at an angle, substantially as shown in Fig. 1, with the elongated orifice 33 thereof lying in a vertical plane transverse to the direction of movement of the conveyance on which the spraying equipment is mounted, and with the narrow V-shaped end 33*a* of the orifice directed substantially directly downward and the wide rounded end 33*b* directed substantially horizontally outward from the nozzle end.

Thus a fan shaped spray is produced, substantially as indicated fragmentarily at 42 in Fig. 1, one edge 43 of which is quite thin and directed downwardly and the opposite edge 44 of which is quite thick and directed outwardly to a far flung distance and with the thickness and volume of the spray progressively increasing from the thin edge 43 to the thick edge 44, so that the spray deposit is uniform throughout the spray range.

For field spraying, the nozzles are usually mounted in pairs and tilted in opposite directions as indicated at 45 and 46 in Figs. 6 and 7 and as explained in detail in my above mentioned copending application Serial No. 292,798 so the thin edge portions 43 of the fan shaped sprays therefrom meet or slightly overlap directly below the nozzles 45 and 46 and the thick edge portions 44 are discharged in opposite directions to a far flung distance as shown in Figs. 6 and 7.

For spraying along roadways, railways, streams and the like a single nozzle is generally employed at the side of the conveyance on which the spraying equipment is mounted and tilted outwardly therefrom so as to discharge downwardly and to a far flung distance sidewise from the conveyance.

A modified form of the invention is shown in Figs. 8, 9, 10, 11 and 12 wherein the nozzle 48 thereof is provided with a nozzle tip 49 which has an elongated orifice 50 centrally located at the outer dome shaped end 51 of the passage 52 thereof to produce a fan shaped spray 53 which is spread out equally at opposite sides of the nozzle location, as shown particularly in Figs. 11 and 12.

In accordance with the present invention this orifice is of least width midway between the ends, as indicated at 54 in Fig. 10 and is of greatest width at the opposite ends 55, which are rounded, and the orifice is of corresponding progressively increasing width from the narrow midportion 54 to each end 55 so that the volume of spray throughout the length of the orifice is suitably proportioned to insure uniform spray distribution throughout the fanwise range of spray deposit.

To make the orifice 50 of the Figs. 8, 9 and 10 shape a narrow V-shaped groove 56 of uniform depth is first cut straight across the end of the nozzle tip 49 with a rotary cutter, like the cutter 36 of Fig. 3, having a V-shaped peripheral or cutting edge and this groove 56 is cut to a depth to cut through the summit of the dome

shaped end 51 of the passage 52 only sufficiently to form an elongated V-ended initial orifice opening, such as indicated by dotted lines at 50*a* in Fig. 10, and which, midway between the ends thereof, is of the minimum width or approximately the minimum width 54 desired in the eventual orifice 50.

Then the same operation with the end mill cutter 40 which is shown in and explained above in connection with Fig. 3 is performed toward one end of the thus provided initial orifice opening 50*a* so as to enlarge the opening at that end as shown at 55 in Fig. 10 after which the same operation with the end mill cutter is performed toward the other end of the initial orifice opening 50*a* so as to enlarge the opening 50*a* at that other end as shown at 55 in Fig. 10, thereby providing an orifice of the shape shown at 50 which is of minimum width midway between the ends as indicated at 54 and of progressively increased width from that midway place to each enlarged rounded end 55 thereof.

The end mill cutter 40 may be moved along a curvilinear path, instead of along a straight line path such as indicated at 41 in Fig. 3, to form the orifice 33 of Figs. 1 to 5 or the orifice 50 of Figs. 8, 9 and 10.

For example, as indicated in Fig. 9, the orifice 50 may be formed by swinging the cutter 40 in an arcuate or substantially arcuate path in front of the dome shaped end 51 of the nozzle passage 52, from one substantially radial position to another, and at the same time adjusting the end mill cutter 40 radially so as to project to the required extent into the dome shaped end 51 of the passage 52 to contour the orifice to the desired shape.

For imparting such movement to the cutter 40 in this orifice forming operation, a guide 58 may be employed, of approximately arcuate shape, along which the rotatable end mill cutter 40 is movable so as to swing the conical cutting end thereof in the plane of and from end to end of the elongated initial orifice opening 50*a* and in a path which corresponds substantially to the curvature of the dome shaped end 51, while at the same time providing such endwise adjustment of the end mill cutter 40 as will increase or decrease the depth of penetration of the pointed end of said cutter into the dome shaped end 51 as will provide the particular contour desired for the orifice 50.

Thus the guide 58 of Fig. 9, while approximately arcuate, has the opposite end portions 58*a* swung inwardly to a position closer to the dome shaped end 51 of the passage 52 than the midway portion of the guide 58, so that as the end mill cutter 40 is moved along the guide 58 from the midway position to which the reference numeral 40 is applied, to a position 40*a* at either end 58*a* of the guide 58, the pointed end of the end mill cutter 40 is projected to a progressively greater depth into the dome shaped end 51 so as to enlarge the opposite end halves of the initial orifice opening 50*a* to the shape thereof of the orifice 50.

Obviously the rate of progressive increase in the width of the orifice 50 from the midway point to each end thereof depends upon the taper of the conical end of the cutter 40 and the rate of progressively increased depth imparted thereto by the guide 58, and by varying the taper of the cutter or the contour of the guide 40 substantially any shape of orifice may be produced.

Moreover, the orifice 50 may be disposed in an off center position by cutting the groove 56 at an inclination similar to that of the groove 34 of Fig. 3 and positioning the cutter 40 and guide 58 directly in front of the midpoint in the length of the off center initial orifice opening 50*a* and swinging the cutter from that position to the opposite extremes of movement thereof to form the final orifice shape.

Moreover, either the central or off center orifice 50 may be made with opposite tapered end portions of unequal length by swinging the cutter 40 unequal distances oppositely from the midportion of the initial orifice opening 50*a* and the shapes of the opposite tapered end portions may be differed by forming the guide 58 to project the cutter unequally into the dome shaped end 51 at the respective sides of the midportion of the initial orifice.

In this operation of forming the orifice 50, the groove 56 is enlarged by the cutter 40 to progressively increased width from the midplace of the orifice 50 to the opposite extremities thereof, as indicated at 59 in Fig. 8, and the progressively increased width corresponds to the increase in the width of the orifice 50 and the correspondingly increased volume of discharge occasioned by such increased orifice width.

While I have indicated in the above description of the making of the orifices 33 and 50 that the grooves and orifices are produced by movement of the cutters, it is to be understood that the invention contemplates relative movements of the cutters and nozzle tip which have the effect of the explained movements of the cutters and that the nozzle tip may be moved, instead of the cutter, in producing the orifices 33 and 50.

The nozzle tips of the present invention may be advantageously made with an orifice protecting groove, such as disclosed in my copending application Serial No. 81,288, filed March 14, 1949 (Patent No. 2,621,078), and also with inclined grooves at opposite ends of the orifice, such as disclosed in my copending application Serial No. 306,236, filed August 25, 1952, now Patent 2,683,627, if desired.

For example, the nozzle tip 49 of Figs. 8 and 9 may be provided, as shown in Figs. 13, 14, 15, 16 and 17 with a wide round bottom orifice protecting groove 60 extending straight across the end of the nozzle tip 49 as indicated by the dotted lines in Fig. 14, in accordance with my aforesaid application Serial No. 81,288, and the nozzle tip may also have, in addition, if desired, inclined round bottom grooves 61 sloping rearwardly at each end of the orifice 60, in accordance with my aforesaid application Serial No. 306,236, the bottom of the groove 60 being near to the outer extremity of the dome shaped end 51 so that there is an abrupt increase in the groove width at the place where the spray stream issues from the orifice 50 and ample air is supplied to the opposite sides of the issuing spray stream, as explained in my application Serial No. 81,288 to relieve the aspiration effect of the issuing spray stream and avoid any tendency of the stream to hug the groove side walls and thus impair the perfection of spray pattern and cause dripping from the nozzle.

The inclined grooves 61 lead forwardly and inwardly close to the opposite extremities of the orifice 50 so as to supply air at the base of the issuing stream in a direction corresponding quite closely to the direction of discharge thereof and which, as explained in my aforesaid application Serial No. 306,236 avoids turbulence at the base of the spray stream and the detrimental effect of such turbulence on the spray stream.

These grooves 60 and 61 are made, in well known manner, with a conventional rotary cutter having a rounded peripheral cutting edge corresponding to the rounded shape of the grooves 60 and 61.

In making nozzles of the present invention with the groove 60 or with the grooves 60 and 61 before the orifice is formed is advantageous, as the prior provision of said grooves minimizes the amount of stock which is required to be cut through by the V-shaped cutter which forms the initial orifice and by the conical milling cutter which contours the initial orifice to the eventual shape.

After the grooves 60 and 61 have been provided, only a very shallow V-shaped groove 62 is required to be cut in the bottom of the groove 60 by a V-edged cutter, like that employed for making the V-shaped grooves 34 and 56 of the above described nozzle tips, and an initial orifice opening 63 is thus formed like the initial orifice

opening shown by dotted lines at 50*a* in Fig. 10, and after this initial orifice opening 63 has been formed, then it is contoured to the desired shape 50 with a conical milling cutter 40 in the same manner as the orifice 50 of the nozzle tip 49 of Fig. 8 is made.

The nozzle tip 24 of Figs. 1, 2, 3 and 4 may be made in like manner with orifice protecting groove 60 and inclined grooves 61, by first providing the nozzle tip with said grooves 60 and 61 and thereafter proceeding in the same manner as explained in connection with Figs. 1, 2, 3 and 4 to form the initial orifice opening 33*x*, 33*y* and the final contoured orifice 33 thereof.

While I have shown and described my invention in a preferred form, I am aware that various changes and modifications may be made therein without departing from the principles of the invention, the scope of which is to be determined by the appended claims.

What is claimed is:

1. The method of making a spray nozzle with an elongated fan-shaped, spray-producing orifice opening from the interior to the exterior thereof, such that the orifice discharges part of its spray in a direction transverse of the length of said nozzle, which said method comprises the steps of providing a nozzle body with a passage therein leading toward and having the outer end thereof located within the outer end of the nozzle body and of forming an external groove in the outer end of the body at a place to intersect the outer end of such passage and mutually therewith form a long orifice having elongated, closely spaced groove side walls extending outwardly therebeyond, and, after said groove-forming step has been performed, interposing a rotatable orifice-widening tool between the opposite side walls of the groove, with its rotative movement in opposite directions respectively at the opposite sides of the groove and rotating the thus interposed tool at such depth in the groove and throughout such length thereof to increase the width of a selected portion of the length of the orifice.

2. The method of claim 1 wherein the external groove is formed with outwardly diverging side walls and the interposed tool is rotated about an axis which is oriented in a position extending outwardly from the groove approximately in the midwidth plane thereof.

3. The method of claim 1 wherein the region of the passage adjacent the outer end thereof decreases in cross section toward said outer end and the external groove is formed in the outer end of the body to intersect the passage end in the region of such decrease in cross section and eccentrically in the direction of the orifice length so that the mid-length of the orifice is at one side of the middle of the outer end of the passage and the rotatable orifice-widening tool is conically tapered in the direction of the length of its axis of rotation and progressively increases the width of the orifice toward the end thereof at said one side of the center of the outer end of the passage.

4. The method of claim 1 wherein the passage is provided with a dome-shaped outer end and the external groove is formed in the outer end of the body to intersect the dome-shaped outer end of the passage eccentrically in the direction of the orifice length so that the mid-length of the orifice is at one side of the summit of the dome-shaped outer end of the passage and the rotatable orifice-widening tool is conically tapered in the direction of the length of its axis of rotation and progressively increases the width of the orifice toward the end thereof at said one side of the summit of the dome-shaped outer end of the passage.

5. The method of making a spray nozzle with an elongated fan-shaped spray discharge orifice at the outer end of a passage, which said method comprises the steps of providing a nozzle body with a passage therein leading toward and having the outer end thereof located within the outer end of the body, forming in the outer end of the body an external groove extending crosswise of the passage end at a depth in the outer end of the body in which it intersects the outer end of the passage and mutually therewith forms an elongated orifice at the place of intersection thereof, and providing at the outer end of the nozzle body an orifice widening cutter which is rotatable on an axis in the mid-width plane of the groove and applicable in the orifice for widening thereof, and while said cutter is rotating on said axis in a direction crosswise of the orifice, relatively advancing said cutter into the orifice and toward one end of the orifice to cause widthwise enlargement of selected portions of the length of the orifice.

6. The method of making a spray nozzle as defined in claim 5 in which the cutter is axially elongated and in the relative advancing movement thereof is advanced sidewise toward said one end of the orifice.

7. The method of making a spray nozzle as defined in claim 5 in which the cutter is conically tapered in the direction of the length of the axis of rotation thereof and is advanced endwise into the orifice and advanced sidewise toward said one end of the orifice.

8. The method of providing a nozzle body with an elongated fan shaped spray discharge orifice at the outer end of a passage, which said method comprises the steps of providing a nozzle body with a passage therein leading toward the outer end of the body and having an annularly sloped outer end located within the outer end of the body, forming in the outer end of the body an external groove extending crosswise of the passage end at a depth and relation with respect to the passage end to intersect the sloped outer end of the passage and mutually therewith form an elongated orifice extending crosswise of said passage and a sloping in conformity with the sloped outer end of the passage, and then projecting a rotatable cutter into the groove at said orifice and while the cutter is rotating on an axis in the midwidth plane of the groove shifting said cutter sidewise and toward the orifice to cause widthwise enlargement of selected portions of the length of the orifice.

9. The method according to claim 8 wherein the said plane thereof substantially coincides with the longitudinal axis of the passage and the axis of rotation of the cutter is disposed in changing angularity to the longitudinal axis of the passage during the sidewise shifting of the cutter.

10. The method according to claim 8 wherein the said plane thereof substantially coincides with the longitudinal axis of the passage and the axis of rotation of the cutter is disposed in changing angularity to the longitudinal axis of the passage during the sidewise shifting of the cutter and during said sidewise shifting the change in angularity of said axis of rotation corresponds to the change in slope of the orifice.

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