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(54) UPRIGHT FIRE PROTECTION NOZZLE

STANDFEUERSCHUTZSTUTZEN

LANCE D'INCENDIE VERTICALE

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Description

TECHNICAL FIELD

[0001] The invention relates to water spray sprinklers and nozzles for fire protection service, and, in particular, to those nozzles in which a single stream of water is discharged and impacts or impinges against a downstream element as a means of deflecting, spreading or diffusing the discharge stream into a spray pattern consisting of individual droplets.

BACKGROUND

[0002] Water sprays consisting of relatively small or fine water droplets, commonly referred to as "water mist", have been shown to be among the most efficient fire extinguishing media currently available. Small water droplets suspended in the atmosphere can be forcibly injected or entrained through the convective currents, into the combustion region of a fire, where they quickly evaporate. The evaporation of these droplets has an impact upon the combustion process by absorbing some quantity of the energy output of the fire, and by displacing gaseous oxidizing agents. At some critical point, when the fire is no longer capable of self-sustained combustion, it is extinguished. It has been shown that droplets of less than 50 microns in size are extremely efficient fire extinguishing agents. As droplet size increases, the efficiency of the fire extinguishing media, typically water, decreases, although it has been demonstrated that water mist with the majority of the droplets between 20 and 250 microns in size can be highly effective and efficient fire extinguishing agents, particularly when delivered in a componentized spray pattern. Fischer U.S. Patent No. 5,839,667 teaches that it can be desirable to selectively provide areas of higher water discharge per unit area, greater droplet size, and/or greater droplet momentum. It has also been shown that different expected fire scenarios may require different spray pattern characteristics, if the effectiveness of fixed fire fighting system is to be maximized.

[0003] The main types of water mist nozzles for fire protection include diffuser impingement nozzles, pressure jet nozzles, and gas atomizing nozzles. Diffuser impingement nozzles operate by impacting a coherent water stream against a diffuser. The diffuser breaks the stream into a predetermined distribution of mist. Diffuser impingement-type water mist nozzles are described in Fischer U.S. Patent No. 5,392,993 and in Fischer U.S. Patent No. 5,505,383. Pressure jet nozzles function by discharging high velocity water streams through small orifices with an internal shape, e.g., a scroll-type arrangement is typical, designed to break up the water stream. A pressure jet type water mist nozzle is described in Sundholm U.S. Patent No. 5,513,708. Gas-atomizing water mist nozzles operate by mixing compressed gas with water in a mixing chamber at the nozzle discharge orifice. A gas atomizing water mist nozzle is described in Loepsinger U.S. Patent No. 2,361,144.

[0004] The spray pattern characteristics produced by existing diffuser elements utilized in impingement-type water mist nozzles fall into two distinct categories. The first category is a relatively uniformly filled, umbrella-shaped spray pattern extending from the discharge nozzle. The second category is a largely hollow cone, with the spray pattern forming a uniform or non-uniform shell of spray. Fischer U.S. Patent No. 5,829,684 describes a nozzle producing a combination of these two fundamental types, with a uniform, umbrella-shaped shell superimposed over a relatively uniformly filled inner cone.

[0005] French specification FR-A-2765172 discloses a diffusion head 8 consisting of a base 50 shaped like a disc, whose upper face has a central peg 52 that is flared at its base. A throat 54 is provided in the extension and around the peg 52 over the entire periphery of the base 50 and defines an outer edge 56 of the diffusion head 8. The outer edge 56 is continuous and provides for regular flow.

SUMMARY

[0006] According to the present invention, there is provided an upright-type fire protection spray mist nozzle according to claim 1. Preferably said concave contour of said impingement surface further comprises a central conical shape surface region extending generally toward the orifice, with an apex portion disposed along the orifice axis, said discontinuous peripheral edge being disposed generally radially outward from the conical shape surface region and defining a face plane, and a concave, substantially toroidal surface region generally between the conical shape surface region and the discontinuous peripheral edge. Preferred embodiments of this aspect of the invention may include one or more of the following additional features. The apex and the peripheral edge are disposed in a plane generally perpendicular to the orifice axis. Preferably, at least a portion of the toroidal surface region is recessed downstream from the plane of the apex and the peripheral edge, relative to the orifice. More preferably, the toroidal surface region is recessed downstream from the plane of the apex and the peripheral edge, relative to the orifice. The stream of fire retardant fluid flowing from the orifice to impinge upon the impingement surface is substantially steady and coherent. The concave, substantially toroidal surface region has a shape formed by rotation of an arcuate surface comprised of at least three relatively smoothly blended arcs, and preferably at least five relatively smoothly blended arcs, about a line defined by the orifice axis passing through the apex. The impingement surface defines at least one surface discontinuity in a region of the peripheral edge for redirecting a portion of the flow of fire retardant fluid along the impingement surface. Preferably, the impingement surface defines a set of surface discontinuities spaced circumferentially about the orifice axis in the region of the peripheral edge for redirecting a portion of the flow of fire retardant fluid along the impingement surface. The set of surface discontinuities generally has the form of a set of notches in the impingement surface. Preferably, the set of notches defines a set of surface regions extending along and outwards from a plane generally tangent to a base region of the concave surface and lying generally perpendicular to the orifice axis, towards the region of the peripheral edge. The set of surface discontinuities comprises a set of at least about eight notches, preferably a set of at least about 16 notches, more preferably a set of at least about 32 notches, and still more preferably a set of at least about 48 notches, in the impingement surface. The stream of fire retardant fluid flowing from the orifice and intersecting the impingement surface has a stream diameter measured as the stream is about to pass through the face plane, and a ratio of the diameter of a region of the concave surface lying generally tangent to a plane that is generally perpendicular to the orifice axis and the stream diameter is greater than or equal to about 2, preferably greater than or equal to about 3, and more preferably greater than or equal to about 4. The peripheral edge has an inner edge diameter measured in the face plane and the stream has a stream diameter measured as the stream is about to pass through the face plane, and a ratio of the inner edge diameter to the stream diameter is at least about 3, preferably at least about 5.5, more preferably at least about 8, and still more preferably of the order of about 20. Preferably, the set of surface discontinuities divides the flow into multiple segments at the region of the peripheral edge with little loss of energy. The upright-type fire protection spray mist nozzle may be in the form of an open nozzle for use in deluge-type fire protection systems, or may be in the form of an automatically-operating nozzle comprising, in a standby condition, a releasable orifice seal secured in position by a thermally-responsive element, or may be in the form of a device remotely actuatable, e.g., in response to a fire condition determined by a separate fire detector.

[0007] Preferably the toroidal surface region is shaped to divert fire-retardant fluid in the stream to flow from the orifice axis radially outward, along the impingement surface, towards the region of said discontinuous peripheral edge of the impingement surface, the impingement surface adapted to substantially redirect the flow of fire-retardant fluid from the stream by at least 90° from the stream direction while maintaining the flow of fire-retardant fluid towards the region of the discontinuous peripheral edge substantially in contact with the impingement surface in a manner to substantially avoid splashing.

[0008] Preferred embodiments of this aspect of the invention may include the following additional feature. The impingement surface is adapted to redirect the flow of fire-retardant fluid by at least 110° from the stream direction while maintaining the flow of fire-retardant fluid towards the region of the peripheral edge substantially in contact with the impingement surface in a manner to substantially avoid splashing.

[0009] Preferably said toroidal surface region of the impingement surface that is at least substantially imperforate in the axial direction and positioned for impingement by a stream of fire-retardant fluid flowing from the Preferably the toroidal surface region of the impingement surface further comprises a central conical shape surface region extending generally toward the orifice, with an apex portion disposed along the orifice axis, said discontinuous peripheral edge disposed generally radially outward from the conical shape surface region, and a concave, toroidal surface region generally between the conical shape surface region and the peripheral edge, the impingement surface being shaped to divert the fire-retardant fluid in the stream to flow from the orifice axis radially outward, along the impingement surface, towards the region of the peripheral edge of the impingement surface, the impingement surface being adapted to redirect the flow of fire-retardant fluid from the stream by at least 90° from the stream direction while maintaining the flow of fire-retardant fluid towards the region of the peripheral edge substantially in contact with the impingement surface in a manner to substantially avoid splashing.

[0010] Preferably the concave contour of the impingement surface further comprises a central conical shape surface region extending generally toward the orifice, with an apex portion disposed along the orifice axis, said discontinuous peripheral edge disposed generally radially outward from the conical shape surface region, and a concave, substantially toroidal or arcuate shaped surface region generally between the conical shape surface region and the discontinuous peripheral edge, the impingement surface having a shape formed by rotation of an arcuate surface comprised of at least three relatively smoothly blended arcs, rotated about a line defined by the orifice axis passing through the apex, to divert the fire-retardant fluid in the stream to flow from the orifice axis radially outward, along the impingement surface, towards the region of the peripheral edge of the impingement surface, the impingement surface being adapted to redirect the flow of fire-retardant fluid from the stream by at least 90° from the stream direction while maintaining the flow of fire-retardant fluid towards the region of the discontinuous peripheral edge substantially in contact with the impingement surface in a manner to substantially avoid splashing.

[0011] According to another aspect of the invention, an upright-type fire protection spray mist nozzle discharges a spray of fire-retardant fluid over an area to be protected from fire, the spray being characterized by a Dv_{90} droplet size diameter of less than about 250 microns, preferably less than about 200 microns, and more preferably less than about 150 microns, when measured at a pressure of a 175 psi at the inlet to the nozzle, in accordance with the procedure recommended in the 2000 edition of the NFPA 750 Standard on Water Mist Fire Protection Systems (also see Section 1-4.5 for the definition of "Dv_{90} droplet size diameter").

[0012] The orifice has an orifice diameter preferably less than about 0.200 inch, and more preferably less than about 0.150 inch, and still more preferably less than about 0.110 inch.

[0013] The invention provides, in its broadest aspect, an upright-type fire protection spray mist nozzle, and further provides a diffuser for an impingement-type nozzle having a solid (i.e., at least substantially imperforate in an axial direction), three-dimensional surface shaped to receive and redirect a coherent fluid stream impinged thereupon with substantially no splashing, even when the primary axis of the fluid stream at impact is substantially completely opposed by the impingement surface. Furthermore, surface discontinuities defined by the impingement surface discretely divide the impinging fluid stream into multiple segments with little energy loss, even at low velocities, and selected segments can be essentially reversed in direction with respect to the initial stream flow direction from the nozzle outlet. Additionally, the resulting spray pattern discharge consists of water droplets that appear to be substantially smaller than those typically associated with impingement-type diffusers, even those with smaller orifices. For example, with a fluid (water) pressure of about 175 psi at the inlet section of the mist nozzle of this invention having an orifice diameter of about 0.106 inch, the nozzle discharges a spray with a Dv_{90} droplet size diameter of less than about 200 microns, as compared to a Dv_{90} droplet size diameter of the order of 300 microns for the Grinnell Type AM4 AquaMist® pendent-type nozzle having a nominal orifice diameter of 0.091 inch, as described in Grinnell Technical Data Sheet TD1173, when measured in accordance with the procedure recommended in the 2000 Edition of the NFPA 750 Standard on Water Mist Fire Protection Systems.

[0014] The required spray pattern characteristics of mist nozzles, including droplet size and droplet count density, for use in fixed spray fire fighting systems are determined by the expected fire scenario. Of particular interest is redirection of a majority of the discharged water downstream of the impingement surface of the diffuser in a direction nominally opposite to the direction of bulk flow of the water stream, upstream of the impingement surface of the diffuser, while maintaining relatively small droplet size within the nozzle spray pattern. The attribute of maintaining small droplet size while reversing the bulk average direction of the fluid flow allows spray pattern characteristics not previously achieved using existing technology.

[0015] The present invention provides a nozzle that can be employed to distribute a water mist discharge pattern that is discretely adjustable, allowing predetermined positioning of a multitude of areas of high and low water discharge density as deemed preferable for an expected fire scenario. The result is an improvement in performance over existing impingement-type water mist diffusers.

[0016] The details of one or more embodiments of the invention are set forth in the accompanying drawings and the description below. Other features, objects, and advantages of the invention will be apparent from the description and drawings, and from the claims.

DESCRIPTION OF DRAWINGS

[0017]

FIG. 1 is a front elevational view of an upright fire protection spray mist nozzle of the invention, while FIG. 1A is a cross-sectional view of an arm, taken at the line 1A-1A of FIG. 1; and

FIG. 2 is side elevational view, taken in section at the line 2-2 of FIG. 1, of the upright fire spray mist nozzle of FIG. 1.

FIG. 3 is an enlarged front elevational view of the diffuser element of the upright fire protection spray mist nozzle of FIG. 1

FIG. 4 is an enlarged bottom elevational view, taken at the line 4-4 of FIG. 3, of the diffuser element of the upright fire spray mist nozzle of FIG. 1;

FIG. 5 is an enlarged side sectional view, taken at the line 5-5 of FIG. 4, of the diffuser element of FIG. 3 and 4; and

FIG. 6 is a much enlarged side elevational view of a blank for forming the diffuser element of FIGS. 3, 4 and 5, prior to formation of the set of surface discontinuities or notches.

FIGS. 7 and 8 are somewhat diagrammatic, enlarged front and side views, respectively, both taken in section, of the upright fire spray mist nozzle of the invention, and FIG. 9 is a somewhat diagrammatic front elevational view, also taken in section, of the diffuser element, all showing fluid flowing from the orifice onto the diffuser element surface, where it is redirected by more than 90° substantially without splash, by remaining generally in contact with the diffuser surface until reaching the region of the peripheral edge.

FIG. 10 is a front elevational view of another embodiment of an upright fire protection spray mist nozzle of the invention, for use in an automatic fire protection system; and

FIG. 11 is an enlarged perspective view of another embodiment of a diffuser element for an upright-type fire protection spray mist nozzle of the invention.

Like reference symbols in the various drawings indicate like elements.

DETAILED DESCRIPTION

[0018] Referring to FIGS. 1, 1A and 2, an upright-type fire spray mist nozzle 10 of the invention has a base 12 defining external threads 14 for threaded, sealed connection to a fire retardant fluid supply system (not shown). The base 12 defines a through passageway 16 extending generally along axis, A, for flow of fire retardant fluid from the inlet 18 (in communication with the fluid supply system) to the outlet 20, exterior of the base. In a region downstream of the outlet, arms 22, 24 extend from the base 12 to an apex 26, positioned downstream of, and coaxial with, an orifice 28 defined by an orifice insert 30 and continuous with passageway 16 of the base 12, e.g. in much the same way as in traditional nozzles typically used for fire protection system service.

[0019] A strainer 32 positioned across the inlet 18 to passageway 16 protects orifice 28 in orifice insert 30 from clogging, e.g., due to debris in the fluid supply system. Under standby conditions, an elastomeric plug (not shown) may be employed to seal the outlet 20 from airborne debris, insects and the like that might tend to clog the orifice, with a flexible lead (not shown), e.g. of metal or plastic, attaching the plug to the base 12 of the nozzle so that the plug will not be blown away from the nozzle upon discharge of fluid from the nozzle outlet.

[0020] Referring now also to FIGS. 3, 4 and 5, in the fire protection nozzle 10 of the invention, a diffuser 40 defining a solid (i.e., at least substantially imperforate in the axial direction) impingement surface 42 opposed to flow of fire retardant fluid from the orifice 28 is mounted to the apex 26, e.g., in threaded engagement therewith, to allow adjustment of the spacing of the impingement surface 42 from the orifice 28 and to allow rotational positioning of discontinuities (notches) 56 defined in the region of the peripheral edge 50.

[0021] Referring also to FIG. 6, the impingement surface 42 of the diffuser 40 for redirecting the water flow from the orifice 28 of the nozzle outlet 20 (FIGS. 1 and 2) is preferably defined by a solid, hemispherical shaped body 44, formed, e.g., by machining, sintering, investment casting or other suitable process, of brass, or other suitable material. The impingement surface includes a protruding, generally conical shape surface region 46 with an apex 48 centered generally on axis, A, and extending relatively toward the orifice 28. Surrounding the conical shape region 46, inward from the peripheral edge 50 of the impingement surface 42, is a substantially toroidal or arcuate shape, concave surface region 52, which is recessed, relative to the orifice 28, from the a plane, H_P, of the apex 48 and peripheral edge 50. In a preferred embodiment, the shape of the concave region 52 is defined by rotating an arcuate surface, E, comprised of three or more arcs of relatively smoothly blended radii, around axis, A, of the hemispherical shaped body 44. By way of example, in one preferred embodiment, for a diffuser 40 of the invention having a diameter, D_D, of 1.00 inch, the arcuate surface, E, may be formed by five relatively smoothly blended arcs, E_1, E_2, E_3, E_4, E_5, e.g., having radii of R_1, R_2, R_3, R_4, R_5, of about 0.169 inch, 0.120 inch, 0.655 inch, 0.120 inch, and 0.195 inch, respectively, where the center point of R_1 is spaced about 0.117 inch from axis, A, and about 0.039 inch upstream from plane H_P, the center point of R_2 is spaced about 0.153 inch from axis, A, and about 0.072 inch upstream from plane H_P, the center point of R_3 is spaced about 0.234 inch from axis, A, and about 0.561 inch upstream from plane H_P, the center point of R_4 is spaced about 0.314 inch from axis, A, and about 0.104 inch upstream from plane H_P, and the center point of R_5 is spaced about 0.351 inch from axis, A, and about 0.038 inch upstream from plane H_P. Preferably, the impingement surface 42 defines a set of discontinuities formed in the region of the outer peripheral edge, with the number, size and shape of the discontinuities determining the precise spray discharge pattern. For example, in the diffuser 40 shown in FIGS. 3-5, the set of discontinuities has the form of a set of notch surfaces 56, e.g., at least about eight notches, preferably at least about 16 notches, and more preferably at least about 32 notches, In the presently preferred embodiment, as described and shown, the set of discontinuities has the form of a set of 48 notches, each having width, N_W, at the peripheral edge 50, e.g., about 0.030 inch, evenly spaced, e.g., at about 7.5°, about the periphery of the diffuser 40, separated by tines 70, each having width, T_W, at the peripheral edge 50, e.g., about 0.035 inch. It has been found that increasing the number of discontinuities or notches, e.g., beyond the eight notches of the diffuser described in the parent to this application (U.S. Application No. 09/603,686, filed June 26, 2000), results in an advantageous decrease in the size of droplets dispersed from the diffuser by creating more surfaces for breakup of the flow. The notch surfaces 56 have smoothly-curved base regions 57 of radii, R_N, e.g., about 0.015 inch, extending along and outwards from a plane, C_P, tangent to the base surface 60 of the concave surface region 52 and extending through the peripheral edge region 50 of the impingement surface 42 and generally parallel to the face plane, H_P, and lateral surfaces that, in a preferred embodiment, are formed, e.g., with an end mill moved radially outward. The peripheral edge 50 of the diffuser 40 has an inner edge diameter, D_I, measured in the face plane, Hp, which defines the peripheral edge. In one preferred embodiment, the inner edge diameter, D_I, is about 0.959 inch.

[0022] Referring to FIGS. 7 and 8, and, in particular, FIG. 9, the bulk (stream) direction of the water flow (arrow, F) striking upon the conical shape region 46 of the impingement surface 42 at the apex 48 initially remains predominantly in the same direction as the water stream, W. Thereafter, as the water flows over the surface of the conical shape region 46 and then relatively outward from the orifice axis, A, over the impingement surface 42, the depth or local thickness of the water is decreased. The bulk flow direction of water flowing radially outward (relative to the orifice axis, A) over the conical shape region 46 of the impingement surface 42 is gradually turned (arrow, L) and then reversed (arrow, M) relative to the direction of the impacting water stream (arrow, F) as the fluid passes from the initial point of impingement, I, upon the apex 48 of the conical shape region 46 of the impingement surface 42 and traverses over the concave inner surface region 52, towards the region of the peripheral edge 50. The resulting thinning layer of water is then broken into discrete segments N_1, N_2 (interconnected, at least initially, by water sheet, O, therebetween) to provide a predetermined droplet distribution pattern by the placement of a set of protruding obstructions or discontinuities, such as a set of notches 56, or a set of ridges, passageways, or the like, upon the impingement surface 42. The condition of the discharge stream, W, impinging on the impingement surface 42 of the diffuser 40 is preferably a steady, well-defined, pencil-like stream, free from excessive expansion, turbulences, and distortions. The orifice geometry attributes that produce such a discharge stream have previously been described in Fischer U.S. Patent No. 5,392,993 and in Fischer U.S. Patent No. 5,505,383, the complete disclosures of which are incorporated herein by reference. A steady, coherent discharge stream, W, produces a relatively more stable, uniform spray pattern from the impingement surface 42 of the diffuser 40, while a discharge stream that is unstable or distorted can typically result in a less stable or skewed spray pattern. It is noted also that the initial direction of fluid flow (arrow, F) from the discharge orifice 28 of the nozzle of the invention is oriented away from the object to be protected, with the impingement surface 42 of the diffuser 40 of the invention reversing the direction of flow so that the fire-fighting agent is discharged back towards the hazard area. In preferred embodiments of the invention, the impingement surface 42 of the diffuser 40 redirects the water flow from the discharge orifice while minimizing the introduction of turbulence prior to water stream breakup. This is preferable, as the introduction of turbulence tends to reduce the efficiency of the water droplet generation, resulting in an increase in mean droplet diameter and ultimately a decrease in fire fighting efficiency and effectiveness. A diffuser that does not cause the water to splash is inherently more efficient because the energy otherwise lost to splashing is instead used either to obtain a reduction in droplet size or to maximize droplet momentum. Also, as the diameter of the impingement stream is expanded and the resulting depth as it flows radially outward over the impingement surface is decreased, the water sheet becomes thinner, and it is apparent that the thinner the water sheet achieved prior to break-up, the smaller the droplets (mist) that will be formed upon break-up.

[0023] Referring again to FIG. 9, the operation of the diffuser element 40 of the invention, as it is presently understood, will now be described (for clarity, and to facilitate understanding, only the notches 56 of discontinuities in the sectional plane are represented in this drawing). The water stream, W, from the discharge orifice 28 impinges upon the impingement surface 42 of the diffuser 40 at the apex 48 of the generally conical shape surface 46 generally centered on axis, A, and extending relatively toward the orifice 28. The bulk direction of the water flow stream striking the impingement surface 42 initially remains predominantly in the same direction as the water stream. However, as the water flows over the conical shape surface 46 (arrow, L), the increasing diameter of the conical surface towards its base reduces the depth or local thickness of the water flowing relatively outward from the orifice axis, A, over the impingement surface 42. The bulk flow direction of water flowing over the impingement surface 42 is gradually turned radially outward (arrow, L), relative to the orifice axis, A, and then reversed (arrow, M), relative to the direction (arrow, F) of the impacting water stream as the fluid passes from the initial point of impingement (apex 48) upon the impingement surface 42 and traverses over the concave inner surface region 52, towards the region of the peripheral edge 50. The resulting layer of water, as it is thinned, stretches until the surface tension is overcome and droplets are formed, to be delivered in a predetermined droplet distribution pattern by the placement of discontinuities, such as notches 56 (as shown), slots, ridges, passageways, and other protruding obstructions or discontinuities upon the impingement surface 42.

[0024] In preferred embodiments, the diameter, D_C, at which the tangent plane, C_P, of the internal concave surface 52 is perpendicular to the bulk fluid flow direction (axis, A, and arrow, F) divided by the diameter of the water stream, D_W, as the stream is about to pass through the face plane, H_P, is equal to or greater than at least about 2, preferably at least equal to or greater than about 3, and more preferably at least equal to or greater than about 4. A ratio value of less than about 2 can result in the water stream splashing off the diffuser. For example, according to the approximate dimensions of one preferred embodiment:

$$D_C = 0.47 \text{ inch}$$

$$D_W = 0.11 \text{ inch}$$

$$D_C / D_W = 4.3 \geq 4 >> 2$$

[0025] Also, it has been found that a ratio of D_I (i.e., inner edge diameter of the peripheral edge of the diffuser element measured in the face plane, H_P) to D_W (i.e., stream diameter of the water stream measured as it is about to pass through the face plane, H_P) of at least about 3 is preferred. A ratio of at least about 5.5 is more preferred, with a ratio of at least about 8 being still more preferred. Basically, as the water stream is distributed radially outward from the apex of the diffuser surface, the expanding stream is maintained as a continuum (provided that the arcuate surface is relatively smooth and there is no significant splashing of water). As a result, as the water stream moves radially outward, the thickness of the water layer decreases, with a corresponding decrease in the size of the droplets created by the interruption of the flow by the set of discontinuities (notches) towards the region of the peripheral edge of the diffuser. For example, according to the approximate dimensions of one preferred embodiment:

$$D_I = 0.96 \text{ inch}$$

$$D_W = 0.11 \text{ inch}$$

$$D_I / D_W = 8.7 >> 3$$

There are, however, practical limits to the degree to which D_I can be increased, and, furthermore, as D_I is increased, the water flow incurs increased friction loss resulting in lower water droplet velocity as the droplets leave the periphery of the diffuser.

[0026] This fundamental shape of the impingement surface 42 of the diffuser of the invention results in an upright-type, water spray mist nozzle 10 providing spray patterns found suitable for fire protection of Class B combustibles, particularly liquid fuels released under elevated pressure from an orifice, as the spray pattern characteristics of upright-type diffusers can be substantially different from those of pendent-type diffusers, and found to meet the fire test requirements of the International Maritime Organization (IMO) MSC/Circ. 913 (4 June 1999). The spray pattern characteristics of upright-type diffusers of the invention can also be designed to be very similar to those of pendent-type diffusers; the fundamental shape of the upright-type diffusers of the invention provide a relatively greater degree of flexibility in designing spray patterns, e.g., as compared to pendent-type nozzle diffusers. Additionally, upright positioning permitted by the nozzle of the invention advantageously allows a preferred method of installation, as the point of origin of the spray pattern can then be placed at the greatest possible distance (i.e., above) from the protected hazard. This can be of critical importance in situations where the available clearance between surface of the hazard and adjacent surfaces is relatively small. Furthermore, with an upright-type nozzle installation, the pipe to which the fire-fighting nozzle is fitted somewhat protects the nozzle from impact damage, e.g. during placement and removal of material from the region to be protected.

[0027] A number of embodiments of the invention have been described. Nevertheless, it will be understood that various modifications may be made without departing from the spirit and scope of the invention. For example, referring to FIG. 10, in another embodiment, an upright fire protection spray mist nozzle 100 of the invention may be used in an automatically operating fire protection system, with a thermal-responsive release element 102, e.g. a glass bulb or fusible link, engaged by a bulb seat 103 at the apex of an axially adjustable diffuser element 104 to secure an orifice seal 106 in normal or standby condition. Alternatively, the thermal-responsive release element 102 may be replaced with a device that is remotely actuatable (released) in response to a fire condition determined by a separate fire detector. Also, the apex of the generally conical shape surface region and the peripheral edge of the impingement surface of a diffuser element of the invention may be disposed in different planes, e.g. relatively closer to or more spaced from the orifice. The peripheral edge of the diffuser may also have the form of a toothed surface, with the tips of the respective teeth in the same or different planes.

[0028] Also, in some embodiments of upright-type fire protection spray mist nozzles of the invention, it is contemplated that the ratio of D_I (i.e., inner edge diameter of the peripheral edge of the diffuser element measured in the face plane, H_P) to D_W (i.e., the stream diameter of the water stream as it is about to pass through the face plane, H_P) may be up to about 20, or even higher. Finally, referring to Fig. 11, a diffuser element 140 of another embodiment of the invention, e.g., as described in the parent to this application (U.S. Application No. 09/603,686, filed June 20, 2000) has a concave region 152 defined by rotation of an arcuate surface, E', around axis, A', and a set of eight, evenly spaced notches 156. In this embodiment, the arcuate surface, E', has the shape, e.g., of a regular ellipse, with three arcs of relatively smoothly blended radii.

[0029] In addition, in some embodiments of upright-type fire protection spray mist nozzles of the invention, the arcuate surface of the diffuser may be comprised of one or more relatively smoothly blended arcs having a substantially infinite radius (i.e., a straight line), and where an arc having a substantially infinite radius is coplanar with the tangent plane, C_P, of the internal concave surface 52, the diameter, D_C, is measured between the centers of the arcs having a substantially infinite radius in the tangent plane, C_P, through the axis, A.

[0030] *Accordingly, other embodiments are within the scope of the following claims.*

Claims

1. An upright-type fire protection spray mist nozzle (10), comprising:

   a base (12) defining an orifice (28), with an orifice axis (A), through which fire-retardant fluid can flow;
   an inlet section (18) having an upstream end and defining a conduit (16) for flow of fire-retardant fluid along said orifice axis (A) and leading to an upstream end of said orifice (28); and
   a diffuser element (40) defining an impingement surface (42) that is at least substantially imperforate in an axial direction and positioned for im-

pingement by a stream (W) of fire-retardant fluid flowing from said orifice (28) in a stream direction (F) along said axis (A),
said diffuser element (40) being positioned generally above a horizontal plane through a downstream end of said orifice (28); and
characterized in that said impingement surface (42) comprises:

a concave substantially toroidal surface region (52) to divert fire-retardant fluid in said stream (W) to flow from said axis (A) radially outward toward a discontinuous peripheral edge (50) of said impingement surface (42).

2. The upright-type fire protection spray mist nozzle (10) of claim 1, wherein said concave surface region (52) of said impingement surface (42) further comprises a central conical shape surface region (46) extending generally toward said orifice (28), with an apex portion (48) disposed along said axis (A); said discontinuous peripheral edge (50) being disposed generally radially outward from said conical shape surface region (46) and defining a face plane (H_P); and said concave, substantially toroidal surface region (52) being generally between said conical shape surface region (46) and said discontinuous peripheral edge (50).

3. The upright-type fire protection spray mist nozzle (10) of claim 2, wherein said apex (48) and said discontinuous peripheral edge (50) are disposed in a plane (H_P) generally perpendicular to said axis (A).

4. The upright-type fire protection spray mist nozzle (10) of claim 3, wherein at least a portion of said toroidal surface region (52) is recessed downstream from said plane (H_P) of said apex (48) and said discontinuous peripheral edge (50), relative to said orifice (28).

5. The upright-type fire protection spray mist nozzle (10) of claim 4, wherein said substantially toroidal surface region (52) is recessed downstream from said plane (H_P) of said apex (48) and said discontinuous peripheral edge (50), relative to said orifice (28).

6. The upright-type fire protection spray mist nozzle (10) of claim 2, wherein said stream (W) of fire retardant fluid flowing from said orifice (28) to impinge upon said impingement surface (42) is substantially steady and coherent.

7. The upright-type fire protection spray mist nozzle (10) of claim 2, wherein said concave, substantially toroidal surface region (52) has a shape formed by rotation of an arcuate surface (E) comprised of at least three relatively smoothly blended arcs (E_1,E_3, E_5) about a line defined by said orifice axis (A) passing through said apex (48).

8. The upright-type fire protection spray mist nozzle (10) of claim 7, wherein said arcuate surface (E) is comprised of at least five relatively smoothly blended arcs (E_1,E_2, E_3,E_4,E_5).

9. The upright-type fire protection spray mist nozzle (10) of claim 2, wherein said impingement surface (42) defines at least one surface discontinuity (56) in a region of said discontinuous peripheral edge (50) for redirecting a portion of said flow of fire retardant fluid along said impingement surface (42).

10. The upright-type fire protection spray mist nozzle (10) of claim 9, wherein said impingement surface (42) defines a set of surface discontinuities (56) spaced circumferentially about said axis (A) in said region of said discontinuous peripheral edge (50) for redirecting at least a portion of said flow of fire retardant fluid along said impingement surface (42).

11. The upright-type fire protection spray mist nozzle of claim 10, wherein said set of surface discontinuities (56) has the form of a set of notches (56) in said impingement surface (42).

12. The upright-type fire protection spray mist nozzle (10) of any of claims 9 or 11, wherein said set of notches (56) in said impingement surface (42) defines a set of surface regions (57) extending along and outwards from a plane (C_P) generally tangent to a base region (60) of said concave surface (52) and lying generally perpendicular to said axis (A), towards said region of said discontinuous peripheral edge (50).

13. The upright-type fire protection spray mist nozzle (10) of any of claims 9, 11 or 12, wherein said set of surface discontinuities (56) comprises a set of at least about 8 notches in said impingement surface (42).

14. The upright-type fire protection spray mist nozzle (10) of any of claims 9, 11, 12 or 13, wherein said set of surface discontinuities (56) comprises a set of at least about 16 notches in said impingement surface (42).

15. The upright-type fire protection spray mist nozzle (10) of claim 14, wherein said set of surface discontinuities (56) comprises a set of at least about 32 notches in said impingement surface (42).

16. The upright-type fire protection spray mist nozzle (10) of claim 15, wherein said set of surface discontinuities (56) comprises a set of at least about 48 notches in said impingement surface (42).

17. The upright-type fire protection spray mist nozzle (10) of any of claims 10 to 16, wherein said set of surface discontinuities (56) divides said flow into multiple segments (N_1,N_2) at said discontinuous peripheral edge (50) with little loss of energy.

18. The upright-type fire protection spray mist nozzle (10) of claim 2, wherein said stream (W) of fire retardant fluid flowing from said orifice (28) has a stream diameter (D_W) measured as said stream (W) is about to pass through said face plane (H_P), and the ratio of a diameter (D_C) of a region of said concave surface (52) lying generally tangent to a plane (C_P) that is generally perpendicular to said axis (A) to said stream diameter (D_W) is greater than or equal to about 2.

19. The upright-type fire protection spray mist nozzle (10) of claim 18, wherein said ratio of the diameter (Dc) of the region of said concave surface (52) lying generally tangent to the plane (C_P) that is generally perpendicular to said axis (A) to said stream diameter (D_W) is greater than or equal to about 3.

20. The upright-type fire protection spray mist nozzle (10) of claim 19, wherein said ratio of the diameter (D_C) of the region of said concave surface (52) lying generally tangent to the plane (C_P) that is generally perpendicular to said axis (A) to said stream diameter (D_W) is greater than or equal to about 4.

21. The upright-type fire protection spray mist nozzle (10) of any of claim 2 or claims 11 to 16, wherein said discontinuous peripheral edge (50) has an inner edge diameter (D_I) measured in said face plane (H_P) and said stream (W) has a stream diameter (D_W) measured as said stream (W) is about to pass through said face plane (H_P), and a ratio of said inner edge diameter (D_I) to said stream diameter (D_W) is at least about 3.

22. The upright-type fire protection spray mist nozzle (10) of any of claims 20 or 21, wherein the ratio of said inner edge diameter (D_I) to said stream diameter (D_W) is at least about 5.5.

23. The upright-type fire protection spray mist nozzle (10) of any of claims 20, 21 or 22, wherein the ratio of said inner edge diameter (D_I) to said stream diameter (D_W) is at least about 8.

24. The upright-type fire protection spray mist nozzle (10) of claim 23, wherein the ratio of said inner edge diameter (D_I) to said stream diameter (D_W) is of the order of about 20.

25. The upright-type fire protection spray mist nozzle (10) of claim 21, wherein said set of surface discontinuities (56) divides said flow into multiple segments (N_1,N_2) at said region of said discontinuous peripheral edge (50) with little loss of energy.

26. The upright-type fire protection spray mist nozzle (100) of claim 2, in the form of an automatically-operating fire nozzle, further comprises, in a standby condition, a releasable orifice seal (106) secured in position by a thermally-responsive element (102).

27. The upright-type fire protection spray mist nozzle (10) of claim 1, wherein said concave surface region (52) being shaped to divert fire-retardant fluid in said stream (W) to flow from said axis (A) radially outward, along said impingement surface (42), towards a region of said discontinuous peripheral edge (50) of said impingement surface (42), said impingement surface (42) adapted to substantially redirect (L,M) said flow of fire-retardant fluid from said stream (W) by at least 90° from said stream direction (F) while maintaining said flow of fire-retardant fluid towards said region of said discontinuous peripheral edge (50) substantially in contact with said impingement surface (42) in a manner to ovoid splashing.

28. The upright-type fire protection spray mist nozzle (10) of claim 27, wherein said impingement surface (42) is adapted to redirect (L,M) said flow of fire-retardant fluid by at least 110° from said stream direction (F) while maintaining said flow of fire-retardant fluid towards said region of said discontinuous peripheral edge (50) substantially in contact with said impingement surface (42) in a manner to substantially avoid splashing.

29. The upright-type fire protection spray mist nozzle (10) of claim 21, wherein said impingement surface (42) is adapted to redirect (L,M) said flow of fire-retardant fluid from said stream (W) by at least 90° from said stream direction (F) while maintaining said flow of fire-retardant fluid towards said region of said discontinuous peripheral edge (50) substantially in contact with said impingement surface (42) in a manner to substantially avoid splashing.

30. The upright-type fire protection spray mist nozzle (10) of claim 1, wherein said impingement surface (42) redirects a spray of fire-retardant fluid over an area to be protected from fire, said spray being **characterized by** a Dv_{90} droplet size diameter of less than about 250 microns when measured at a pressure of a (175 psi) 1210 kPa at the inlet to the nozzle, in accordance with the procedure recommended in the 2000 edition of the NFPA 750 Standard on Water Mist Fire Protection Systems.

31. The upright-type fire protection spray mist nozzle (10) of any of claims 1 or 30, wherein said spray being **characterized by** a Dv_{90} droplet size diameter, of less than about 200 microns when measured at a pressure of a (175 psi) 1210 kPa at the inlet to the nozzle,in accordance with the procedure recommended in the 2000 edition of the NFPA 750 Standard of Water Mist Fire Protection Systems.

32. The upright-type fire protection spray mist nozzle (10) of any of claims 1, 30 or 31, wherein said spray being **characterized by** a DV_{90} droplet size diameter of less than a bout 150 microns when measured at a pressure of a (175 psi) 1210 kPa at the inlet to the nozzle, in accordance with the procedure recommended in the 2000 edition of the NFPA 750 Standard on Water Mist Fire Protection Systems.

33. The upright-type fire protection spray mist nozzle (10) of claim 1, wherein said orifice (28) having an orifice diameter preferably less than about (0.200 inch) 5080 microns.

34. The upright-type fire protection spray mist nozzle (10) of claim 33, wherein said orifice diameter is less than about (0.150 inch) 3810 microns.

35. The upright-type fire protection spray mist nozzle (10) of any of claim 33 or 34, wherein said orifice diameter is less than about (0.110 inch) 2790 microns.

36. The upright-type fire protection spray mist nozzle (10) of claim 1, wherein said concave surface region (52) delivers a water spray mist having a D_{v90} droplet size diameter of less than 200 microns when measured at a pressure of 175 psi at the inlet to the nozzle, in accordance with the 2000 edition of the NFPA 750 Standard on Water Mist Fire Protection Systems.

Patentansprüche

1. Aufrechte Feuerschutz-Sprühnebeldüse (10), die Folgendes aufweist:

Eine Basis (12), die eine Öffnung (28) festlegt, mit einer Öffnungsachse (A), durch die feuerhemmendes Fluid fließen kann;
einen Einlassabschnitt (18) mit einem stromaufwärtigen Ende, der einen Kanal (16) für den Fluss von feuerhemmendem Fluid entlang der Öffnungsachse (A) festlegt und zu dem stromaufwärtigen Ende der Öffnung (28) führt; und
ein Diffusorelement (40), das eine Aufprallfläche (42) festlegt, die mindestens im Wesentlichen in einer Axialrichtung öffnungsfrei, und zum Aufprall für einen Strom (W) von feuerhemmendem Fluid positioniert ist,
das von der Öffnung (28) in einer Strömungsrichtung (F) entlang der Achse (A) fließt, wobei das Diffusorelement (40) im Allgemeinen über einer Horizontalebene durch ein stromabwärtiges Ende der Öffnung (28) hindurch positioniert ist; und
dadurch gekennzeichnet, dass die Aufprallfläche (42) Folgendes aufweist:

Einen konkaven, im Wesentlichen ringförmigen Flächenbereich (52) zum Umleiten des feuerhemmenden Fluids in dem Strom (W), so dass es von der Achse (A) radial nach außen in Richtung einer unterbrochenen Umfangskante (50) der Aufprallfläche (42) fließt.

2. Aufrechte Feuerschutz-Sprühnebeldüse (10) nach Anspruch 1, wobei der konkave Flächenbereich (52) der Aufprallfläche (42) weiterhin einen zentralen kegelförmigen Flächenbereich (46) aufweist, der sich im Allgemeinen in Richtung der Öffnung (28) erstreckt, wobei ein Spitzenabschnitt (48) entlang der Achse (A) positioniert ist; wobei die unterbrochene Umfangskante (50) im Allgemeinen von dem kegelförmigen Flächenbereich (46) radial nach außen angeordnet ist und eine Seitenfläche (H_P) festlegt; wobei der konkave, im Wesentlichen ringförmige Flächenbereich (52) im Allgemeinen zwischen dem kegelförmigen Oberflächenbereich (46) und der unterbrochenen Umfangskante (50) liegt.

3. Aufrechte Feuerschutz-Sprühnebeldüse (10) nach Anspruch 2, wobei die Spitze (48) und die unterbrochene Umfangskante (50) in einer im Allgemeinen senkrecht zu der Achse (A) verlaufenden Ebene (H_P) angeordnet sind.

4. Aufrechte Feuerschutz-Sprühnebeldüse (10) nach Anspruch 3, wobei mindestens ein Abschnitt des ringförmigen Flächenbereiches (52) stromabwärts der Ebene (H_P) von der Spitze (48) und der unterbrochenen Umfangskante (50) im Verhältnis zu der Öffnung (28) ausgespart ist.

5. Aufrechte Feuerschutz-Sprühnebeldüse (10) nach Anspruch 4, wobei der im Wesentlichen ringförmige Flächenbereich (52) stromabwärts der Ebene (H_P) von der Spitze (48) und der unterbrochenen Umfangskante (50) im Verhältnis zu der Öffnung (28) ausgespart ist.

6. Aufrechte Feuerschutz-Sprühnebeldüse (10) nach Anspruch 2, wobei der Strom (W) von feuerhemmendem Fluid, der aus der Öffnung (28) fließt, um auf die Aufprallfläche (42) aufzuprallen, im Wesentlichen stetig und zusammenhängend ist.

7. Aufrechte Feuerschutz-Sprühnebeldüse (10) nach Anspruch 2, wobei der konkave, im Wesentlichen ringförmige Flächenbereich (52) eine Form aufweist, die durch die Drehung einer gekrümmten Fläche (E) ausgebildet ist, die aus mindestens drei, relativ glatt verblendeten Bögen (E_1, E_3, E_5) um eine Linie besteht, die durch die Öffnungsachse (A) festgelegt ist, die durch die Spitze (48) hindurchgeht.

8. Aufrechte Feuerschutz-Sprühnebeldüse (10) nach Anspruch 7, wobei die gekrümmte Fläche (E) aus mindestens drei, relativ glatt verblendeten Bögen (E_1, E_2, E_3, E_4, E_5) besteht.

9. Aufrechte Feuerschutz-Sprühnebeldüse (10) nach Anspruch 2, wobei die Aufprallfläche (42) mindestens eine Flächenunterbrechung (56) in einem Bereich der unterbrochenen Umfangskante (50) festlegt, um einen Teil des Stromes von feuerhemmendem Fluid entlang der Aufprallfläche (42) umzuleiten.

10. Aufrechte Feuerschutz-Sprühnebeldüse (10) nach Anspruch 9, wobei die Aufprallfläche (42) einen Satz von Flächenunterbrechungen (56) festlegt, die umfangsmäßig um die Achse (A) in dem Bereich der unterbrochenen Umfangskante (50) angeordnet sind, um mindestens einen Teil des Stromes von feuerhemmendem Fluid entlang der Aufprallfläche (42) umzuleiten.

11. Aufrechte Feuerschutz-Sprühnebeldüse nach Anspruch 10, wobei der Satz von Flächenunterbrechungen (56) die Form eines Satzes von Kerben (56) in der Aufprallfläche (42) aufweist.

12. Aufrechte Feuerschutz-Sprühnebeldüse (10) nach einem der Ansprüche 9 oder 11, wobei der Satz von Kerben (56) in der Aufprallfläche (42) einen Satz von Flächenbereichen (57) festlegt, die sich entlang einer Ebene (C_P), und von derselben nach außen erstreckt, die im Allgemeinen tangential zu einem Basisbereich (60) der konkaven Fläche (52) verläuft und im Allgemeinen senkrecht zu der Achse (A) in Richtung des Bereiches der unterbrochenen Umfangskante (50) liegt.

13. Aufrechte Feuerschutz-Sprühnebeldüse (10) nach einem der Ansprüche 9, 11 oder 12, wobei der Satz von Flächenunterbrechungen (56) einen Satz von mindestens etwa 8 Kerben in der Aufprallfläche (42) aufweist.

14. Aufrechte Feuerschutz-Sprühnebeldüse (10) nach einem der Ansprüche 9, 11, 12 oder 13, wobei der Satz von Flächenunterbrechungen (56) einen Satz von mindestens etwa 16 Kerben in der Aufprallfläche (42) aufweist.

15. Aufrechte Feuerschutz-Sprühnebeldüse (10) nach Anspruch 14, wobei der Satz von Flächenunterbrechungen (56) einen Satz von mindestens etwa 32 Kerben in der Aufprallfläche (42) aufweist.

16. Aufrechte Feuerschutz-Sprühnebeldüse (10) nach Anspruch 15, wobei der Satz von Flächenunterbrechungen (56) einen Satz von mindestens etwa 48 Kerben in der Aufprallfläche (42) aufweist.

17. Aufrechte Feuerschutz-Sprühnebeldüse (10) nach einem der Ansprüche 10 bis 16, wobei der Satz von Flächenunterbrechungen (56) den Strom an der unterbrochenen Umfangskante (50) mit wenig Energieverlust in mehrere Segmente (N_1,N_2) unterteilt.

18. Aufrechte Feuerschutz-Sprühnebeldüse (10) nach Anspruch 2, wobei der Strom (W) von feuerhemmendem Fluid, das aus der Öffnung (28) fließt, einen Stromdurchmesser (D_W) aufweist, der gemessen wird, wenn der Strom (W) dabei ist, durch die Seitenebene (H_P) hindurchzugehen, wobei das Verhältnis eines Durchmessers (D_C) eines Bereiches der konkaven Fläche (52), die im Allgemeinen tangential zu einer Ebene (C_P) liegt, die im Allgemeinen senkrecht zu der Achse (A) zu dem Stromdurchmesser (D_W) verläuft, größer oder gleich etwa 2 ist.

19. Aufrechte Feuerschutz-Sprühnebeldüse (10) nach Anspruch 18, wobei das Verhältnis des Durchmessers (D_C) des Bereiches der konkaven Fläche (52), die im Allgemeinen tangential zu der Ebene (C_P) liegt, die im Allgemeinen senkrecht zu der Achse (A) zu dem Stromdurchmesser (D_W) verläuft, größer oder gleich etwa 3 ist.

20. Aufrechte Feuerschutz-Sprühnebeldüse (10) nach Anspruch 19, wobei das Verhältnis des Durchmessers (D_C) des Bereiches der konkaven Fläche (52), die im Allgemeinen tangential zu der Ebene (C_P) liegt, die im Allgemeinen senkrecht zu der Achse (A) zu dem Stromdurchmesser (D_W) verläuft, größer oder gleich etwa 4 ist.

21. Aufrechte Feuerschutz-Sprühnebeldüse (10) nach einem der Ansprüche 2 oder Ansprüche 11 bis 16, wobei die unterbrochene Umfangskante (50) einen inneren Kantendurchmesser (D_I) aufweist, der in der Seitenfläche (H_P) gemessen wird, und wobei der Strom (W) einen Stromdurchmesser (D_W) aufweist, der gemessen wird, wenn der Strom (W) dabei ist, durch die Seitenebene (H_P) hindurchzugehen, wobei ein Verhältnis des inneren Kantendurchmessers (D_I) zu dem Stromdurchmesser (D_W) mindestens etwa 3 beträgt.

22. Aufrechte Feuerschutz-Sprühnebeldüse (10) nach einem der Ansprüche 20 oder 21, wobei das Ver-

hältnis des inneren Kantendurchmessers (D_I) zu dem Stromdurchmesser (D_W) mindestens etwa 5,5 beträgt.

23. Aufrechte Feuerschutz-Sprühnebeldüse (10) nach einem der Ansprüche 20, 21 oder 22, wobei das Verhältnis des inneren Kantendurchmessers (D_I) zu dem Stromdurchmesser (D_W) mindestens etwa 8 beträgt.

24. Aufrechte Feuerschutz-Sprühnebeldüse (10) nach Anspruch 23, wobei das Verhältnis des inneren Kantendurchmessers (D_I) zu dem Stromdurchmesser (D_W) in der Größenordnung von etwa 20 liegt.

25. Aufrechte Feuerschutz-Sprühnebeldüse (10) nach Anspruch 21, wobei der Satz von Flächenunterbrechungen (56) den Strom an dem Bereich der unterbrochenen Umfangskante (50) mit wenig Energieverlust in mehrere Segmente (N_1,N_2) unterteilt.

26. Aufrechte Feuerschutz-Sprühnebeldüse (100) nach Anspruch 2, in Form einer automatisch betriebenen Feuerschutzdüse, die weiterhin in einem Standby-Zustand eine lösbare Öffnungsdichtung (106) aufweist, die durch ein thermisch reagierendes Element (102) in ihrer Position gehalten wird.

27. Aufrechte Feuerschutz-Sprühnebeldüse (10) nach Anspruch 1, wobei der konkave Flächenbereich (52) so ausgebildet ist, dass er das feuerhemmende Fluid in dem Strom (W) derart umleitet, dass es von der Achse (A) radial nach außen entlang der Aufprallfläche (42) in Richtung der unterbrochenen Umfangskante (50) der Aufprallfläche (42) fließt, wobei die Aufprallfläche (42) derart angepasst ist, dass sie den Strom (W) um mindestens 90° von der Strömungsrichtung (F) umleitet (L,M), wobei sie den Fluss von feuerhemmendem Fluid in Richtung des Bereiches der unterbrochenen Umfangskante (50) aufrecht erhält, die im Wesentlichen mit der Aufprallfläche (42) derart in Kontakt steht, um Spritzen im Wesentlichen zu vermeiden.

28. Aufrechte Feuerschutz-Sprühnebeldüse (10) nach Anspruch 27, wobei die Aufprallfläche (42) so angepasst ist, dass sie den Fluss des feuerhemmenden Fluids um mindestens 110° von der Strömungsrichtung (F) umleitet (L,M), wobei sie den Fluss von feuerhemmendem Fluid in Richtung des Bereiches der unterbrochenen Umfangskante (50) aufrecht erhält, die im Wesentlichen mit der Aufprallfläche (42) derart in Kontakt steht, um Spritzen im Wesentlichen zu vermeiden.

29. Aufrechte Feuerschutz-Sprühnebeldüse (10) nach Anspruch 21, wobei die Aufprallfläche (42) so angepasst ist, dass sie den Fluss des feuerhemmenden Fluids von dem Strom (W) um mindestens 90° von der Strömungsrichtung (F) umleitet (L,M), wobei sie den Fluss von feuerhemmendem Fluid in Richtung des Bereiches der unterbrochenen Umfangskante (50) aufrecht erhält, die im Wesentlichen mit der Aufprallfläche (42) derart in Kontakt steht, um Spritzen im Wesentlichen zu vermeiden.

30. Aufrechte Feuerschutz-Sprühnebeldüse (10) nach Anspruch 1, wobei die Aufprallfläche (42) einen Sprühnebel aus feuerhemmendem Fluid über einen vor Feuer zu schützenden Bereich umleitet, wobei der Sprühnebel durch einen Tröpfchengrößendurchmesser Dv_{90} von weniger als etwa 250 Mikron **gekennzeichnet** ist, wenn bei einem Druck von (175 psi) 1210 kPa am Einlass der Düse in Übereinstimmung mit dem in der 2000er-Ausgabe der NFPA 750-Norm für Wassernebel-Feuerschutzsysteme (2000 Edition of the NFPA 750 Standard on Water Mist Fire Protection Systems) empfohlenen Verfahren gemessen wird.

31. Aufrechte Feuerschutz-Sprühnebeldüse (10) nach einem der Ansprüche 1 oder 30, wobei der Sprühnebel durch einen Tröpfchengrößendurchmesser Dv_{90} von weniger als etwa 200 Mikron **gekennzeichnet** ist, wenn bei einem Druck von (175 psi) 1210 kPa am Einlass der Düse in Übereinstimmung mit dem in der 2000er-Ausgabe der NFPA 750-Norm für Wassernebel-Feuerschutzsysteme (2000 Edition of the NFPA 750 Standard on Water Mist Fire Protection Systems) empfohlenen Verfahren gemessen wird.

32. Aufrechte Feuerschutz-Sprühnebeldüse (10) nach einem der Ansprüche 1, 30 oder 31, wobei der Sprühnebel durch einen Tröpfchengrößendurchmesser Dv_{90} von weniger als etwa 150 Mikron **gekennzeichnet** ist, wenn bei einem Druck von (175 psi) 1210 kPa am Einlass der Düse in Übereinstimmung mit dem in der 2000er-Ausgabe der NFPA 750-Norm für Wassernebel-Feuerschutzsysteme (2000 edition of the NFPA 750 Standard on Water Mist Fire Protection Systems) empfohlenen Verfahren gemessen wird.

33. Aufrechte Feuerschutz-Sprühnebeldüse (10) nach Anspruch 1, wobei die Öffnung (28) einen Öffnungsdurchmesser von vorzugsweise weniger als etwa (0,200 Inch) 5080 Mikron aufweist.

34. Aufrechte Feuerschutz-Sprühnebeldüse (10) nach Anspruch 33, wobei der Öffnungsdurchmesser vorzugsweise weniger als etwa (0,150 Inch) 3810 Mikron aufweist.

35. Aufrechte Feuerschutz-Sprühnebeldüse (10) nach einem der Ansprüche 33 oder 34, wobei der Öffnungsdurchmesser weniger als etwa (0,110 Inch) 2790 Mikron aufweist.

36. Aufrechte Feuerschutz-Sprühnebeldüse (10) nach Anspruch 1, wobei der konkave Flächenbereich (52) einen Wassersprühnebel ausgibt, der einen Tröpfchengrößendurchmesser D_{V90} von weniger als etwa 200 Mikron aufweist, wenn bei einem Druck von 175 psi am Einlass der Düse in Übereinstimmung mit dem in der 2000er-Ausgabe der NFPA 750-Norm für Wassernebel-Feuerschutzsysteme (2000 Edition of the NFPA 750 Standard on Water Mist Fire Protection Systems) empfohlenen Verfahren gemessen wird.

Revendications

1. Buse (10) de type vertical pour protection anti-incendie par brumisation, comportant :

une embase (12) définissant un orifice (28), doté d'un axe (A) d'orifice, à travers lequel peut s'écouler un fluide ignifuge ;
une section (18) d'entrée dotée d'une extrémité amont et définissant un conduit (16) pour l'écoulement de fluide ignifuge le long dudit axe (A) d'orifice et menant à une extrémité amont dudit orifice (28) ; et
un élément (40) de diffuseur définissant une surface (42) d'impact qui est au moins sensiblement imperforée dans une direction axiale et positionnée en vue d'être frappée par un flux (W) de fluide ignifuge s'écoulant à partir dudit orifice (28) dans une direction (F) de flux le long dudit axe (A), ledit élément (40) de diffuseur étant positionné de façon générale au-dessus d'un plan horizontal à travers une extrémité aval dudit orifice (28) ; et
caractérisée en ce que ladite surface (42) d'impact comporté :

une région (52) de surface concave sensiblement toroïdale destinée à dévier du fluide ignifuge dudit flux (W) de façon à ce qu'il s'écoule radialement vers l'extérieur à partir dudit axe (A), en direction d'un bord périphérique discontinu (50) de ladite surface (42) d'impact.

2. Buse (10) de type vertical pour protection anti-incendie par brumisation selon la revendication 1, ladite région (52) de surface concave de ladite surface (42) d'impact comportant en outre une région centrale (46) de surface de forme conique s'étendant de façon générale en direction dudit orifice (28), dotée d'une partie (48) de sommet disposée le long dudit axe (A) ; ledit bord périphérique discontinu (50) étant disposé de façon généralement extérieure dans le sens radial à ladite région (46) de surface de forme conique et définissant un plan (H_P) de face ; et ladite région (52) de surface concave sensiblement toroïdale se situant généralement entre ladite région (46) de surface de forme conique et ledit bord périphérique discontinu (50).

3. Buse (10) de type vertical pour protection anti-incendie par brumisation selon la revendication 2, ledit sommet (48) et ledit bord périphérique discontinu (50) étant disposés dans un plan (H_P) généralement perpendiculaire audit axe (A).

4. Buse (10) de type vertical pour protection anti-incendie par brumisation selon la revendication 3, au moins une portion de ladite région (52) de surface toroïdale étant en retrait, en aval dudit plan (H_P) dudit sommet (48) et dudit bord périphérique discontinu (50), par rapport audit orifice (28).

5. Buse (10) de type vertical pour protection anti-incendie par brumisation selon la revendication 4, ladite région (52) de surface sensiblement toroïdale étant en retrait, en aval dudit plan (H_P) dudit sommet (48) et dudit bord périphérique discontinu (50), par rapport audit orifice (28).

6. Buse (10) de type vertical pour protection anti-incendie par brumisation selon la revendication 2, ledit flux (W) de fluide ignifuge s'écoulant à partir dudit orifice (28) pour frapper ladite surface (42) d'impact étant sensiblement stable et cohérent.

7. Buse (10) de type vertical pour protection anti-incendie par brumisation selon la revendication 2, ladite région (52) de surface concave sensiblement toroïdale présentant une forme engendrée par rotation d'une surface incurvée (E) constituée d'au moins trois arcs (E_1, E_3, E_5) fusionnés de façon relativement lisse autour d'une ligne définie par ledit axe (A) d'orifice passant par ledit sommet (48).

8. Buse (10) de type vertical pour protection anti-incendie par brumisation selon la revendication 7, ladite surface incurvée (E) étant constituée d'au moins cinq arcs (E_1, E_2, E_3, E_4, E_5) fusionnés de façon relativement lisse.

9. Buse (10) de type vertical pour protection anti-incendie par brumisation selon la revendication 2, ladite surface (42) d'impact définissant au moins une discontinuité (56) de surface dans une région dudit bord périphérique discontinu (50) afin de rediriger une partie dudit flux de fluide ignifuge le long de ladite surface (42) d'impact.

10. Buse (10) de type vertical pour protection anti-incendie par brumisation selon la revendication 9, ladite surface (42) d'impact définissant un ensemble de discontinuités (56) de surface espacées circonférentiellement autour dudit axe (A) dans ladite région dudit bord périphérique discontinu (50) afin de rediriger au moins une partie dudit flux de fluide ignifuge le long de ladite surface (42) d'impact.

11. Buse de type vertical pour protection anti-incendie par brumisation selon la revendication 10, ledit ensemble de discontinuités (56) de surface prenant la forme d'un ensemble d'encoches (56) dans ladite surface (42) d'impact.

12. Buse (10) de type vertical pour protection anti-incendie par brumisation selon l'une quelconque des revendications 9 ou 11, ledit ensemble d'encoches (56) dans ladite surface (42) d'impact définissant un ensemble de régions (57) de surface s'étendant le long et au-delà d'un plan (C_P) généralement tangent à une région (60) de base de ladite surface concave (52) et situé de façon généralement perpendiculaire audit axe (A), en direction de ladite région dudit bord périphérique discontinu (50).

13. Buse (10) de type vertical pour protection anti-incendie par brumisation selon l'une quelconque des revendications 9, 11 ou 12, ledit ensemble de discontinuités (56) de surface comportant un ensemble d'au moins environ 8 encoches dans ladite surface (42) d'impact.

14. Buse (10) de type vertical pour protection anti-incendie par brumisation selon l'une quelconque des revendications 9, 11, 12 ou 13, ledit ensemble de discontinuités (56) de surface comportant un ensemble d'au moins environ 16 encoches dans ladite surface (42) d'impact.

15. Buse (10) de type vertical pour protection anti-incendie par brumisation selon la revendication 14, ledit ensemble de discontinuités (56) de surface comportant un ensemble d'au moins environ 32 encoches dans ladite surface (42) d'impact.

16. Buse (10) de type vertical pour protection anti-incendie par brumisation selon la revendication 15, ledit ensemble de discontinuités (56) de surface comportant un ensemble d'au moins environ 48 encoches dans ladite surface (42) d'impact.

17. Buse (10) de type vertical pour protection anti-incendie par brumisation selon l'une quelconque des revendications 10 à 16, ledit ensemble de discontinuités (56) de surface divisant ledit écoulement en segments multiples (N_1, N_2) au niveau dudit bord périphérique discontinu (50) avec une faible perte d'énergie.

18. Buse (10) de type vertical pour protection anti-incendie par brumisation selon la revendication 2, ledit flux (W) de fluide ignifuge qui s'écoule à partir dudit orifice (28) présentant un diamètre (D_W) de flux mesuré là où ledit flux (W) s'apprête à traverser ledit plan (H_P) de face, et le rapport du diamètre (D_C) d'une région de ladite surface concave (52) située de façon généralement tangente à un plan (C_P) généralement perpendiculaire audit axe (A) audit diamètre (D_W) de flux étant supérieur ou approximativement égal à 2.

19. Buse (10) de type vertical pour protection anti-incendie par brumisation selon la revendication 18, ledit rapport du diamètre (D_C) d'une région de ladite surface concave (52) située de façon généralement tangente au plan (C_P) généralement perpendiculaire audit axe (A) audit diamètre (D_W) de flux étant supérieur ou approximativement égal à 3.

20. Buse (10) de type vertical pour protection anti-incendie par brumisation selon la revendication 19, ledit rapport du diamètre (D_C) d'une région de ladite surface concave (52) située de façon généralement tangente au plan (C_P) généralement perpendiculaire audit axe (A) audit diamètre (D_W) de flux étant supérieur ou approximativement égal à 4.

21. Buse (10) de type vertical pour protection anti-incendie par brumisation selon la revendication 2 ou l'une quelconque des revendications 11 à 16, ledit bord périphérique discontinu (50) présentant un diamètre (D_I) de bord intérieur mesuré dans ledit plan (H_P) de face et ledit flux (W) présentant un diamètre (D_W) de flux mesuré là où ledit flux (W) s'apprête à traverser ledit plan (H_P) de face, et un rapport dudit diamètre (D_I) de bord intérieur audit diamètre (D_W) de flux valant au moins environ 3.

22. Buse (10) de type vertical pour protection anti-incendie par brumisation selon l'une quelconque des revendications 20 ou 21, le rapport dudit diamètre (D_I) de bord intérieur audit diamètre (D_W) de flux valant au moins environ 5,5.

23. Buse (10) de type vertical pour protection anti-incendie par brumisation selon l'une quelconque des revendications 20, 21 ou 22, le rapport dudit diamètre (D_I) de bord intérieur audit diamètre (D_W) de flux valant au moins environ 8.

24. Buse (10) de type vertical pour protection anti-incendie par brumisation selon la revendication 23, le rapport dudit diamètre (D_I) de bord intérieur audit diamètre (D_W) de flux étant de l'ordre de 20 environ.

25. Buse (10) de type vertical pour protection anti-incendie par brumisation selon la revendication 21, ledit ensemble de discontinuités (56) de surface divisant ledit écoulement en segments multiples (N_1, N_2) au niveau de ladite région dudit bord périphérique discontinu (50) avec une faible perte d'énergie.

26. Buse (100) de type vertical pour protection anti-incendie par brumisation selon la revendication 2, sous la forme d'une buse anti-incendie à action automatique, comportant en outre, en condition de veille, un obturateur libérable (106) d'orifice maintenu en position par un élément thermosensible (102).

27. Buse (10) de type vertical pour protection anti-incendie par brumisation selon la revendication 1, ladite région (52) de surface concave étant conformée de façon à dévier du fluide ignifuge dudit flux (W) de façon à s'écouler radialement vers l'extérieur à partir dudit axe (A), le long ladite surface (42) d'impact, en direction d'une région dudit bord périphérique discontinu (50) de ladite surface (42) d'impact, ladite surface (42) d'impact étant prévue pour rediriger sensiblement (L, M) ledit écoulement de fluide ignifuge issu dudit flux (W) d'au moins 90° par rapport à ladite direction (F) de flux tout en maintenant ledit écoulement de fluide ignifuge vers ladite région dudit bord périphérique discontinu (50) sensiblement en contact avec ladite surface (42) d'impact de manière à éviter sensiblement les éclaboussures.

28. Buse (10) de type vertical pour protection anti-incendie par brumisation selon la revendication 27, ladite surface (42) d'impact étant prévue pour rediriger (L, M) ledit écoulement de fluide ignifuge d'au moins 110° par rapport à ladite direction (F) de flux tout en maintenant ledit écoulement de fluide ignifuge vers ladite région dudit bord périphérique discontinu (50) sensiblement en contact avec ladite surface (42) d'impact de manière à éviter sensiblement les éclaboussures.

29. Buse (10) de type vertical pour protection anti-incendie par brumisation selon la revendication 21, ladite surface (42) d'impact étant prévue pour rediriger (L, M) ledit écoulement de fluide ignifuge issu dudit flux (W) d'au moins 90° par rapport à ladite direction (F) de flux tout en maintenant ledit écoulement de fluide ignifuge vers ladite région dudit bord périphérique discontinu (50) sensiblement en contact avec ladite surface (42) d'impact de manière à éviter sensiblement les éclaboussures.

30. Buse (10) de type vertical pour protection anti-incendie par brumisation selon la revendication 1, ladite surface (42) d'impact redirigeant une pulvérisation de fluide ignifuge sur une zone à protéger de l'incendie, ladite pulvérisation étant **caractérisée par** un diamètre Dv_{90} de taille des gouttelettes inférieur à environ 250 microns lorsqu'il est mesuré à une pression de 1210 kPa (175 psi) à l'entrée de la buse, conformément à la procédure recommandée dans l'édition 2000 de la norme NFPA 750 sur les systèmes de protection anti-incendie par brumisation d'eau.

31. Buse (10) de type vertical pour protection anti-incendie par brumisation selon l'une quelconque des revendications 1 ou 30, ladite pulvérisation étant **caractérisée par** un diamètre Dv_{90} de taille des gouttelettes inférieur à environ 200 microns lorsqu'il est mesuré à une pression de 1210 kPa (175 psi) à l'entrée de la buse, conformément à la procédure recommandée dans l'édition 2000 de la norme NFPA 750 sur les systèmes de protection anti-incendie par brumisation d'eau.

32. Buse (10) de type vertical pour protection anti-incendie par brumisation selon l'une quelconque des revendications 1, 30 ou 31, ladite pulvérisation étant **caractérisée par** un diamètre Dv_{90} de taille des gouttelettes inférieur à environ 150 microns lorsqu'il est mesuré à une pression de 1210 kPa (175 psi) à l'entrée de la buse, conformément à la procédure recommandée dans l'édition 2000 de la norme NFPA 750 sur les systèmes de protection anti-incendie par brumisation d'eau.

33. Buse (10) de type vertical pour protection anti-incendie par brumisation selon la revendication 1, ledit orifice (28) présentant un diamètre d'orifice de préférence inférieur à environ 5080 microns (0,200 pouce).

34. Buse (10) de type vertical pour protection anti-incendie par brumisation selon la revendication 33, ledit diamètre d'orifice étant inférieur à environ 3810 microns (0,150 pouce).

35. Buse (10) de type vertical pour protection anti-incendie par brumisation selon l'une quelconque des revendications 33 ou 34, ledit diamètre d'orifice étant inférieur à environ 2790 microns (0,110 pouce).

36. Buse (10) de type vertical pour protection anti-incendie par brumisation selon la revendication 1, ladite région (52) de surface concave distribuant un brouillard d'eau pulvérisée présentant un diamètre Dv_{90} de taille des gouttelettes inférieur à 200 microns lorsqu'il est mesuré à une pression de 175 psi à l'entrée de la buse, conformément à l'édition 2000 de la norme NFPA 750 sur les systèmes de protection anti-incendie par brumisation d'eau.

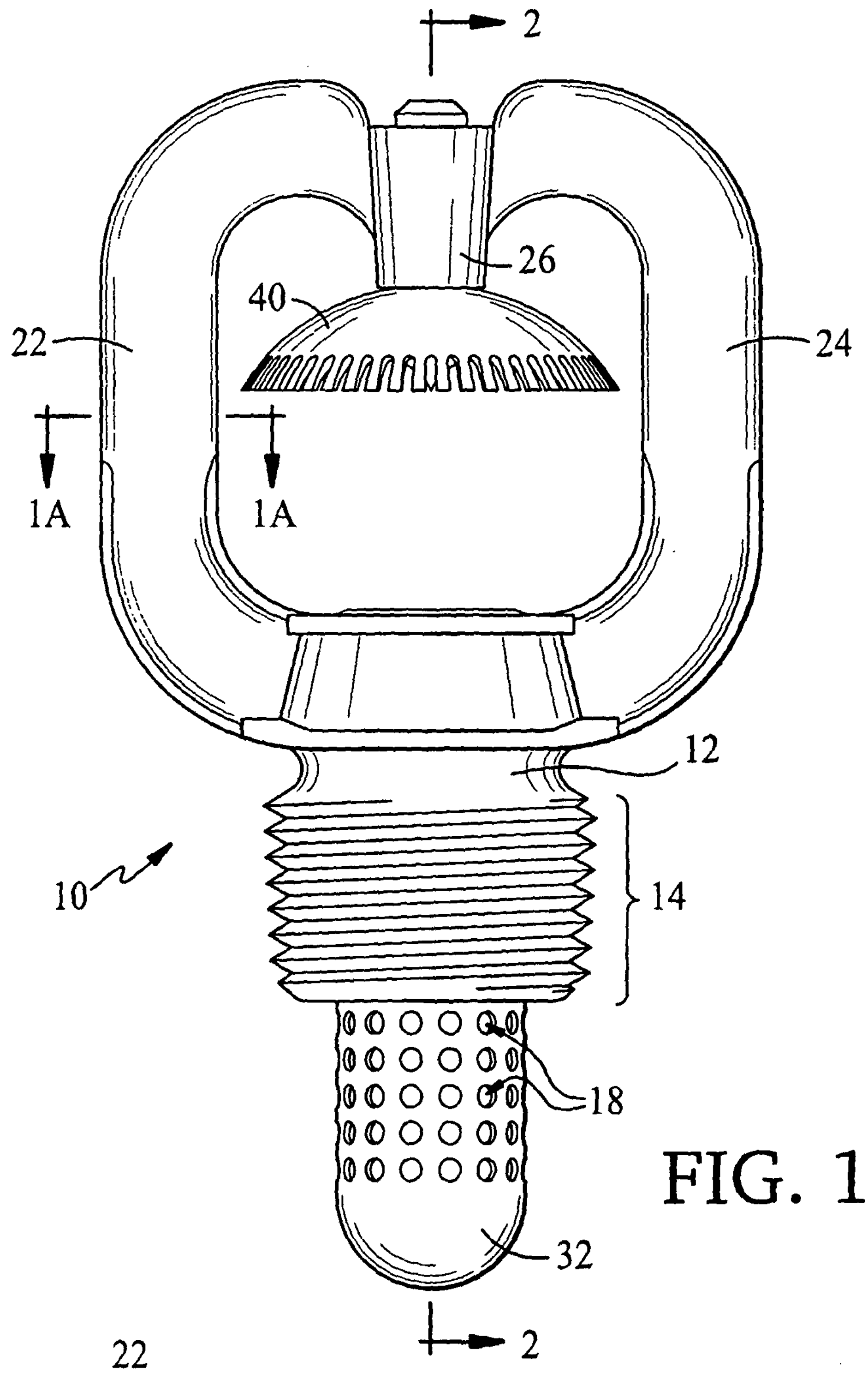


FIG. 1

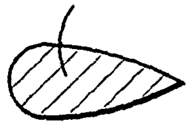


FIG. 1A

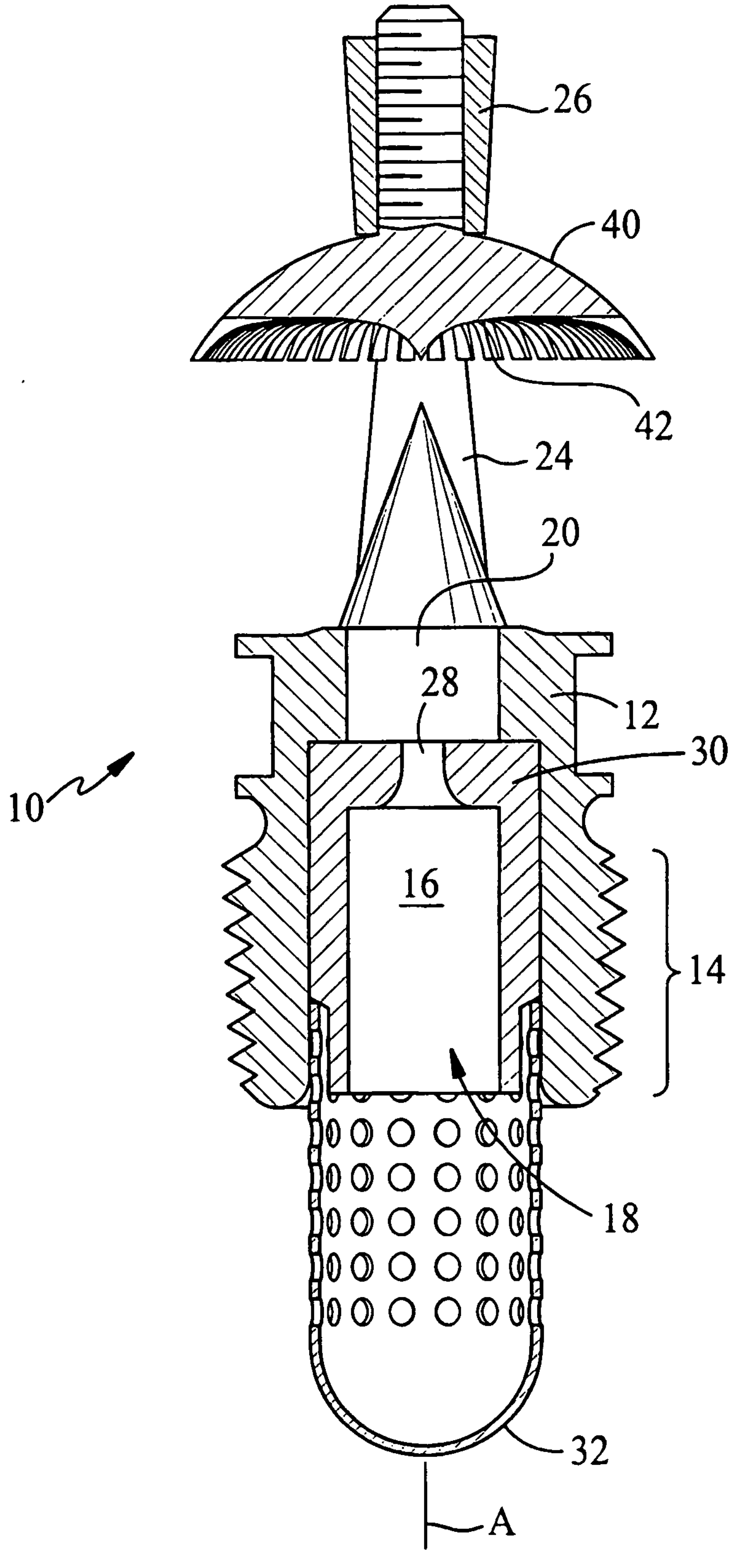


FIG. 2

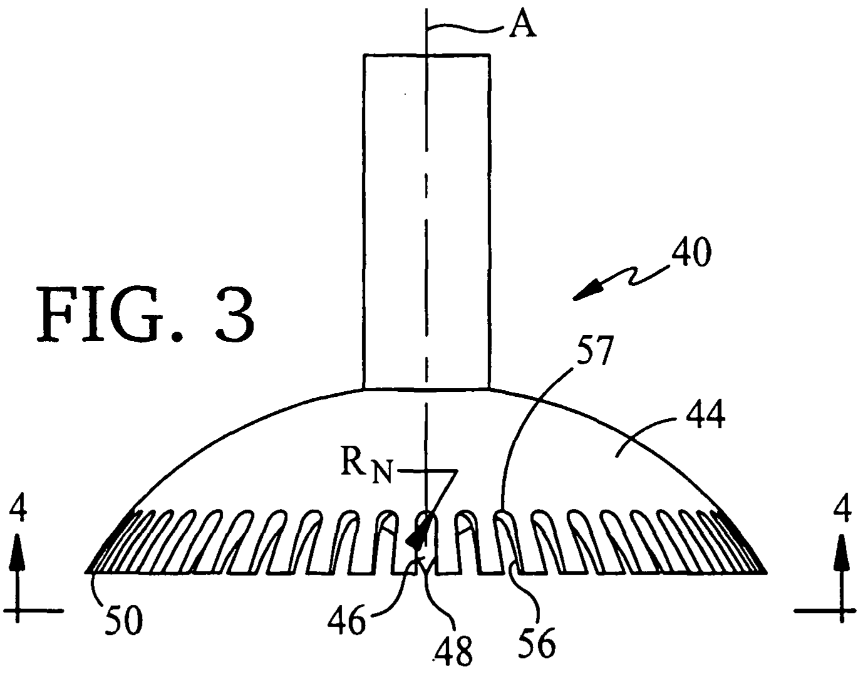


FIG. 3

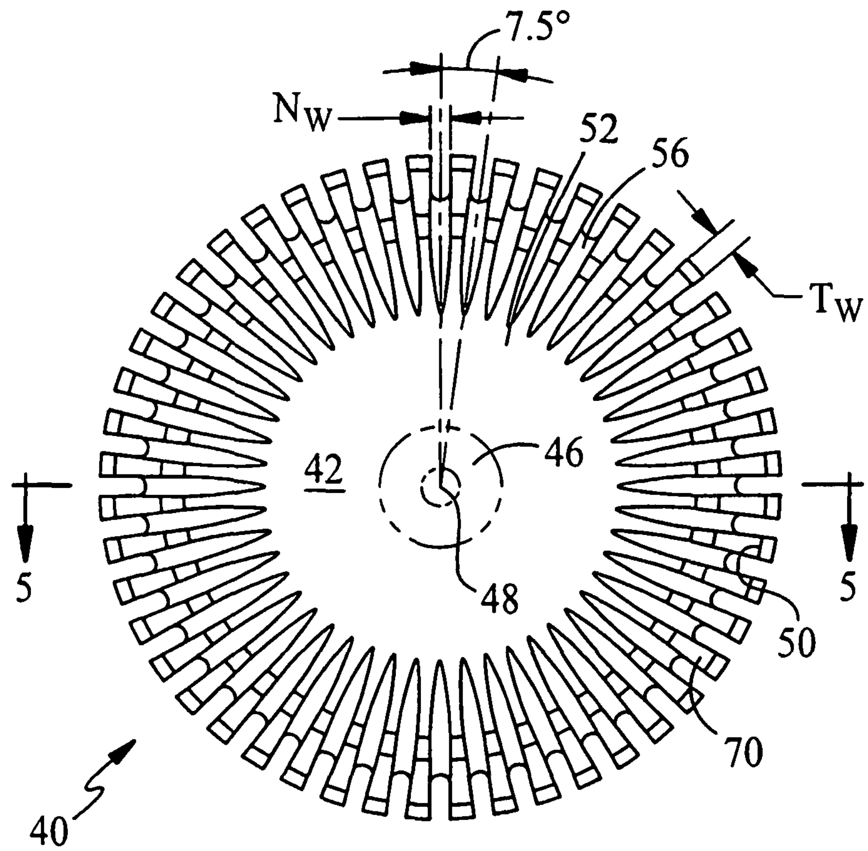


FIG. 4

FIG. 5

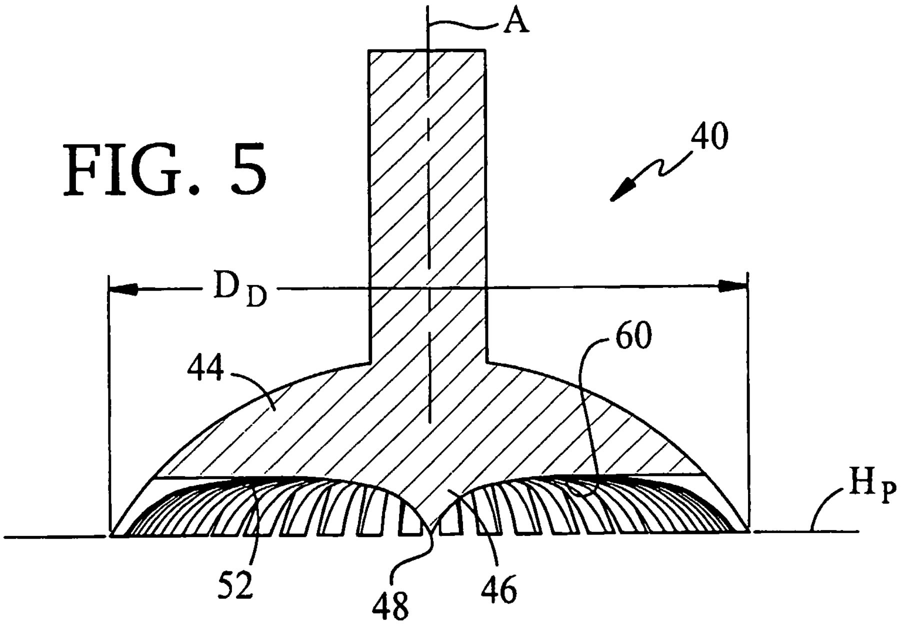
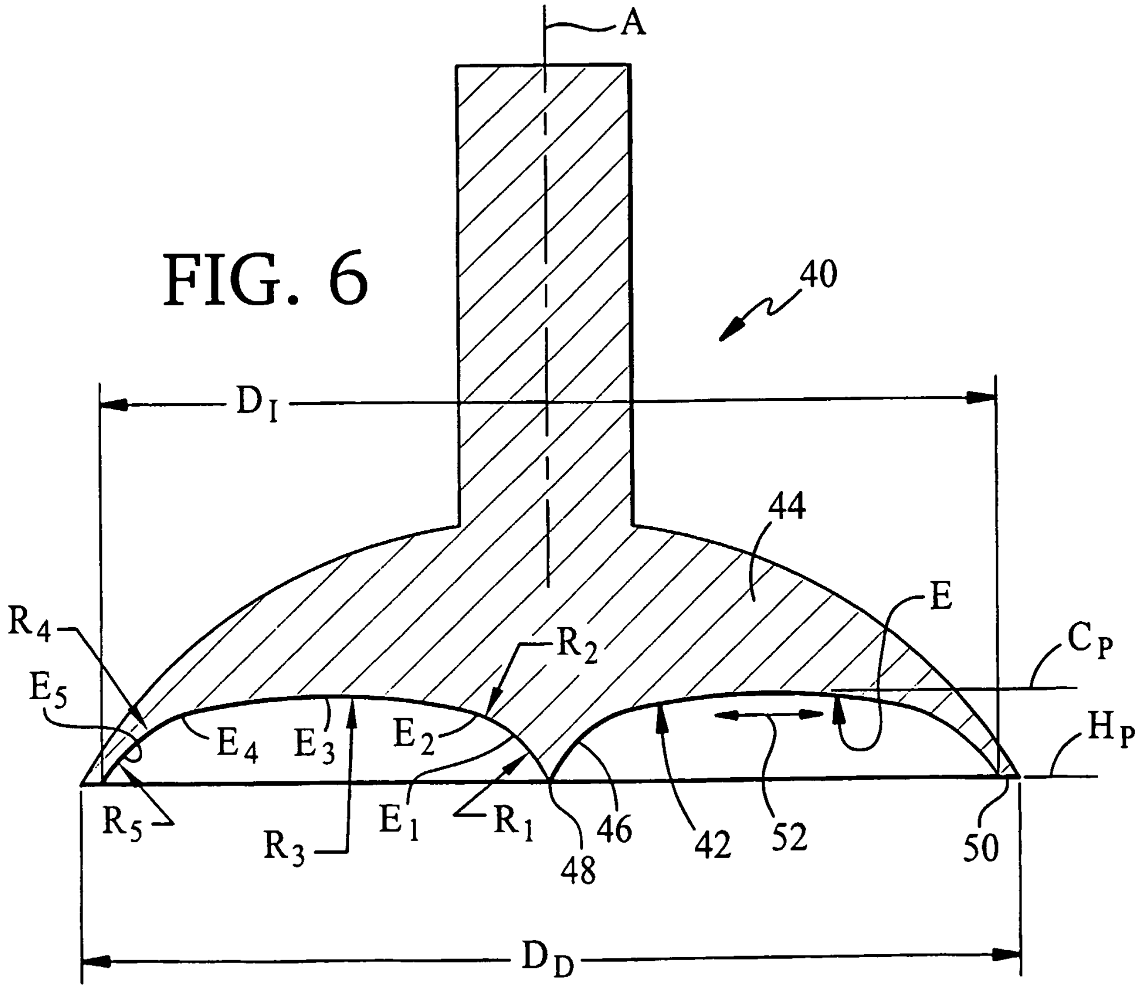

A
40
D_D
44
60
H_P
52
48
46

FIG. 6


A
40
D_I
44
E
C_P
H_P
R_4
E_5
R_2
E_4
E_3
E_2
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46
42
52
50
D_D

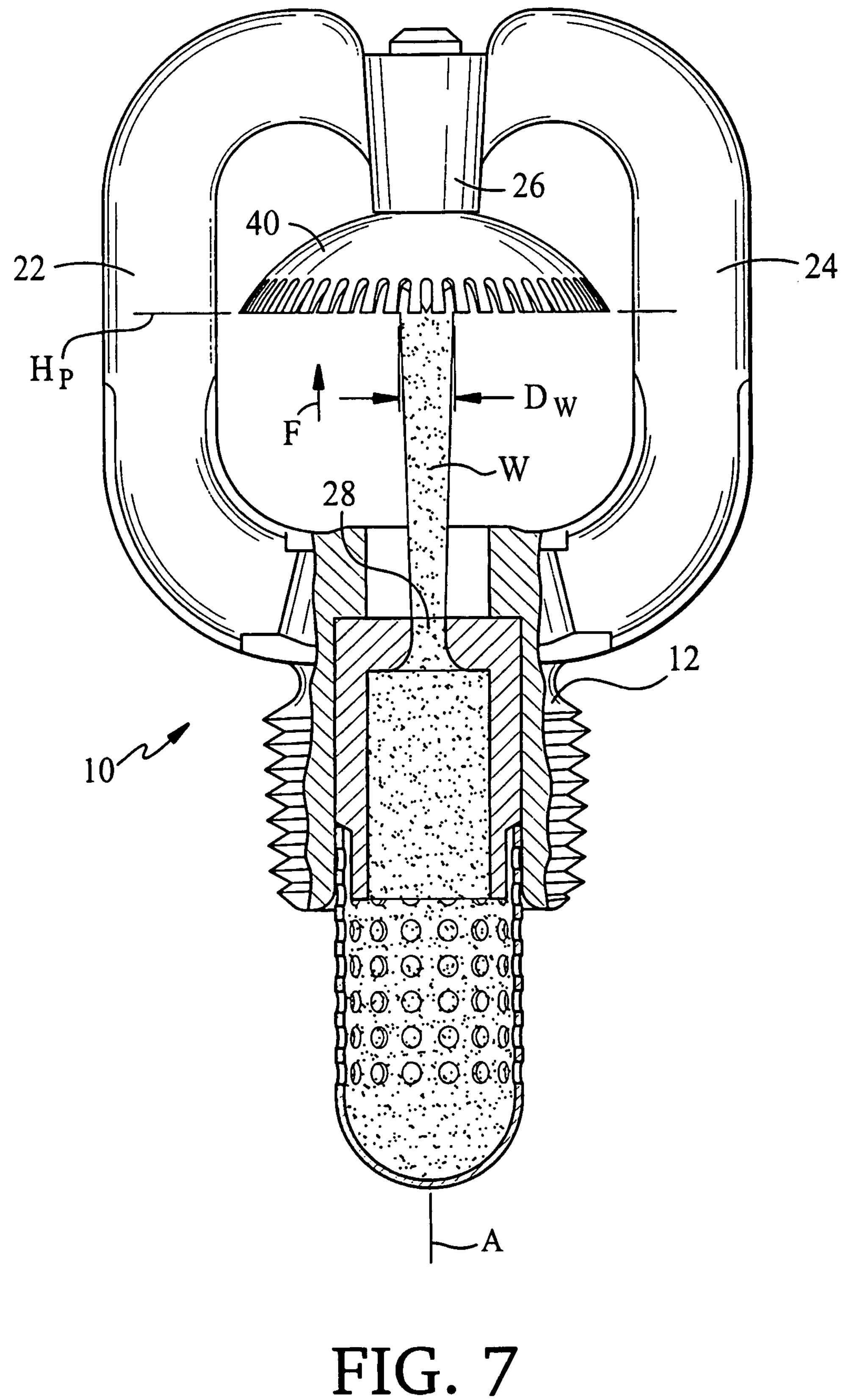


FIG. 7

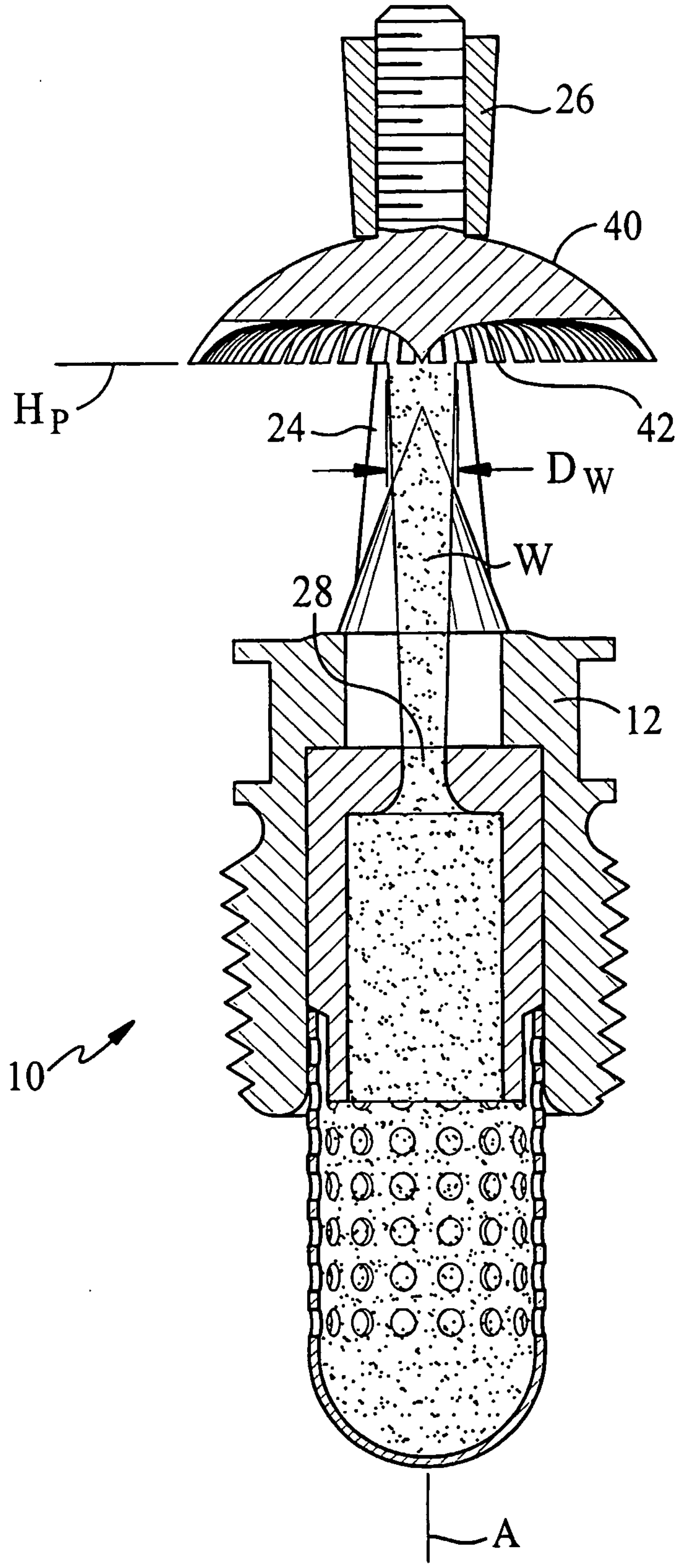
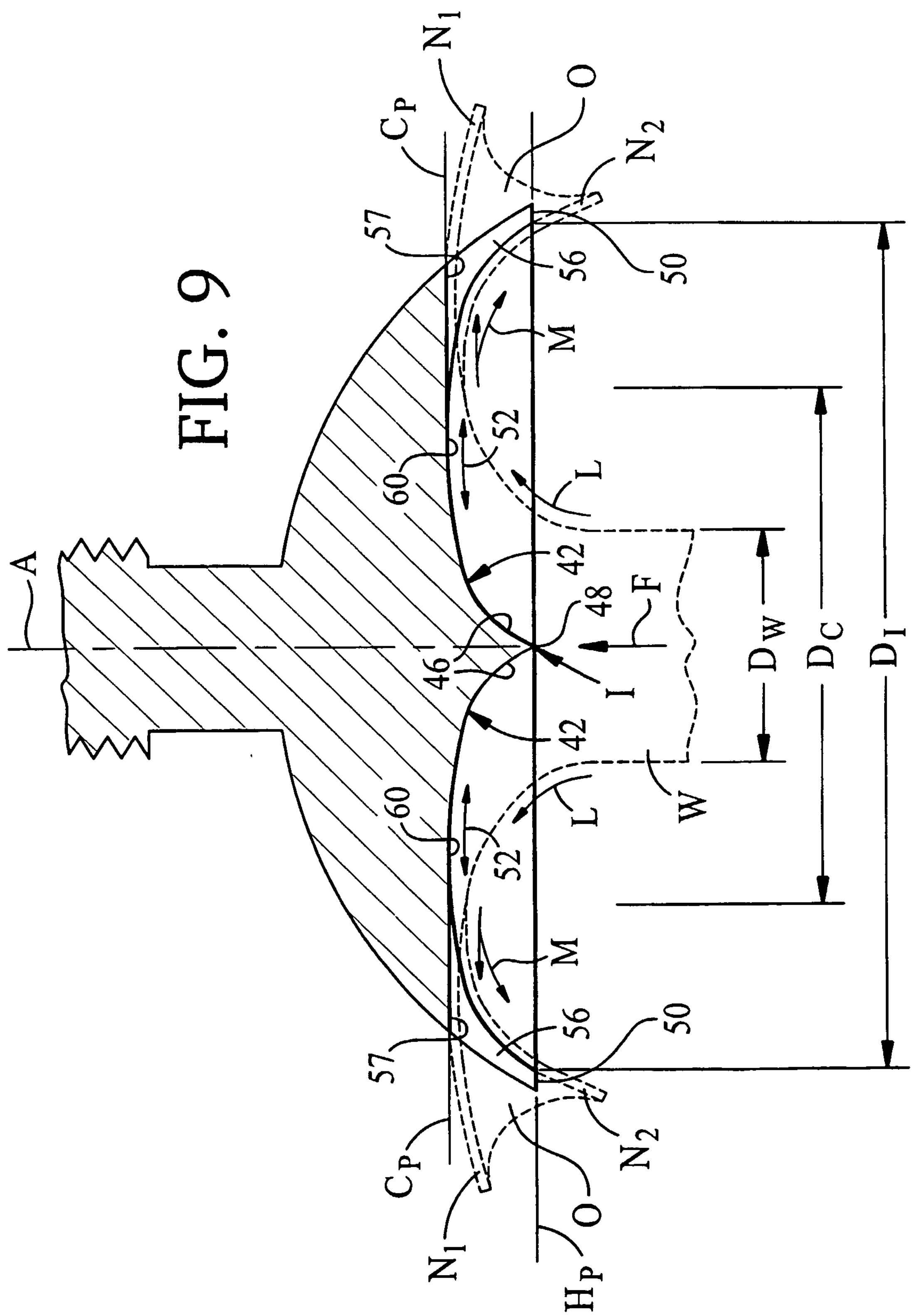


FIG. 8

FIG. 9



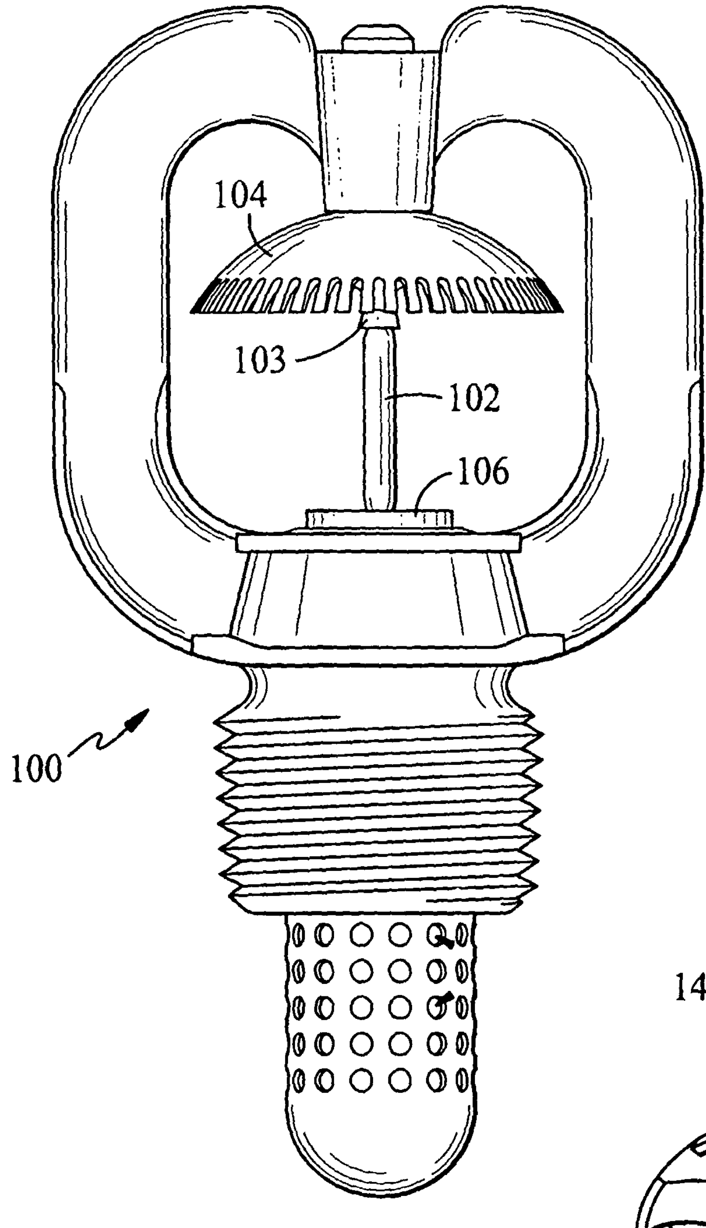


FIG. 10

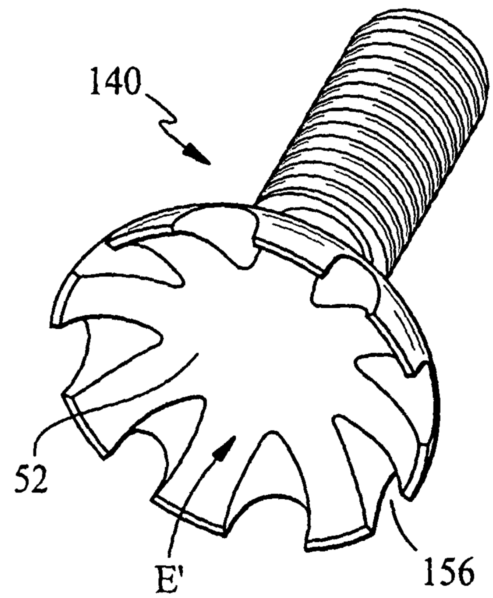


FIG. 11

REFERENCES CITED IN THE DESCRIPTION

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