Dec. 13, 1955 H. B. DUPONT 2,726,897

FIRE FIGHTING SPRAY NOZZLE

Filed March 26, 1952 2 Sheets-Sheet 1

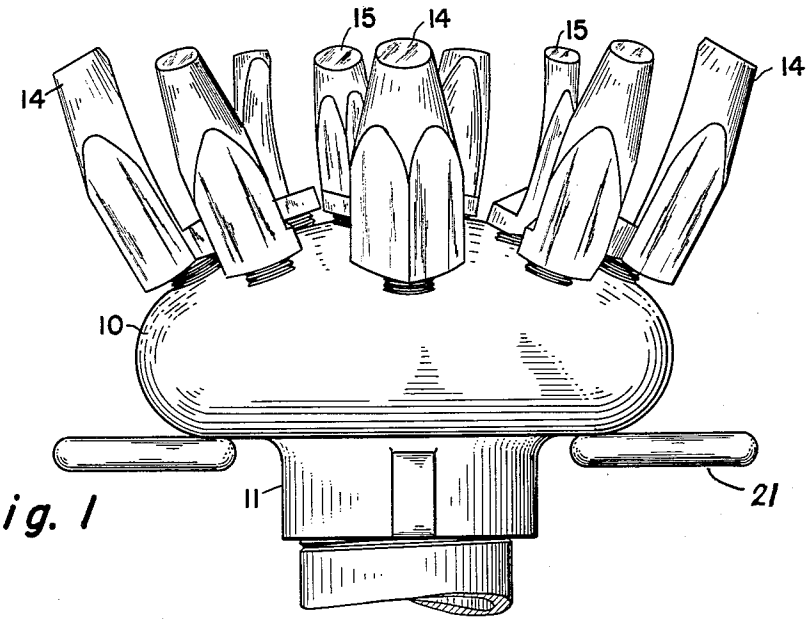


Fig. 1

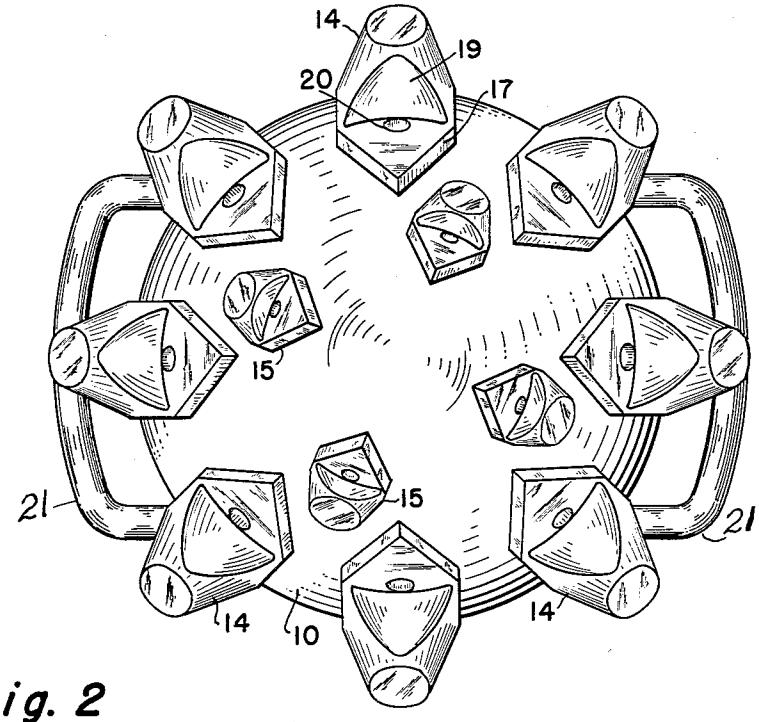


Fig. 2

INVENTOR.
Harry B. Dupont
BY Green McCallister & Miller
HIS ATTORNEYS

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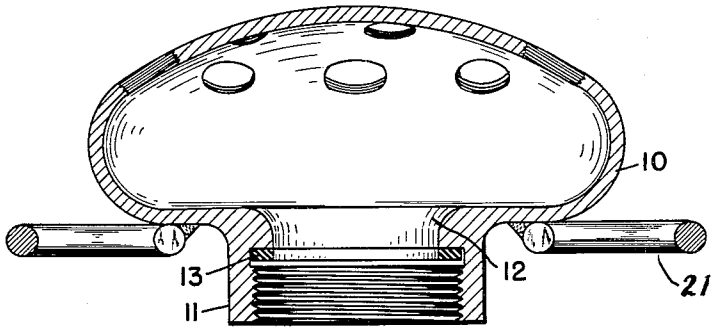


Fig. 3

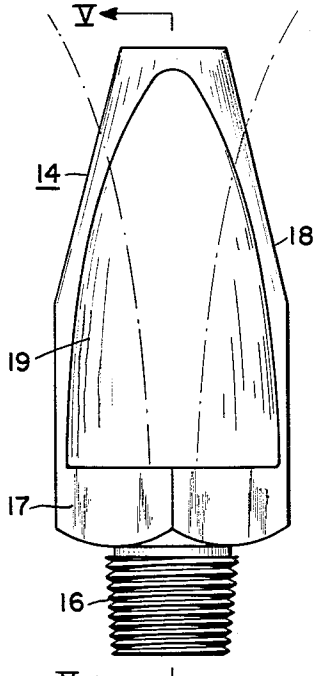


Fig. 4

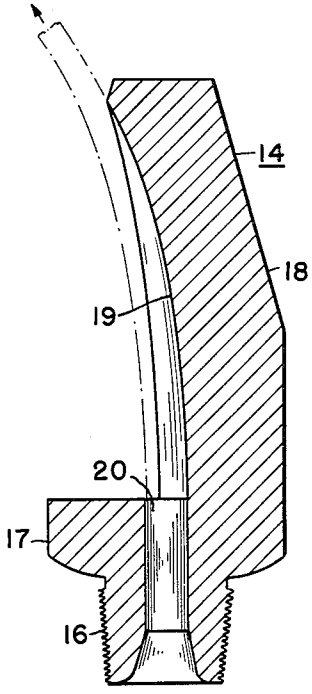


Fig. 5

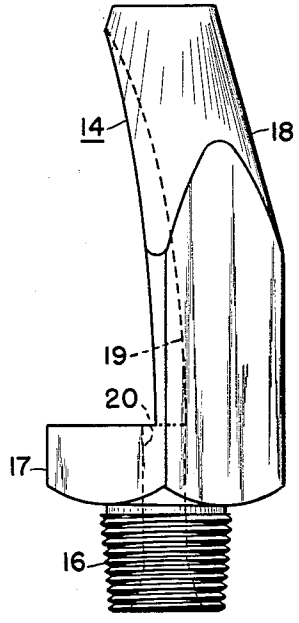


Fig. 6

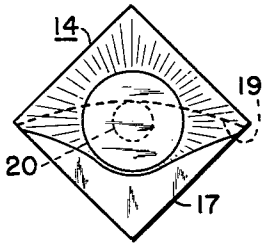


Fig. 7

INVENTOR.
Harry B. Dupont
BY Green McCallister & Miller
HIS ATTORNEYS.

United States Patent Office

2,726,897

Patented Dec. 13, 1955

2,726,897

FIRE FIGHTING SPRAY NOZZLE

Harry B. Dupont, Braddock, Pa.

Application March 26, 1952, Serial No. 278,616

7 Claims. (Cl. 299—141)

This invention relates generally to fire fighting equipment and particularly to a nozzle for delivering liquid in the form of a fog-like spray and an object thereof is to produce such a nozzle which will project liquid in the form of fog-like spray for a substantial distance and under conditions such that the spray so projected may be directed and may be employed to substantially submerge a moderate size building or other source of fire.

A further object is to produce procedure which contributes to the formation of a relatively long and laterally expanding stream consisting essentially of a mass of fog-like spray intimately intermingled with several substantially consolidated high velocity liquid jets and/or a moving mass of separate drops of liquid which contribute to the continued forward movement of such spray, the proportioning being such that the fog-like spray has sufficient body to penetrate even a powerful up draft occasioned by a large fire.

A further object is to produce apparatus and procedure for projecting a stream of liquid for a substantial distance, for example at least 150 feet horizontally and for continuously breaking a substantial portion of the liquid so projected into a fog-like spray throughout substantially the major portion of the length of the liquid stream.

A further object is to produce apparatus and procedure for forming a well defined liquid stream, a substantial portion of which consists of a fog-like spray and which is capable of being directed in such a way as to render it highly effective as a fire fighting medium.

These and other objects are attained by means of the apparatus illustrated and the procedure defined herein.

In the drawings accompanying and forming a part hereof,

Figure 1 is a side elevation of a nozzle embodying my invention.

Figure 2 is a top plan view of the apparatus shown in Figure 1.

Figure 3 is a sectional elevation taken through the center of the manifold forming a part of the spray nozzle illustrated in Figures 1 and 2.

Figure 4 is a front elevation of one of several jet-producing nozzles included as a part of the spray nozzle illustrated in Figures 1 and 2.

Figure 5 is a longitudinal sectional view taken along the line V—V of Figure 4.

Figure 6 is a side elevation of the jet nozzle shown in Figures 4 and 5 and Figure 7 is a plan view of the jet nozzle shown in Figures 4, 5 and 6.

Prior attempts have been made to project a liquid stream in the form of a stream of spray, but such attempts have been only partially successful and then only under conditions where the spray formed by the nozzle is carried by naturally produced air currents. I have found that in order to produce fog-like spray in the form of a stream which can be substantially controlled as to direction and extent of throw, substantially independently

of existing air currents of normal velocities, it is necessary to produce a liquid stream which consists in part of liquid spray and in part of substantially consolidated jets or streams of liquid moving at a high velocity and breaking into a mass of separate drops at different points along the stream to produce a mass of separate drops of substantial size which continue to move for a substantial distance in the general direction of the initial movement of the stream. To state this in another way, I have found that in order to produce a controllable liquid stream, including a fog-like spray as a substantial portion thereof, it is necessary to so control the formation of such spray that it takes place along a substantial portion of the stream and while the stream includes a number of separate consolidated jets or streams of liquid moving at a high velocity and in that way creating a well defined air current in the general direction of the initial flow of liquid from the spray nozzle. From the foregoing it will be apparent that my invention involves a new principle of operation wherein a stream of fog-like spray is created by projecting a series of separate consolidated jets of liquid which may be initially divergent and which move independently of each other throughout a substantial distance from the jet-forming apparatus and then marginally impinge upon each other in progressively increasing amounts so as to form fog-like spray throughout the major portion of the length of the projected and consolidated or combined stream. As a result, the major portion of the stream consists of a more or less intimate mixture of spray, a number of separate consolidated jets or streams of liquid and/or a mass of liquid drops of substantial size which are moving in the general direction of liquid flow as it issues from the stream projecting nozzles or apparatus.

From the foregoing it will be apparent that the cooperative action of the initially formed and freely moving jets, induce an air current in the direction of liquid flow and contribute to the formation of fog-like spray as the jets are broken up by marginal impingement on each other and by the resistance of the air to the movement of the liquid. The principle of operation may be briefly described as one wherein a plurality of liquid jets are independently projected at a high velocity in the same general direction and are so formed and so located with relation to each other that they form a circular series and adjacent jets move independently of each other for a substantial distance and then marginally impinge on each other in progressively increasing amounts along the length of the combined stream, but under conditions such that the major portion of the length of the combined stream includes a mixture of spray and air-current-inducing consolidated jets and/or masses of liquid drops of substantial size and weight which, by reason of inertia, continue moving in the general direction of the initially formed jets of liquid leaving the jet projecting apparatus and by such movement entrain with them the spray formed along the length of the stream.

Referring now to the drawings, the spray delivery nozzle constituting the illustrated embodiment of my invention, includes a manifold **10** which, as shown, is of the general shape of an oblate spheroid. It is hollow and is provided with a threaded annular flange **11** surrounding an inlet port **12**, all as disclosed in Figure 3 of the drawings. The threaded flange is adapted to receive a hose connection or the threaded liquid delivery end of a deluge gun. For this reason I have disclosed the inlet port **12** surrounded by a suitable gasket **13** for sealing the joint between the wall of the manifold **10** and the cooperating liquid delivering element, such as a hose connection or the coupling end of a deluge gun. The side of the manifold opposed to the inlet port **12** is convex and substantially circular and is provided with

a plurality of nozzle-receiving apertures, each of which is threaded to receive the threaded end of a separate nozzle which may be termed a jet delivery nozzle to distinguish it from the combined structure, which I have termed a spray delivery nozzle. As shown in Figure 2, the manifold is adapted to receive two annular series of jet delivery nozzles, and the two series being located concentrically, with the inner series including smaller jet delivery nozzles than the outer series.

The outer series of nozzles consists of a plurality of substantially equally spaced jet delivery nozzles **14**, which surround the inner series of jet delivery nozzles **15**. In the illustrated embodiment of the invention the nozzles of both series are substantially similar except that the nozzles **15** of the inner series are smaller than the nozzles **14** and project smaller jets than those projected by the nozzles **14**. They are shown as substantially equally spaced and may be arranged in a circular series. As shown in Figures 1 to 3 of the drawings, the manifold **10** is so formed that each of the nozzles **14** is inclined outwardly with relation to the central axis of the manifold **10** and each of these jet delivery nozzles also diverge with relation to the jet delivery nozzles of the circular series which are adjacent to it. The positioning and relationship of the nozzles **15** of the inner series may be similarly described.

The individual jet nozzles are not new with me. I have, however, combined them with a new form of manifold and in such a way as to produce a new spray delivery nozzle and one which operates in accordance with the new principle of operation. In view of the similarity of the jet nozzles **14** and **15**, I have only illustrated the detailed structure of the nozzles **14**. As shown in Figures 5 to 7 each such nozzle includes a hollow externally threaded shank portion **16**, a body portion **17** and a projecting portion **18** which is so formed as to provide a water deflecting face **19**. The body portion **17** is preferably so formed as to provide a series of surfaces which may be engaged by a wrench for the purpose of installing and adjusting the nozzle. The interior of the tubular shank portion **16** communicates with the interior of the manifold **10** and a circular aperture **20** formed in the body portion **17** and which constitutes the jet delivering aperture of the nozzle. The liquid delivery edge of this aperture is tangentially located with relation to the jet deflecting surface **19** of the nozzle. Each surface is convex, i. e., curved laterally and longitudinally, and its marginal edge is in the form of half of a somewhat elongated ellipse. The portion of the scoop shaped surface **19** which is remote from the delivery edge of the aperture **20**, in effect, over-hangs the aperture, i. e., extends across the normal line of flow of liquid issuing from the aperture. The liquid stream issuing from the aperture **20** and moving axially with relation thereto is, therefore, gradually redirected by the surface **19** to move inwardly of the circular series of nozzles **14** and is converted into a fan-shaped stream. Thus the form of the surface **19** and its positional relationship to the jet delivery aperture **20** is such that the circular jet issuing from the aperture **20** is gradually reformed by the surface **19** so that it leaves the surface **19** in the form of a fan-shaped jet. In addition to this the general direction of the fan-shaped jet leaving the surface **19** is somewhat divergent with relation to the central axis of the manifold **10** but is more nearly parallel to that axis than the axis of the circular aperture **20**, from which the jet is initially projected.

As a result of the formation of each of the nozzles **14**, it may be said that each such nozzle delivers a jet of fan-like shape which, while gradually expanding laterally, moves through an appreciable distance without contacting any portion of an adjacent jet. However, as the fan-shaped jet of each nozzle **14** of the outer series expands, it marginally impinges upon adjacent jets of that series and, due to the high velocity of the liquid constituting the jets, the impinging jets contribute to the breaking up of a portion of the liquid flow into a mass of fine spray which may be defined as fog-like spray. In order to obtain the proper relationship between the extent of marginal impingement along the length of the projected and combined stream, I turn each jet nozzle to a position such that a portion of each fan-like jet delivered thereby, overlaps a portion of the fan-like jet delivered by an adjacent nozzle and so that each such jet is projected independently of every other jet for an appreciable distance from the jet delivery nozzle which produced it. Under some conditions it may be desirable to adjust one or more of the jet delivery nozzles so that each fan-like stream delivered thereby is overlapped by the stream delivered by both of the adjacent nozzles **14**.

The marginal impingement of adjacent jets continues and may increase in extent as the jets move forward in the general direction of their initial projection, with the result that spray is continuously formed along the length of the combined streams of liquid issuing from the nozzles **14**, whereas, a portion of each jet continues in the form of a more or less consolidated stream until it is broken up by the normal resistance of the air to the movement of the liquid constituting such stream.

From the foregoing it will be apparent that the outer series of nozzles **14** cooperate to, in effect, produce a stream of liquid which is substantially annular in cross section and which is made up of spray, consolidated jets or streams of liquid and/or drops of substantial size and weight which move in the general direction of movement of the jets leaving the nozzles **14** of the series.

In the illustrated embodiment, the inner series of nozzles primarily function to fill in the space surrounded by the hollow stream produced by the outer series of nozzles. It is, however, apparent that the nozzles **15**, though smaller than the nozzles **14**, function in substantially the same way as those nozzles function, i. e., they produce a stream which is made up of fog-like spray, consolidated jets and/or a mass of drops moving at a relatively high velocity in the general direction of movement of the jets issuing from the nozzles **14** and **15**. In this way a substantailly homogeneous stream is projected from the spray nozzle and the portions thereof which have enough weight (inertia) to continue to move in the direction of movement of the liquid issuing from the jet nozzles, function to induce and maintain a current of air which tends to hold the spray produced along the length of the projected and combined stream in more or less intimate relationship with the consolidated jets and/or the mass of moving drops which are included in the make-up of the entire or combined stream.

It is because of this induced and continued air current that the spray, which is continuously increasing in quantity as the stream moves away from the spray nozzle, can be projected in different directions and controlled, at least to some extent, independently of normal air currents. This is, to some extent, due to the fact that the induced air current in the direction of stream flow occasions a slight inflow of air toward the stream of liquid which aids in preventing a wide dispersal of the fog-like spray formed along the length of the liquid stream. It should be noted that the stream of liquid is continuously increasing in diameter (girth) and that the velocity of the induced air flow in the direction of the stream, diminishes as the stream increases in diameter so that at the effective end of the stream it is capable of engulfing a fire without at the same time feeding air to it.

I have referred to jets and masses of separate drops moving at a high velocity. When it is understood that a deluge gun may be connected to several "pumpers" and that the liquid pressure within the manifold **10** may be materially above 100 p. s. i., even under flow conditions, it will be apparent that each jet issuing from an aperture **20** is moving at a high velocity and that, consequently, the fan-shaped jets and the drops of liquid of substantial

size into which such jets are broken by air resistance, are also moving at a high velocity although it may be somewhat less than the velocity of the initially formed jets.

Attention is also directed to the fact that the inner series of nozzles need not be duplicates either as to size or function of the outer series or of the nozzles **15** shown. The primary function of the inner series of nozzles is to fill out the interior of the stream produced by the series of nozzles **14** and for that reason it may not be necessary or even desirable, to employ an inner series of nozzles so formed as to produce as great a proportion of spray as is produced by the outer series of nozzles. It is, of course, apparent that the air resistance encountered by any rapidly moving unsupported stream of liquid will occasion a breaking up of the liquid into separate drops and even spray, but the inner series of nozzles may be such as to materially contribute to the production of the induced air current along the line of liquid flow and in this way make it possible to extend the length of the spray-laden liquid stream, to more readily direct the same and render it more effective as a fire fighting medium.

It will also be apparent that the liquid stream issuing from the spray nozzle may be employed as a blanket of liquid capable of submerging a source of fire and cutting off the supply of air to the fire. It also may be employed as a protective blanket projected between a burning building and a building adjacent thereto. It also may be so located in connection with fire fighting equipment with which it is associated, as to protect the firemen from the heat of the fire that is being fought by them. It will be apparent that the thickness of the spray-laden stream at different points along its lengh will be dependent upon the shape of the jet nozzle supporting portion of the manifold **10**, i. e., the amount of divergency of the jet nozzles, and will also depend on the relative adjustment of the jet nozzles with relation to each other. As to this it will be noted that by varying the adjustment of the different jet nozzles with relation to each other, the number of jet nozzles in each series and the diameter of the outer series of jet nozzles, the length and/or the width of the stream of spray may be increased, one at the expense of the other.

I have also disclosed the spray nozzle as equipped with a pair of handles **21** which may be employed as hand holds in mounting and directing the nozzle and which are particularly useful in holding and directing the nozzle when the same is directly connected to a hose, instead of a deluge gun. The spray nozzle is, however, more effectively employed for use with a deluge set, deluge gun, a water tower, an aerial truck ladder pipe, a fire boat and, of course, may be effectively employed in connection with any type of foam generating apparatus.

While I have described but one form of apparatus which may be employed in carrying forward the procedure here outlined, it will be apparent that various changes in structural features and also in the procedural steps defined may be made without departing from the spirit and scope of my invention as defined by the appended claims.

What I claim is:

1. A method of producing an extended stream of liquid in the form of a substantially homogeneous moving mass of liquid spray and separate drops of liquid, which consists in simultaneously projecting a ring-like series of substantially consolidated streams of liquid with each such stream of the series moving in the same general direction but diverging slightly from the center of such series and from each adjacent stream of such series; substantially simultaneously with the projection thereof, flattening each such stream into a substantially consolidated fan-shaped stream without materially changing the direction of movement thereof or materially reducing the velocity of such movement; causing marginal portions of adjacent fan-shaped streams of such series to impinge upon each other and to intermingle while maintaining the remaining portion of each such stream substantially in consolidated

form and moving at a high velocity; progressively increasing the marginal impingement and intermingling of adjacent streams throughout the length of the same while maintaining the movement of the resulting mass of spray and separate drops of liquid in the general direction of movement of said integrally projected streams of liquid, and while continuously maintaining a liquid flow in the form of a plurality of substantially consolidated liquid streams, moving in the general direction of the initially projected streams and throughout a substantial portion of the moving mass of spray and separate drops.

2. A method of producing a long, gradually expanding, unsupported liquid stream including in the make-up thereof a mass of separate drops of liquid and liquid spray, which consists in establishing a source of liquid under pressure; maintaining the pressure of said source while simultaneously projecting a ring-like series of substantially consolidated separate streams of liquid moving in the same general direction; substantially simultaneously with the projection of each such stream, altering the shape thereof to a substantially consolidated fan-shaped stream; creating a mass of separate drops and liquid spray moving with said streams by causing a marginal portion of each such separate stream to impinge upon a marginal portion of an adjacent stream while said streams are moving at substantially the initial velocity of their formation and while other than the marginal portions thereof continue a free unsupported movement in substantially consolidated form; progressively increasing the marginal impingement and intermingling of adjacent streams as the streams move outwardly from said source and while continuously maintaining a plurality of substantially consolidated liquid streams moving in the same general direction from said source and with such mass of spray and separate drops; and simultaneously with the creation of said ring-like series of streams, creating a separate flow of liquid from such source and within such circular series to thereby form a substantially homogeneous stream of gradually increasing girth and spray content as it moves away from such source.

3. A spray nozzle for delivering two separate series of unsupported consolidated streams of water which gradually intermingle and form a mass of separate drops and spray moving in the general direction of such consolidated streams and which comprises a hollow manifold having an inlet port in one portion of the wall thereof and a nozzle-supporting wall forming another portion of such wall; two sets of jet nozzles mounted on said supporting wall, one such set located in a circular series around the other set with the jet nozzles of the series equally spaced and directed in the same general direction and with each such nozzle having a jet delivery aperture formed therein and communicating with the interior of said manifold and also having a concave liquid-directing surface formed thereon, projecting beyond said aperture, overhanging and partially surrounding said aperture and located tangentially with relation to said aperture at the liquid delivery edge of said aperture; each such nozzle being so positioned on said supporting wall that the fluid-directing surface thereof faces inwardly toward the center of said circular series.

4. A spray nozzle for fire fighting equipment comprising a hollow manifold having a nozzle-supporting portion forming a part of the wall thereof and an inlet port formed in another portion of such wall; two sets of jet nozzles mounted on said nozzle-supporting portion, one such set being located in a circular series around the other set with the nozzles of the series substantially equally spaced and directed in the same general direction but with each such nozzle slightly divergent with relation to every other nozzle of the series; each such nozzle having a jet-delivery aperture formed therein and communicating with the interior of such manifold and having a concave liquid-directing surface formed thereon located in tangential relationship to said aperture at the

issuing edge thereof and projecting beyond, overhanging and partially surrounding said aperture; each such nozzle being so positioned on said wall that the aperture formed therein is located between said liquid-directing surface formed thereon and the center of such circular series.

5. A spray nozzle for use with fire fighting equipment, which consists of a hollow manifold having a nozzle-supporting wall formed as a part thereof and having an inlet port communicating with the interior thereof; a plurality of liquid delivery nozzles mounted on said nozzle-supporting wall in a substantially equally spaced, substantially circular series, each such nozzle having a liquid delivery aperture formed therein communicating with the interior of the manifold and positioned so that the axis thereof is located in divergent relationship with the axis of the jet delivery aperture of every other nozzle of said series and each such nozzle is provided with a concave curved liquid-directing surface extending beyond said aperture, located in tangential relationship with, and over-hanging and partially surrounding said aperture and positioned with relation to such aperture to reshape the liquid jet issuing therefrom and to redirect the same; each such aperture being located between the cooperating liquid-directing surface and the center of the circular series of nozzles.

6. A spray nozzle for use with fire fighting equipment which consists of a hollow manifold having a nozzle-supporting wall formed as a part thereof and having an inlet port communicating with the interior thereof; a plurality of jet delivery nozzles mounted on said nozzle-supporting wall and arranged in a substantially equally spaced, substantially circular series, each such nozzle having a jet delivery aperture formed therein communicating with the interior of the manifold and positioned so that the axis thereof diverges with relation to the center of said series of nozzles and the axis of the jet delivery apertures of each of the other nozzles of said series, and a concave, curved, liquid-directing surface formed on each such nozzle, projecting beyond such aperture, partially surrounding and over-hanging the same and located tangentially with relation thereto with the aperture located between said surface and the center of said circular series; and at least one liquid delivery nozzle mounted on said nozzle-supporting wall and surrounded by said circular series of spray nozzles.

7. A spray nozzle for use with fire fighting equipment which consists of a hollow manifold having a substantially circular convex nozzle supporting portion and an inlet port communicating with the interior thereof, and two series of nozzles mounted on said supporting portion, one such series being circular and surrounding the other and consisting of a plurality of substantially equally spaced jet delivery nozzles, with each such jet delivery nozzle located in divergent relationship with every other nozzle of such series; each nozzle of such series having a jet delivery aperture formed therein communicating with the interior of said manifold and located in divergent relationship with the axis of said circular series and each such nozzle having a concave liquid directing surface projecting beyond said aperture, located in tangential relationship thereto, partially overhanging and partially surrounding said aperture and positioned with relationship to such aperture to reshape the liquid jet issuing therefrom and to direct it inwardly toward the center of said circular series.

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