BEST AVAILABLE COPY

July 16, 1940. P. E. REHSE 2,207,758

HOSE NOZZLE

Filed April 8, 1938 2 Sheets-Sheet 1

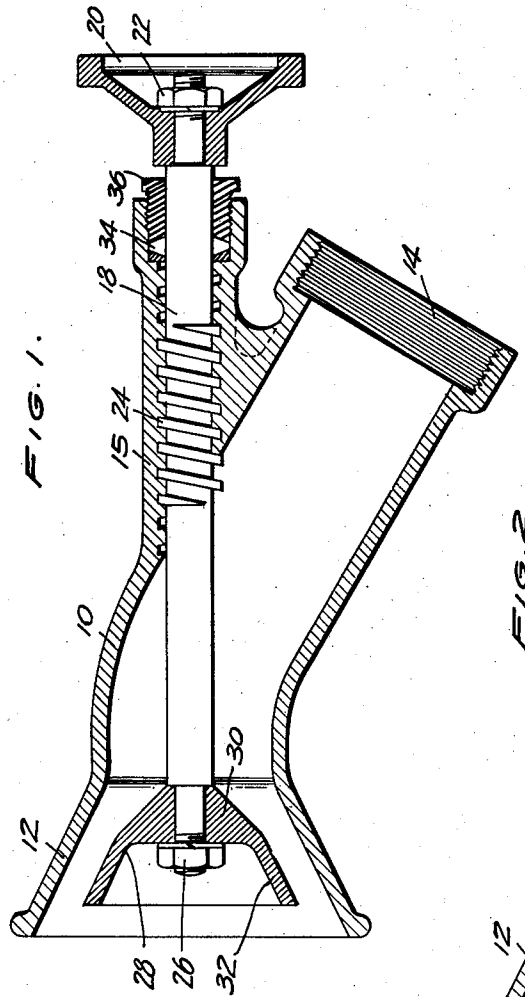


FIG. 1.

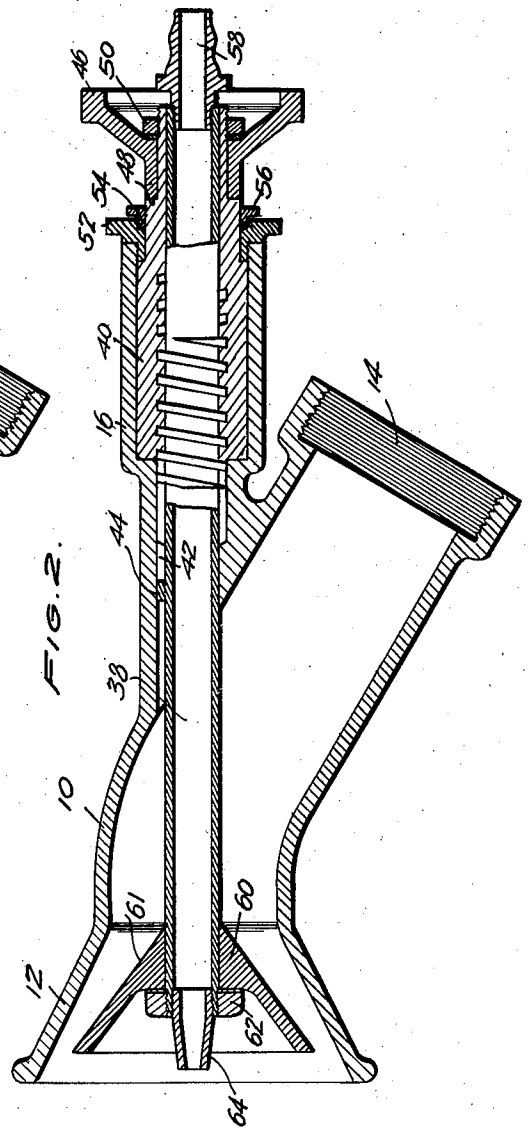


FIG. 2.

INVENTOR
PAUL E. REHSE
BY John J. Hamand
Wade Houck
ATTORNEYS

July 16, 1940. P. E. REHSE 2,207,758

HOSE NOZZLE

Filed April 8, 1938 2 Sheets-Sheet 2

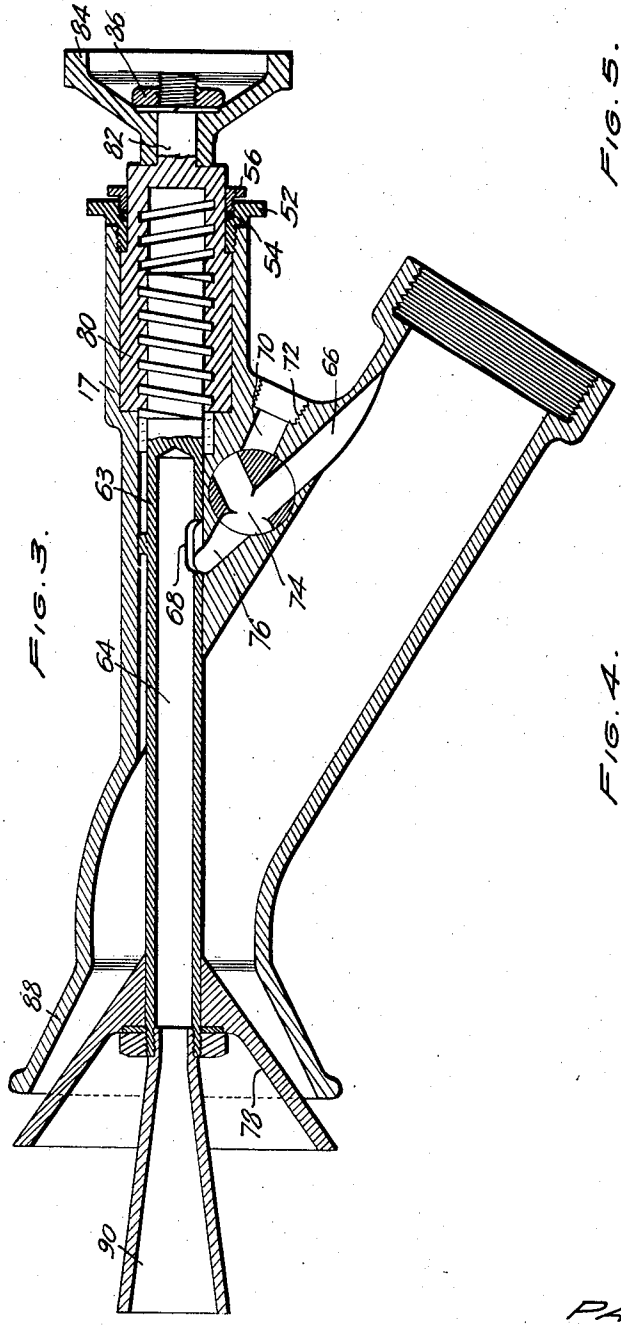


FIG. 3.

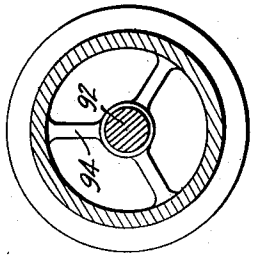


FIG. 5.

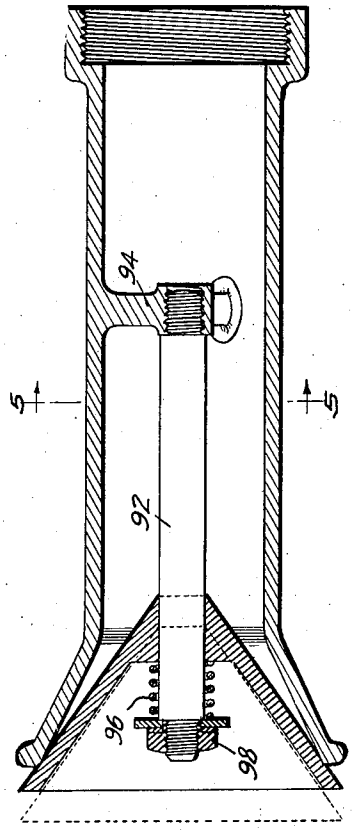


FIG. 4.

INVENTOR
PAUL E. REHSE
BY John J. Hogan and Blade Kronitz
ATTORNEYS

Patented July 16, 1940 2,207,758

UNITED STATES PATENT OFFICE

2,207,758

HOSE NOZZLE

Paul E. Rehse, Dayton, Ohio

Application April 8, 1938, Serial No. 200,946

6 Claims. (Cl. 299—140)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to me of any royalty thereon.

This invention relates to hose nozzles, and particularly to nozzles for use with fire fighting equipment employing water, foam, and other materials, singly or in combination.

It is very desirable, in the fighting of certain kinds of fires, especially those in connection with aircraft, that the fire fighting equipment be of such a nature as to permit a man to enter into the fire for such purposes as the saving of lives, shutting off motors and fuel valves, or salvaging valuable materials. This can be accomplished by forming the discharge stream in the shape of a cone of sufficient diameter at its base or maximum operating distance portion to envelop a man, and of sufficient wall thickness to protect him as a shield against the flames and fire gases. This hollow cone-shaped stream is formed by the use of a conical-shaped core in the center of the discharge portion of the nozzle, thereby providing a conical-channel orifice. Since the distance of the projection of the discharge stream will depend on the factors of pressure and degree of the angle of diversion of the opening, it is desirable that the angle of divergence be kept as small as possible, consistent with the operating pressure, and of no greater size than sufficient to form a cone with diameter at the projected operating distance sufficient to inclose a man.

Modern fire fighting methods, using the principle of smothering fire with foam forming materials, introduce new problems in the proper spraying of such foam forming materials, different from the problems in the spraying of water alone. Foam is usually formed by mixing with water, solids producing carbon dioxide, and some solid material or materials to increase the surface tension, thereby forming bubbles of carbon dioxide surrounded by a thin membrane of water solution.

In the case of fires of liquid, such as gasoline and oils, the fire area is usually a flat layer, and it is then desired that the foam should have a maximum coverage per unit of material. This maximum coverage for a given quantity of fluid is to be achieved by the use of bubbles of the smallest possible structure, due to the well known fact that the ratio of surface area to volume increases as the volume is reduced. Another objective in the case of said liquid fires is that the foam should have a free flowing characteristic, which is likewise promoted by the smaller size bubbles since the flow characteristic is dependent upon the "wetness" of the foam, and the proportion of water to carbon dioxide is greater in small size bubbles than in larger size bubbles.

In the case of burning structures, it is desired that the foam be of as dry a nature as possible to enable the foam to cling to the burning surface, and thereby build an accumulation of volume sufficient to cover the burning surface, and sufficiently dry that it will not flow out.

The bubble size is controlled by the orifice width of the hose nozzle. There is a break down in the bubble structure of the bubbles formed from carbon dioxide and solid materials used to produce high surface tension when the stream is being discharged through a nozzle orifice area less than the cross section area of the foam delivery line. The foam which has been reduced in volume by passing through a restricted orifice composes a greater number of bubbles per unit volume than the foam which does not pass through such a restricted orifice and consequently contains a higher ratio of liquid to gas. In other words, the volume of liquid to gas is increased and foam becomes wetter as the size of the nozzle orifice is decreased and, conversely, the volume of gas to liquid is increased as the nozzle orifice area approaches the cross sectional area of the foam delivery line.

There is the further problem, in the discharging of foam forming materials, to obtain for all conditions of suitable bubble structure a maximum projection of discharge. Since foam is of much lighter nature than water, there is a greater tendency for the bubble structure to dissociate than in the case of a stream of water. It is also well known that the maximum efficiency in obtaining distance for the projection of the discharge consistent with a given pressure is to be obtained when the discharge stream is compact and of a solid nature being laminar in the case of the conical stream, and when all eddy or vortex effects produced in the stream prior to its discharge from the nozzle have been corrected or eliminated. It follows, as a corrollary, that the problem of eliminating the eddy effects is lessened if the creation of eddy effects has been reduced to a minimum. It is therefore imperative that the nozzle be provided with a stream directing channel of sufficient length in the desired directed path for all effective orifice adjustments to maintain a stream of optimum solidity, whether small orifice area for wet foam, or large orifice area for dry foam, and of sufficient length to eliminate the said eddy effects. This problem is further complicated by the need and utility of using the

same nozzle for discharging foam, to discharge water alone.

In addition to the length requirements, the effective area of the conical channel must be maintained substantially uniform throughout its length, or of progressively decreasing cross section from the inner to the outer end thereof. If the cross section area at the outer end is greater than at some interior point, the flow is restricted at the point of smallest cross section, and the maximum effectiveness of the stream controlling channel for the remainder of the distance is lost.

It is, therefore, an object of my invention to provide a fire hose nozzle for the discharge of foam material or water that will form a conical discharge stream of predetermined diameter and laminar character for all operative orifice adjustments and of maximum discharge projection for normal operating pressures. In accordance with my invention I have provided a nozzle in which the resistance to the flow of fluid therethrough is reduced to a minimum by gradually changing the direction of flow through the nozzle by a predetermined, minimum angle, and by continuing the flow through, and confining it in, a conical channel of sufficient length to maintain the stream in a desired directed path and to reduce the turbulence created by the change in direction of flow to a minimum, thereby obtaining a flow of laminar quality for the maximum range of operation, consistent with a given pressure.

It is a further object of my invention to provide, in a nozzle of the above type, means for discharging a portion of the fluid material through the center of the nozzle and within the conical shaped outer stream for the purpose of spraying on a man enclosed in the conical shield a stream of cooling liquid.

Another object of my invention is to provide, in a nozzle of the above type, means for discharging a second fluid material through the center of said nozzle and within the conical shaped outer stream for the same purpose as provided in the previous object, or for the purpose of discharging into the conical shield carbon dioxide, dew gas, or carbon tetrachloride, or other fire repellent agents which will more completely protect the man within the shield from the flames.

Another object of my invention is to provide, in a nozzle of the character described, means for alternately selecting and controlling the discharge of either a portion of the main fluid being discharged therethrough, or a second fluid material for discharge through the center of said nozzle and within the conical stream form.

Still another object of my invention is to provide, in a nozzle of the character described, means for automatically closing the orifice when the nozzle is not in use in order to exclude vermin, mud wasps, or the like, from taking possession of the channel so provided when the apparatus is not in use. This feature is particularly useful in connection with automatically controlled fire extinguishing systems.

The above and still further objects and advantages of the invention will become apparent from a study of the following specification, taken in connection with the accompanying drawings, wherein like reference characters designate corresponding parts throughout the several views, and wherein:

Fig. 1 is a vertical section of my improved hose nozzle;

Fig. 2 is a vertical section of another embodiment of my invention;

Fig. 3 is a vertical section of another embodiment of my invention;

Fig. 4 is a vertical section of still another embodiment of my invention, showing a dotted line for full open position of the core; and

Fig. 5 is a sectional view taken on the lines 5—5 of Fig. 4.

Now referring to the drawings in detail, Fig. 1 shows a hose nozzle unit comprising a main body portion 10, a flared or conical shaped discharge portion 12, a portion 14 for making connection with the hose, and a portion 15 so constructed and arranged as to form a housing concentric with the discharge portion for mounting therein an axially adjustable shaft 18 extending from the discharge portion of the nozzle and projecting through the housing portion 15 sufficiently to provide for the rigid attachment of an adjustment wheel 20 by means of a nut 22. The said shaft is further provided with a helical thread 24 on that portion of the shaft contained within the said housing portion 15, which is likewise provided with a corresponding helical thread. On the end of the shaft extending within the discharge portion of the nozzle is mounted and secured by a nut 26, a conical core 28 having a portion 30 so constructed as to provide with the discharge portion 12 a channel progressively decreasing in width from the inner to the outer end of said portion, and a further portion 32 with outer peripheral surface substantially parallel to the interior surface of the discharge portion, thereby imparting a conical shape and laminar character to the stream discharged therethrough. In order to give further directive effect to the stream after it leaves the outlet of the channel, the discharge portion 12 of the nozzle projects beyond the outer end of the core. While assembling the nozzle, after the arrangement of the shaft within the nozzle and before attaching the adjustment wheel 20, the shaft is secured in the nozzle and sealed against leakage of water by means of a packing 34 and packing nut 36. The nozzle is illustrated with the core near its maximum effective opened position, at which point the cross sectional area at the most interior point of the portion 32 is approximately equal to the cross sectional area of the main body portion. Adjustment of the orifice from the effective maximum opened position to a closed position is obtained by rotation of the adjustment wheel, causing axial progression of the shaft in the helically threaded housing. It is to be further noted that when the nozzle is in either the maximum effective open, or closed, position, the annular, stream directing channel is of sufficient length to provide a laminar flow of the fluid discharged therethrough in a single directed path substantially corresponding to a maximum cone projection for the desired field of inclosure; that is, of diameter sufficient to envelop a man. Good results have been obtained throughout a useful range of adjustment by making the length of the shorter wall approximately twice the width of the opening at the maximum effective open adjustment. I am aware that nozzles of the centrally disposed core type are familiar in the art, but the opposing walls of the conical channel so provided are not in effective "opposition" for a sufficient length for all adjustments; that is, the relation of length to width is not such as will produce the desired results for all useful adjustments of reducing the bubble structure, and provide a sufficient length to reduce the resistance of flow due to the turbulence or eddy currents caused by direction changes

in passing through the nozzle, and to direct the stream in a single path for all desirable adjustments.

The angle formed by the walls of the discharge portion of the nozzle with its longitudinal axis fixes the angle of deviation of the discharge stream. Since the object of this invention is to provide a conical shield, with diameter slightly larger than the height of a man, at the maximum operating point consistent with a given pressure, it is important that this angle should be kept as small as possible, as a small angle will enable the attainment of greater distance than a large angle for the same pressure. It will be seen that, as the pressure is lowered, the distance of projection is shortened with a consequent reduction in diameter of the projected cone, and the angle of deviation would have to be increased to maintain a cone of the specified diameter at its base portion. As the angle is increased, however, the corresponding greater change in direction of the path of the stream being discharged will induce greater turbulence of the fluid as it is discharged through the nozzle and orifice, and therefore the annular space in the discharge portion of the nozzle which directs the path of the stream would have to be lengthened in order to eliminate the greater turbulence produced.

Fig. 2 shows a modification of my invention in which the hose nozzle proper and discharge portion are similar to that in Fig. 1, but the shaft housing portion has been modified to provide for the use of an axially adjustable but non-rotatable tube 38 in lieu of the shaft in Fig. 1. The tube is provided with a helical thread similar to the shaft in Fig. 1, but engages in a corresponding helical thread form in the driving screw member 40 contained within the housing portion 16. Non-rotatability is obtained by provision of the groove 42 in the shaft housing portion and the fixed lug 44 on the shaft adapted for engagement with said groove. The adjustment wheel 46 is mounted on the shoulder 48 provided on the said member 40 and rigidly secured to said member by a nut 50. In assembling the above apparatus, before the attachment of the adjustment wheel, the said member 40 is secured within the housing portion by means of the lock nut 52 and is further protected against leakage by means of the packing 54 and packing nut 56. The posterior end of the tube is internally threaded to receive a connection 58 for a second fluid, and the forward end of the tube to which is mounted, by a driving fit, the conical shaped core 60 rigidly secured by means of the nut 62, is interiorly threaded to receive a nozzle 64 with "converging" orifice for directing the stream being discharged therethrough. Shaft assembly is accomplished by entering the threaded shaft, with core dismounted, from the posterior end of said shaft housing, aligning lug 44 in the groove 42. The internally threaded member 40 may be placed in position before or after positioning the shaft. Next, the core is mounted, and the member 40 is secured in the housing by the locking nut, packing, and packing nut, as aforesaid. Adjustment wheel, nut, and hose connection are thereafter mounted in the order named.

The operating characteristics of this nozzle, so far as the discharge of the main stream is concerned, are similar to those of the nozzle in Fig. 1, but the core is so constructed that its outer peripheral surface 61 provides with the inner surface of the discharge portion 12 of the nozzle a channel of gradually decreasing width from its inner to its outer end. As shown in Fig. 2, the core is a single conical section and in its maximum effective opened position, the cross sectional area of the channel at the outlet end is substantially equal to the effective cross sectional area of the nozzle proper, and of substantially uniform area throughout the length thereof, thereby providing said channel of a shape to maintain positive confinement and control throughout its length of the liquid being discharged therethrough, and of a sufficient length for all useful adjustments to overcome the turbulence created by change of direction of the stream and to maintain the stream in a singly directed path through a useful range of adjustment. There is also eliminated one corner in the interior surface of the nozzle of Fig. 1, thereby reducing the tendency to create turbulence.

The embodiment of my invention shown in Fig. 3 is similar to that shown in Fig. 2 except that in lieu of the full length tubular shaft 38, I have used a shaft 63 provided with a tubular portion 64 at the end located within the main body portion and extending into the shaft housing portion of the nozzle. A channel 66 has been provided to connect the main body portion of the nozzle with an aperture 68 in the tubular shaft for diverting a portion of the stream being discharged through the main body portion through the central orifice. There is also provided a channel 70 with threaded female connection 72 for connecting said central orifice with a second source of fluid material. The channels 66 and 70 are constructed with a two-way valve 74 which enables the alternate selection of either of the two fluid sources for discharge through the central portion. The aperture 68 in the tubular shaft 63 is of a length sufficient to make contact with the connecting channel portion 76 from the two-way valve for all effective adjustments of the orifice made by extending or retracting the core 78, and is arranged so as to shut off contact with the connecting channel when the shaft with core mounted thereon has been retracted to close the main orifice.

Similarly to the tubular shaft in Fig. 2, the shaft 63 is provided with a helical thread on the solid portion of the shaft engaging in a corresponding helically threaded member 80 contained within the housing portion 17. This member 80 is slightly different from the corresponding member 40 in Fig. 2. Because of the solid construction of the shaft, the member 80 is provided at its posterior end with a turned down solid portion 82 on which is mounted the control wheel 84 and rigidly secured thereto by the nut 86. In assembling the above apparatus, before attachment of the control wheel, the said member 80 is secured within the housing portion by means of the lock nut 52 and is further protected against leakage by means of the packing 54 and packing nut 56. Full assembly of the shaft is accomplished in the same manner as provided for the modification in Fig. 2.

The core in this modification is similar to the core in Fig. 2 except that it is longer and extends beyond the discharge portion 88 of the nozzle. In this arrangement, the discharge portion 88 of the nozzle is correspondingly shortened. By making the core longer than the discharge portion, the core surface is made to give additional directive effect from within to the stream after it leaves the outlet of the channel.

The central nozzle 90 as shown in Fig. 3 is for

use primarily with carbon dioxide gas. Since carbon dioxide gas, in expanding from its compressed condition, has a tremendous cooling effect and tends to become solid upon release, it is necessary for a carbon dioxide nozzle to be constricted with diverging sides in order to relieve the expanding gas and prevent clogging of the nozzle by the solidification of the gas therein. However, this nozzle may also be used for the other materials, such as foam, water, carbon tetrachloride, or dew gas, which might be discharged therethrough, although with less efficiency than with the "constriction" type of central nozzle shown in Fig. 2. The central nozzles shown in Fig. 3 and Fig. 2 are interchangeable, so that the carbon dioxide type of nozzle shown in Fig. 3 may be used with either modification when it is desired to discharge carbon dioxide through the central orifice.

Fig. 4 shows an embodiment of my invention for use in a fire sprinkler system or in permanent installations. Here, I have used the same type nozzle discharge portion and core as in Fig. 3, but have modified the core mounting to provide for its closure except when fluid is passing through. The core assembly is mounted on a shaft 92 centered in the nozzle and threadedly attached to a spider 94 in the interior of the nozzle. Automatic closing of the core is provided by the following construction: The core is mounted on the shaft by a running fit to enable sliding engagement. The core is then secured to the shaft by means of a coil spring 96 of less capacity than the fluid pressure to be used in the nozzle, and a nut 98. Sufficient tension is put on the spring to maintain the core in closed position, as shown, when not in use.

It is believed that the many advantages of a hose nozzle constructed in accordance with the present invention will be readily understood, and although preferred embodiments of the invention are as illustrated and described, it is to be understood that further modifications and changes in the details of construction may be resorted to which will fall within the scope of the invention as claimed.

What is claimed is:

1. A nozzle provided with an outwardly diverging discharge portion and an axially arranged core concentric with and disposed within said discharge portion, said core extending from substantially the inner end of said discharge portion to a point beyond said discharge portion, the inner portion of said core and said discharge portion cooperating to provide an annular channel having throughout the length thereof both a substantially straight mean direction and a substantially constant effective cross-sectional area for the maximum optimum operative position of said core, said channel having similar configurations in each cross-sectional plane throughout the length thereof and being of sufficient length and so disposed as to affect a laminar flow of the fluid discharged through said channel in a directed path substantially corresponding to a maximum distance of fluid cone projection for a predetermined elevation of field enclosure, and the outer portion of said core extending beyond said discharge portion for a distance comparable to the length of the discharge portion to maintain the laminar flow beyond the point of discharge.

2. A nozzle provided with an outwardly diverging discharge portion and an axially adjustable core concentric with and disposed within said discharge portion, said core extending from substantially the inner end of said discharge portion to a point beyond said discharge portion, the inner portion of said core and said discharge portion cooperating to provide an annular channel having throughout the length thereof both a substantially straight mean direction and a substantially constant effective cross-sectional area for the maximum optimum operative position of said core, said channel having similar configurations in each cross-sectional plane throughout the length thereof and being of sufficient length and so disposed as to effect a laminar flow of the fluid discharged through said channel within the range of useful adjustments in a directed path substantially corresponding to a maximum distance of fluid cone projection for a predetermined elevation of field enclosure, and the outer portion of said core extending beyond said discharge portion for a distance comparable to the length of the discharge portion to maintain the laminar flow beyond the point of discharge.

3. A nozzle provided with an outwardly diverging discharge portion and an axially arranged core concentric with and disposed within said discharge portion, said core extending beyond the inner and outer ends of said discharge portion, the inner portion of said core cooperating with the said discharge portion to provide an annular channel having throughout the length thereof both a substantially straight mean direction and a substantially constant effective cross-sectional area for the maximum optimum operative position of said core, said channel having similar configurations in each cross-sectional plane throughout the length thereof and being of sufficient length and so disposed as to effect a laminar flow of a fluid discharged through said channel in the directed path substantially corresponding to a maximum distance of fluid cone projection for a predetermined elevation of field enclosure, and the outer portion of said core extending beyond said discharge portion for a distance comparable to the length of the discharge portion to maintain the laminar flow beyond the point of discharge.

4. A nozzle provided with an outwardly diverging discharge portion and an axially arranged core concentric with and disposed within said discharge portion, said core extending from substantially the inner end of said discharge portion to a point beyond said discharge portion, and being mounted upon a tube in communication with a second fluid source and provided with a discharge nozzle centrally disposed within said core, the inner portion of said core and said discharge portion cooperating to provide an annular channel having throughout the length thereof both a substantially straight mean direction and a substantially constant effective cross-sectional area for the maximum optimum operative position of said core, said channel having similar configurations in each cross-sectional plane throughout the length thereof and being of sufficient length and so disposed as to effect a laminar flow of the fluid discharged through said channel in the directed path substantially corresponding to a maximum distance of fluid cone projection for a predetermined elevation of field enclosure, and the outer portion of said core extending beyond said discharge portion for a distance comparable to the length of the discharge portion to maintain the laminar flow beyond the point of discharge.

5. A nozzle having at one end two inlet openings for communication with two fluid sources,

and at the other end being provided with an outwardly diverging discharge portion and an axially adjustable core having a central opening extending therethrough and constituting a further discharge opening, said core being coaxial with and disposed within said outwardly diverging discharge portion and extending from substantially the inner end of said discharge portion to a point beyond said discharge portion, the inner portion of said core and said discharge portion cooperating to provide an annular channel having throughout the length thereof both a substantially straight mean direction and a substantially constant effective cross-sectional area for the maximum optimum operative position of said core, said channel having similar configurations in each cross-sectional plane throughout the length thereof and being of sufficient length and so disposed as to effect a laminar flow of the fluid discharged through said channel within the range of useful adjustments in the directed path substantially corresponding to a maximum distance of cone projection for a predetermined elevation of field enclosure, the outer portion of said core extending beyond said discharge portion for a distance comparable to the length of the discharge portion to maintain the laminar flow beyond the point of discharge, and valve means for establishing communication of said central opening with either of said fluid inlets.

6. A nozzle provided with an outwardly diverging discharge portion and a core slidably mounted upon an axially disposed shaft, said core being coaxial with and disposed in said discharge opening and extending from substantially the inner end of said discharge portion to a point beyond said discharge portion, the inner portion of said core and said discharge portion cooperating to provide an annular channel having throughout the length thereof both a substantially straight mean direction and a substantially constant effective cross-sectional area for the maximum optimum operative position of said core, said channel having similar configurations in each cross-sectional plane throughout the length thereof and being of sufficient length and being so disposed as to effect a laminar flow of the fluid discharged through said channel in a directed path substantially corresponding to a maximum distance of fluid cone projection for a predetermined elevation of field enclosure, the outer portion of said core extending beyond said discharge portion for a distance comparable to the length of the discharge portion to maintain the laminar flow beyond the point of discharge, and yieldable means for maintaining said core in closed position when the nozzle is not in use.

PAUL E. REHSE.