

Sept. 27, 1966

E. J. O'BRIEN ET AL

3,275,248

MODIFIED FULL CONE NOZZLE

Filed Aug. 7, 1964

3 Sheets-Sheet 1

Fig. 1.

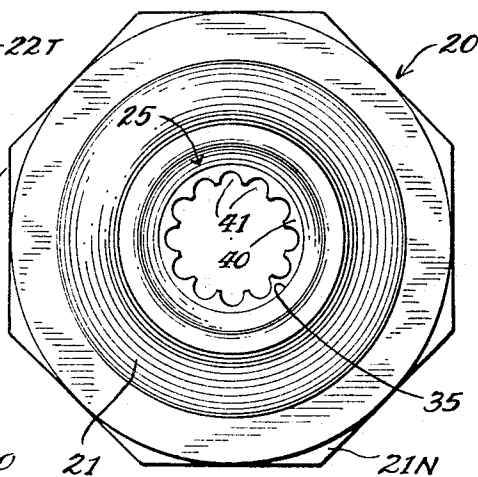
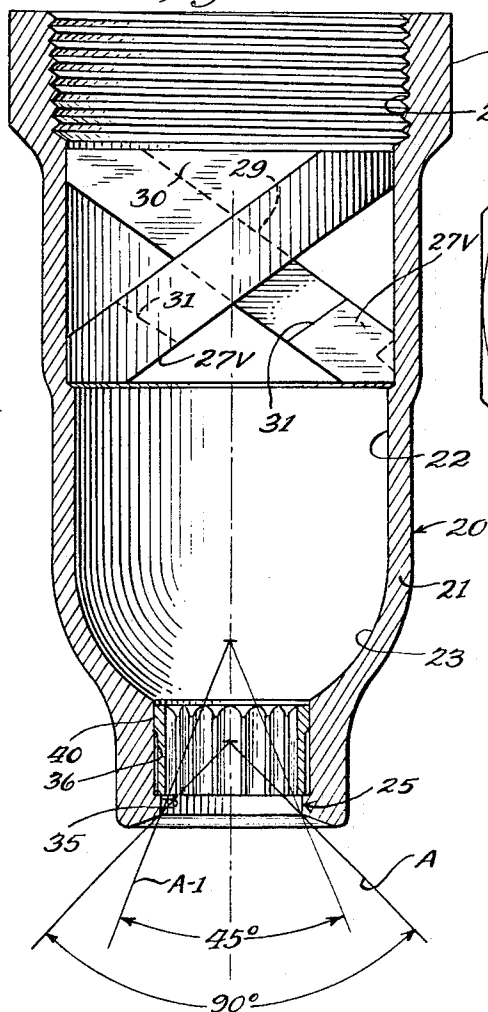


Fig. 2.

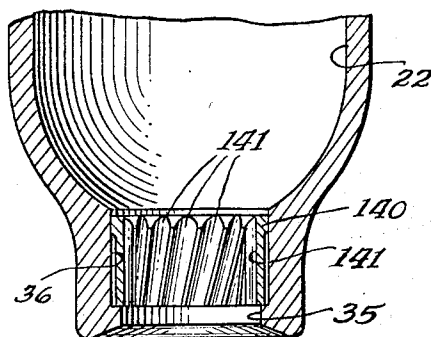


Fig. 3.

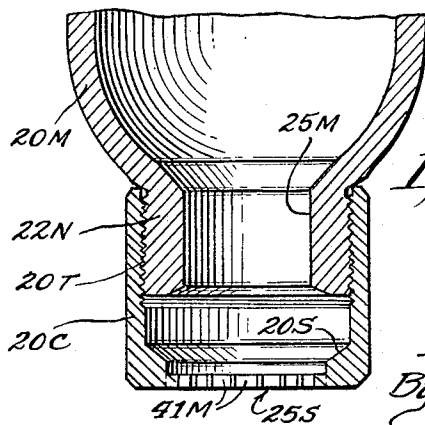


Fig. 1A.

Inventors
Edward J. O'Brien
Robert P. Williams
By Mann, Brown & McWilliams
Attys.

Sept. 27, 1966

E. J. O'BRIEN ET AL
MODIFIED FULL CONE NOZZLE

3,275,248

Filed Aug. 7, 1964

3 Sheets-Sheet 3

Fig. 7.

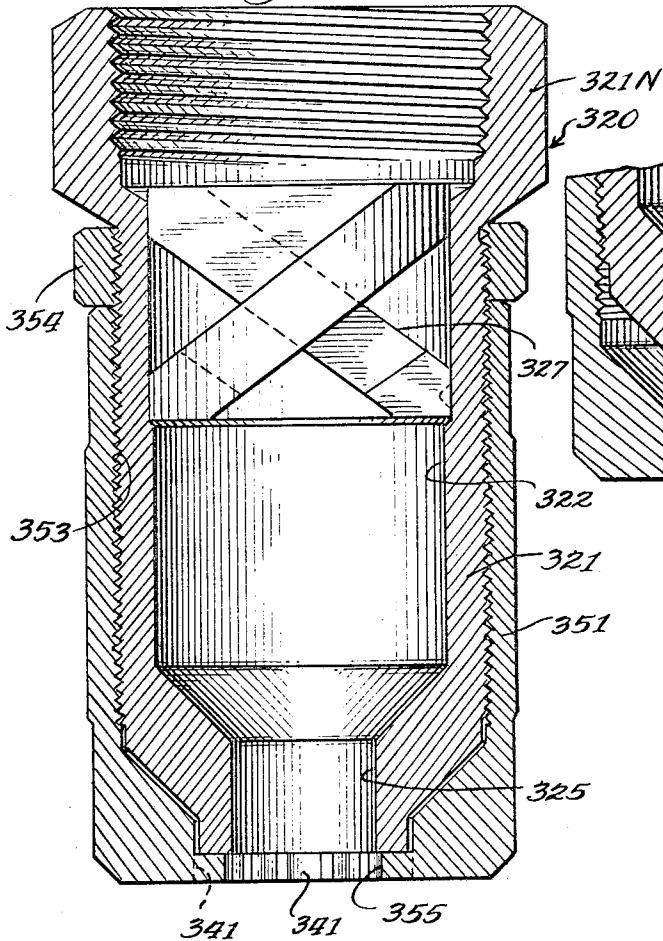


Fig. 7A.

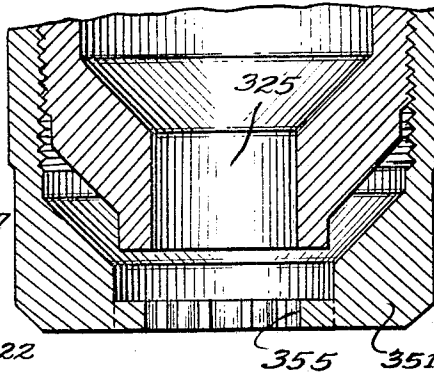


Fig. 9.

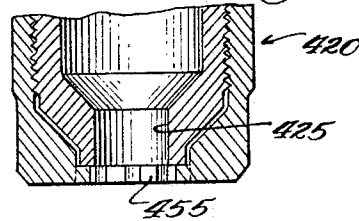
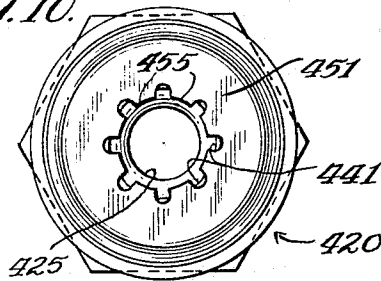
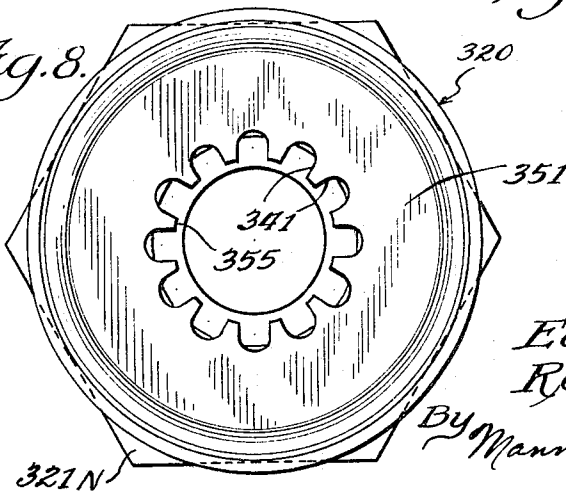


Fig. 10.

Fig. 8.



Inventors
Edward J. O'Brien,
Robert P. Williams.

By Mann, Brown & McWilliams
Attys

1

3,275,248

MODIFIED FULL CONE NOZZLE

Edward J. O'Brien, Glen Ellyn, and Robert P. Williams,
Naperville, Ill., assignors to Spraying Systems Co., a
corporation of Illinois

Filed Aug. 7, 1964, Ser. No. 383,137

2 Claims. (Cl. 239-487)

This invention relates to full cone spray nozzles wherein a conical spray is formed that provides for substantially even distribution of the liquid throughout the entire spray pattern, as contrasted with hollow cone sprays where no liquid is present in the center portion of the spray.

Full cone spray nozzles of the aforesaid character have long been made and have been widely used in industry, and have been made in large number of different sizes, capacities and spray angles. Such full cone spray nozzles are provided basically by a nozzle body with an internal chamber into one end of which the liquid is introduced, and with a reduced diameter axial discharge orifice at the other end of the chamber, and within the chamber and spaced a substantial distance from the discharge orifice, vane means are provided, either separately formed or integral with the body, so that liquid passing through the chamber has a swirling or rotative motion applied thereto coupled with a controlled amount of turbulence so that when the liquid is discharged from the orifice, this liquid assumes a conical form with uniform distribution of the particles of water throughout the transverse cross-sectional area of the spray.

In full cone spray nozzles, the capacity, of course, is determined by the area of discharge orifice with the operating pressure serving as a secondary factor, but in attainment of a particular spray angle and in attainment of the desired uniformity of particle distribution in the spray, the relationships between the orifice dimensions, the form, dimensions and location of the vane means, and the dimensions of the internal chamber constitute variables that contribute and interact in attaining the desired results. Because full cone spray nozzles find such a wide field of usefulness, there has been a constant increase in the number of nozzles that have been made available in an effort to provide nozzles having the desired combination of capacity, spray angle and pressure factors to satisfy the majority of design situations. Thus, applicants' assignee now produces and stocks well over two hundred different nozzles of this type, which at twenty pounds per square inch liquid pressure, provide capacities of from .10 gallon per minute to 2410 gallons per minute with spray angles ranging between 15° and 125°.

While the wide selection of full cone spray nozzles that is thus available appears on its face to be sufficient to meet most design situations, but in fact the necessity for satisfying three variables, pressure, capacity and spray angle, renders it practically impossible to provide stock nozzles for every different set of conditions.

It is, therefore, the primary object of the present invention to simplify the provision of full cone spray nozzles where special requirements are involved, and a related object is to enable the operation of full cone spray nozzles of known characteristics to be modified in a relatively simple manner to change the spray angle thereof while maintaining the same or substantially the same capacity and preserving the uniform distribution of the liquid within the modified spray angle.

Other and related objects are to enable the standard full cone spray nozzles to be modified to vary the spray angle thereof, and to enable this to be done while maintaining the original form of practically all of the parts or elements of the standard spray nozzle. More specific

2

objects are to provide a method of modification of standard full cone spray nozzles whereby relatively simple forming and machining operations on a limited portion of the standard spray nozzle produces a spray of a different angle and with a good distribution of the liquid within the spray pattern.

Another and more specific object of this invention is to enable the spray angle of full cone spray nozzles to be varied and adjusted to meet the design or operating problems of the installation in which they are used, and a related object is to enable this to be done with full cone spray nozzles of proven design.

Other and further objects of the present invention will be apparent from the following description and claims, and are illustrated in the accompanying drawings which show structures embodying preferred features of the present invention and the principles thereof, and what is now considered to be the best mode in which to apply these principles.

In the accompanying drawings forming a part of this specification and in which like numerals are employed to designate like parts throughout the same:

FIG. 1 is a longitudinal cross-sectional view showing a full cone spray nozzle according to one aspect of the present invention;

FIG. 1A is a lengthwise cross-sectional view of a nozzle embodying an alternative form of the invention;

FIG. 2 is an end elevational view showing the discharge end of the nozzle of FIG. 1;

FIG. 3 is a view generally similar to the orifice end of the nozzle of FIG. 1 and illustrating a modified construction;

FIG. 4 is a longitudinal cross-sectional view of another full cone spray nozzle embodying the invention;

FIG. 5 is a sectional view taken along the line 5-5 of FIG. 4;

FIG. 6 is an end view of the nozzle shown in FIGS. 4 and 5;

FIG. 7 is a longitudinal cross-sectional view of another embodiment of the invention wherein the spray angle of the full cone jet may be readily adjusted;

FIG. 7A is a fragmental view showing the spray angle adjusting means in a different position than in FIG. 7;

FIG. 8 is an end view of the nozzle shown in FIG. 7; and

FIGS. 9 and 10 are cross-sectional and end views respectively showing the adjustable means as incorporated in a full cone nozzle of smaller capacity.

For purposes of disclosure, the invention is herein illustrated as embodied in several different forms of full cone spray nozzles that in most of their structural features are identical with and make use of the basic components of full cone spray nozzles that have been made and used for many years.

Thus, in FIGS. 1 and 2, a spray nozzle 20 is shown, and in FIGS. 4 to 6, a spray nozzle 220 is shown, and both of the nozzles 20 and 220 have fixed spray angles, while in FIGS. 7 to 10, spray nozzles 320 are illustrated wherein the spray angle may be adjusted.

The nozzle 20, illustrated in FIGS. 1 and 2, has an elongated nozzle body 21 that is generally cylindrical throughout most of its length, but which is formed at its inlet and with a hexagonal wrench flange 21N. The nozzle body 20 has an elongated chamber 22 of cylindrical form and at the inlet end of the nozzle body and the chamber, this chamber 22 is internally threaded as at 22T for connection with a source of liquid to be sprayed. At its other or outlet end, the chamber 22 is gradually rounded or tapered as at 23 toward a discharge orifice 25 that is of special form and construction as will be hereinafter described in detail.

Spaced substantially from the outlet end of the nozzle

3

body 21, vane means 27 are provided in fixed position within the chamber 22 and such vane means may be of any known construction that is operable to impart a swirling and turbulent motion to the liquid as it advances through the chamber 22 toward the discharge orifice 25. As shown in FIG. 1, the vane means 27 are of the specific separately formed type illustrated, for example, in Wahlin Patent No. 2,305,210, patented December 15, 1942, and in Wahlin et al. Patent No. 2,999,648, patented September 12, 1961.

Such vane means is thus in the form of a separate unit that is press fitted into the inlet end of the chamber 22 and against a locating shoulder 28. The vane unit 27 embodies a pair of oppositely sloping vane elements 27V, these vanes being generally semicircular in form and being joined together in a triangular area 29 where the flat side edges of the vanes cross each other, and also being joined by a web 30 as described in some detail in the two aforesaid prior patents. The two vanes 27V as thus described, tend to impart a swirling movement to the liquid passing therethrough, and slots 31 formed in the flat side faces of the vanes 27V on the outlet side of the unit act to cause a limited amount of reverse swirling movement of the liquid so as to thus provide turbulence in the advancing liquid.

As the swirling and turbulent liquid moves through the balance of the chamber 22 and through the tapered portion 23 to the orifice 25, this turbulence and swirling movement continues so that when the liquid passes through the orifice 25, it is formed into a conical spray that is of the solid cone form.

Ordinarily the discharge orifice 25 in nozzles of this type is in the form of a cylindrical passage, the length of which varies in different designs of nozzles, and the angle A of the resulting spray is determined by the various combinations of design factors that have been embodied in the nozzles. Thus, in designing such a nozzle, the effective area of the discharge orifice serves as a first basic factor in determining the capacity of the nozzle and, of course, the capacity is also determined in part by the pressure of the liquid that is being sprayed. The spray angle, of course, is also determined by a number of variable factors, the same is true with respect to the distribution pattern of the liquid particles in the spray. Thus the spacing of the vane unit from discharge orifice constitutes one variable factor, and the design and slope of the vanes constitutes another governing factor. With these factors determined, however, the spray angle may vary in accordance with the pressure of the liquid being sprayed, and it is found quite generally as to any nozzle of this type that throughout a certain range of pressures, the particle distribution in the spray will remain satisfactory.

It will thus be apparent that when a commercial design for a full cone spray has been developed and tested to determine its performance as to capacity, and its spray angle for different pressures, such a nozzle may be selected and installed with assurance that it will perform satisfactorily under the conditions that are to apply in such installation. As above pointed out, many different nozzle sizes have been commercially developed so as to provide a fairly wide range of selection according to the controlling factors that are to be encountered in various installations. It is found, however, that the commercially available nozzles will not, in every instance, fit the conditions that are to be encountered in a particular installation. Usually the pressure that is to be employed and the capacity that is to be attained are the primary controlling factors, but the desired spray angle for such capacity and pressure is also critical in most instances. Actually, among the commercially available nozzles of this kind, it is usually possible to locate a nozzle that will meet all of the requirements except the desired spray angle, and under and in accordance with the present invention, this problem is overcome by modifying a known

4

spray nozzle so as to maintain substantially the same capacity at the pressure that is to be used, while modifying and reducing the spray angle to the value that is desired. This is accomplished under the present invention by relatively simple modification of conventional nozzles so that most of the basic and more complicated parts thereof are utilized in their original or slightly modified form.

Under the present invention, the modifications are made in or in close association with the spray orifice 25 so as to reduce the spray angle and cause redistribution of the liquid into the reduced area of the spray. Thus, as shown in FIG. 1, the nozzle body 21 has a central or axial bore 35 formed therein that is counterbored at 36 to receive an orifice insert sleeve 40. This orifice insert sleeve 40 fits with a press fit in the counterbore 36 and has its internal surface formed so that it modifies the action of the swirling liquid as this liquid moves through the sleeve 40. As will be evident from FIGS. 1 and 2 of the drawings, the sleeve 40 has an annular series of grooves 41 formed therein so as to extend parallel to the axis of the sleeve 40, and these grooves 41 are equally spaced so as to have a tooth-like form. The total area of the opening provided in the sleeve 40 is selected so as to be substantially equal to the area of the orifice that would normally be provided in the conventional nozzle that is being used as the basis for modification. This results in provision of a capacity which closely approximates that of the original nozzle.

As the liquid swirls into and through the sleeve 40, it is, of course, moving transversely of the grooves 41 at an acute angle to these grooves, so that the tooth-like form of the surfaces that are engaged by the swirling liquid serves to retard the rotative or swirling movement of the outer portion of the liquid and, at the same time, serves to throw portions of this liquid inwardly toward the axis of the sleeve. The slowing down of the swirling action of the liquid serves basically to cause the liquid to be discharged at a smaller spray angle, such as the angle A-1 of FIG. 1, while the droplets of liquid that are thrown inwardly serve to preserve a substantially uniform distribution of the liquid in the spray pattern.

It is pointed out that the modifying action that is accomplished by the grooves 41 is dependent upon the number, width and depth of these grooves, and the action is dependent to a lesser extent upon the length of these grooves. Thus in the present instance, twelve grooves 41 are provided, and these are relatively deep and wide, this arrangement being employed for relatively large capacity nozzles where a considerable modification or narrowing of the spray angle A is to be accomplished. In nozzles where the discharge is to be somewhat small, a lesser number of grooves may be employed, and it is found that the variation that may be desired may be accomplished usually by variation in the number of grooves 41 while utilizing the same width and depth thereof.

In FIG. 3 a modified form of the invention is illustrated wherein all of the elements of the structure, as above described, are utilized in the same relationship, but in this instance, the disposition of the spray-modifying grooves about the discharge orifice is somewhat different. Thus in FIG. 3 a sleeve 140 is used that is mounted in the same manner as hereinbefore described, but in this instance, internal grooves 141 are provided that are arranged at an angle with respect to the axis of the sleeve 140. This angular disposition of the groove 141 may be in either direction from the parallel arrangement shown in FIG. 1, and the extent of the modifying action of the grooves is determined by the slope and direction of slope of the grooves 141. In this connection it is apparent that the modification of the spray angle by the grooves 141 is dependent upon and related to the angle at which the swirling liquid encounters the grooves 141, and this, of course, provides a factor that can be varied in producing a spray nozzle for a selected spray angle.

The principles of the present invention may, of course,

5

be applied to other specific forms of solid cone spray nozzles, and as an example, FIGS. 4 to 6 illustrate an alternative embodiment of the invention as embodied in the basic structure of a spray nozzle that is shown in Wahlin Patent No. 2,747,936, patented May 29, 1956 and which has been commercially made and widely used for many years.

Thus, as illustrated in FIGS. 4 to 6, the invention is embodied in a solid cone spray nozzle 220 having a nozzle body 221 that is produced by casting, and in this embodiment of the invention, vane means 227 are cast integrally within the internal chamber 222 of the nozzle body. In this instance the nozzle body is externally threaded at 221T for connection with a supply pipe, and the nozzle body has a discharge orifice 225 at the end that is remote from the vane means 227.

In the embodiment of the invention that is shown in FIGS. 4 to 6, the discharge orifice 225 has grooves 241 formed therein at equally spaced intervals about the periphery of the orifice 225, and these grooves 241 may be formed either in the casting operation or at a later time by milling, broaching or other convenient means. Grooves 241 serve the same function as the grooves 41 hereinbefore described, while these grooves 241 are herein shown as being parallel to the axis of the nozzle, it will be realized that the grooves may be disposed at an angle in the general manner described with respect to FIG. 3 of the drawings.

The grooves 241 accomplish the desired reduction in the spray angle A that would be normally attained in the basic structure of the nozzle 220, thus to produce a spray having an angle such as the angle A-1 of FIG. 4.

In the embodiments of the invention heretofore described, the grooves that produce modification and reduction of the spray angle are formed in the sides of the spray orifice, but it is pointed out that the spray angle may be modified by grooves of the same general character formed in an annular series in an independent member disposed forwardly of the normal discharge orifice of a full cone spray nozzle so that the grooves act upon the outer or bordering portions of the spray that has been formed.

Thus, in FIG. 1A of the drawings, a full cone spray nozzle 20M is fragmentally illustrated which in all of its details may be like that shown in FIGS. 1 and 2, but as shown in FIG. 1A, the nozzle 20M has the normal spray orifice 25M formed in the forward necked portion 22N of the nozzle body. The structure provided in the nozzle body and by the orifice 25M would normally produce a fairly wide spray angle, and under the present invention, this fairly wide spray angle may be reduced through the provision of a cap 20C secured on the nozzle body as by being threaded at 20T onto the neck 20N. The cap 20C has an orifice 25S in its forward wall. The orifice 25S is of approximately the same area as the orifice 25M and has a plurality of slots 41M formed in an annular series about the edge of the orifice 25S in the same general relationship as shown in FIG. 2 of the drawings. Thus, the relatively wide angle spray that is emitted from the orifice 25M is more or less confined in its outer portions by the cap 20C so that these outer portions of the spray are directed inwardly toward the axis of the orifice 25M in part by a sloping internal annular shoulder 20S as shown in FIG. 1A. This spray, being rotating in character, encounters the several grooves 41M so that portions of the spray are directed toward the axis of the spray in a drop-let form, thus to preserve the uniform distribution of liquid in the spray pattern while reducing the angle of the spray to an extent that is determined in part by the number and shape of the grooves 41M and in part by the spacing of the orifice 25S from the end of the main orifice 25M.

The cap 20C thus forms a separate element that may be designed as to the form and number of its teeth 41M and the diameter or area of its orifice 25S to produce the

6

desired modification of the spray produced by the basic nozzle structure. The structure that is provided as disclosed in FIG. 1A is designed primarily as a fixed modification of a full cone spray nozzle, but as will hereinafter become apparent, this structure may also be employed in the same basic form to produce a full cone spray nozzle wherein the spray angle may be adjusted throughout a limited range by the use of the adjustment provided by the screw threaded connection 20T.

In FIGS. 7 to 10, the invention is illustrated as embodied in spray nozzles of the full cone type wherein adjustable means are provided for varying the normally produced spray angle of the basic spray nozzle. Thus, in FIGS. 7, 7A and 8, a spray nozzle 320 is illustrated that is produced from the same basic spray nozzle as shown in FIGS. 1 and 2 of the drawings. The spray nozzle 320 has an elongated nozzle body 321 having a wrench flange 321N at its inlet end and having an internal chamber 322 and a vane unit 327 of the same general form. The internal chamber 322 terminates in an elongated cylindrical spray orifice 325 which may be the same as in the basic form of nozzle that is to be modified in producing an improved nozzle. The particular internal chamber, vane unit 327 and the spray orifice 325 will, of course, produce a full cone spray having a particular spray angle which is usually relatively wide, and under this invention means are provided in association with the nozzle body 321 for reducing and modifying the spray angle in much the same way as in the structure shown in FIG. 1A of the drawings, and with the further advantage, however, that a considerable range of spray angle adjustment is provided from the original relatively wide angle to other angles that are less than the original spray angle. In accomplishing this reduction of the spray angle, an elongated sleeve-like cap 351 is provided that has its internal surface threaded for cooperation as at 353 with threads on the outer surface of the nozzle body 321. A lock nut 354 is provided that is threaded onto the outer surface of the nozzle tip 34 for locking engagement with the upper or rear end of the cap 351 to maintain any position of adjustment that has been established.

At its outer or lower end, the cap 351 has a control orifice 355 that is somewhat larger than the diameter of the original discharge orifice 325, and about the inside edges of the orifice 355, the cap is formed with an annular series of grooves 341 that have the tooth-like form and arrangement that is shown, for example, in FIGS. 1 and 1A. The cap 351 is arranged so that it may be screwed in an upward or rear direction as viewed in FIG. 7 so that the inside of the wall in which the orifice 351 is formed may be directly engaged with the end of the nozzle body that surrounds the main orifice 325. When the cap 351 is in its fully retracted position as shown in FIG. 7, the normal wide angle spray is formed and passes through the toothed or grooved orifice 355 with substantially no modification of the normal and relatively wide spray angle produced by the basic nozzle structure. However, when it is desired to reduce this normal spray angle, the cap 351 may be screwed with relation to the nozzle 321 to separate the toothed or grooved orifice 355 from the outer or lower end of the basic discharge orifice 325, as is illustrated in FIG. 7A of the drawings. The several grooves 341 are thus in position to be engaged by the rotating spray that has emerged from the orifice 325 so that the interaction of the grooves 341 with the spray causes droplets from the outer portion of the spray to be thrown inwardly into the main body of the spray. Thus the ultimate angle of the spray is reduced, and the liquid that has engaged the several control grooves 341 is thrown in a reverse direction into the center of the spray so as to preserve substantial uniformity of distribution of the liquid in the spray pattern.

The structure shown in FIGS. 7, 7A and 8 is intended to be embodied in spray nozzles having a relatively large capacity. It must be recognized, however, that the attain-

ment of a reduced spray angle may be desirable in solid cone spray nozzles of a relatively small capacity. Thus, in FIGS. 9 and 10, a nozzle 420 is shown that is of the same general character as the nozzle shown in FIGS. 7, 7A and 8, with the exception, however, that the nozzle of FIGS. 9 and 10 is of a relatively low capacity. Thus, the discharge orifice 425 thereof is somewhat smaller than the orifice 325 shown in FIG. 7 and since the spray emitted from the orifice 425 is somewhat smaller in circumference and area, the cap 451 is provided with an orifice 455 that has a smaller number of grooves 441. In both instances, however, the grooves serve as through portions of the original spray inwardly toward the axis of the spray, thus to preserve the desired uniformity of distribution of the droplets in the final spray pattern.

From the foregoing description it will be apparent that the present invention provides a new and improved solid cone spray nozzle, and it will also be apparent that the improved nozzle of this invention may be produced economically and from the unchanged basic parts of the commercially available solid cone spray nozzles.

Thus, while a preferred embodiment of the invention has been illustrated herein, it is to be understood that changes and variations may be made by those skilled in the art without departing from the spirit and scope of the appended claims.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. In a full cone spray nozzle of the character described, a nozzle body having an elongated generally cylindrical internal chamber therein, one end of which chamber constitutes an inlet end through which liquid may pass into said chamber, vane means disposed in said chamber adjacent to said inlet end for imparting swirling and turbulent motion to liquid advancing through said chamber, said chamber at its other end being gradually reduced in

diameter and terminating in an end wall having a discharge orifice coaxial with said chamber, a cap having a skirt portion threaded longitudinally onto the nozzle body and a cross wall spanning said end wall, said cross wall having a central opening larger than and coaxial with said discharge orifice, said central opening having an annular series of grooves formed about its periphery and parallel with the axis of said discharge orifice for engagement by outer portions of a spray issuing from the orifice for directing part of the swirling liquid in droplet form inwardly toward the center of the spray emerging from said orifice.

2. A full cone spray nozzle according to claim 1 wherein said cap is adjustable from a fully retracted position wherein the spray issuing from said orifice is unaffected by said grooves to forward positions wherein the spray angle is gradually reduced as the space between said walls is increased.

References Cited by the Examiner

UNITED STATES PATENTS

1,667,943	5/1928	Munz	239—466
2,044,445	6/1936	Price et al.	239—502
2,303,478	12/1942	McLean	239—498
2,747,936	5/1956	Wahlin	239—490
2,871,059	1/1959	O'Brien	239—502
3,072,346	1/1963	Wahlin et al.	239—463

FOREIGN PATENTS

14,724	10/1908	Great Britain.
816,143	4/1937	France.
890,328	9/1953	Germany.

M. HENSON WOOD, JR., *Primary Examiner.*

R. S. STROBEL, *Assistant Examiner.*