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(54) **Adjustable nozzle**

(57) A nozzle (12) for fire suppression includes a first portion (26) and a second portion (28). The first portion (26) has a first passageway (42) with a gas inlet (30) and a gas outlet (44). The first portion (26) has a cavity (38) therein with a liquid inlet (40) and a liquid outlet (46). The cavity (38) is disposed around at least a portion of the first passageway (42) such that the gas outlet (44) is disposed radially inward of the liquid outlet (46) from the cavity (38). The second portion (28) is connected to the first portion (26) and has a second passageway (48) with an outlet (32). The second passageway (48) has a first region (50) with an increasing diameter toward the outlet (32) and a throat (52) communicating with both the outlet (44) of the first passageway (42) and the outlet (46) of the cavity (38).

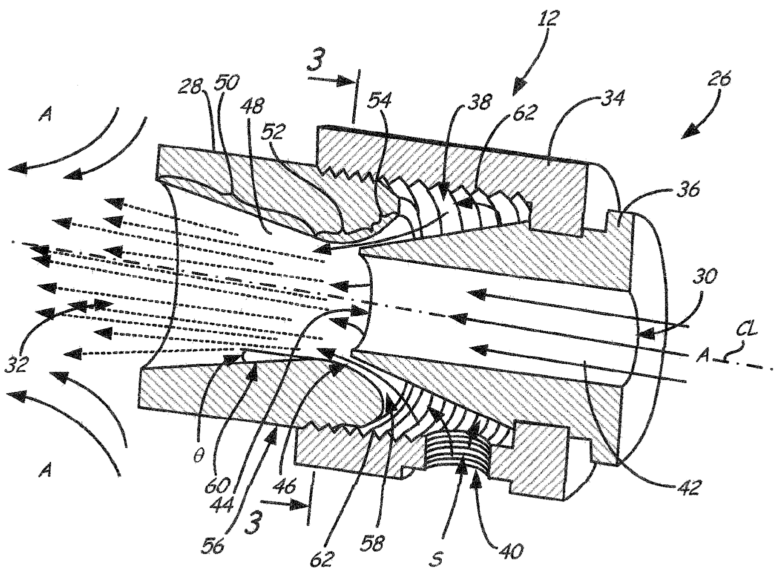

FIG. 2

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Description

BACKGROUND

[0001] The invention relates generally to nozzles, and more particularly to an adjustable nozzle for fire suppression.

[0002] A wide variety of fire suppression systems and apparatuses are commercially available. Fires are identified according to one or more fire classes. Each class designates the fuel involved in the fire, and thus, the most appropriate extinguishing agent. The classifications allow for the selection of appropriate extinguishing agents. The appropriate agent is selected based on effectiveness at putting out the class of fire, as well as avoiding unwanted side-effects. Multiple classification systems exist, for example the United States has a classification system that differs from that of Europe and Australia.

[0003] Fires whose fuel is a flammable or combustible liquid or gas can be treated by inhibiting the chemical chain reaction of the fire. One form of fire suppression system that accomplishes this is a "clean agent" gaseous fire suppression system. Clean agent fire extinguishing systems extinguish fires by creating a fire extinguishing atmosphere consisting of agent vapor or gas that is mixed with the air within the protected space. Clean agent systems are used in enclosed areas to suppress fires without water, powder or foam so not as to destroy or damage an enclosed area.

[0004] Most commonly, the chemical that forms the agent for the clean agent system is stored in liquefied form under normal storage conditions but should be vaporized to form a gaseous mixture with air once released into the atmosphere of the enclosed area. Once released, the agent mixes with the ambient air of the enclosed space to inhibit combustion and extinguish the fire.

[0005] Ideally, liquefied-gas agents exist in liquid form when confined in a closed container but exist as a gas when not confined in the container. However, this is not always the case. In some instances, the liquid agent does not become entrained and evaporate rapidly in the ambient air of the enclosed area. If the agent remains a liquid for too long during discharge it can contact objects within the enclosed area and fall to the floor to pool. Pooling of agent is wasteful and limits the effectiveness of the agent to fight the fire.

SUMMARY

[0006] A nozzle for fire suppression includes a first portion and a second portion. The first portion has a first passageway with a gas inlet and a gas outlet. The first portion has a cavity therein with a liquid inlet and a liquid outlet. The cavity is disposed around at least a portion of the first passageway such that the gas outlet is disposed radially inward of the liquid outlet from the cavity. The second portion is connected to the first portion and has a second passageway with an outlet. The second passageway has a first region with an increasing diameter toward the outlet and a throat communicating with both the outlet of the first passageway and an outlet of the cavity.

[0007] The first portion may include a conically shaped member that has a cross-sectional area which decreases from an inlet side to an outlet side. The first passageway may have a slightly converging or constant cross-sectional area and extend through the member from the inlet side to the outlet side. The housing may be connected to and surrounding a portion of the member. The housing may form an outer wall of the cavity and the member forms an inner wall of the cavity. The conically shaped member and the second portion may form a venturi stage with a converging section adjacent the outlet of the cavity and a diverging section distal to the outlet of the cavity.

[0008] The second passageway may have a second region with an increasing diameter that is disposed within or adjacent to the outlet of the cavity. The second portion may be adjustable relative to the first portion such that the area of the outlet of the cavity can be varied. The area of the outlet of the first passage may be between one and ten times larger than the area of the outlet of the cavity. In one particular embodiment, the area of the outlet of the first passage is four times larger than the area of the outlet of the cavity.

[0009] In another aspect, a method entraining a liquid in a gas to facilitate evaporation of the liquid includes a nozzle having a venturi stage with a converging section and a diverging section. The method additionally includes flowing a gas through the nozzle to the diverging section, flowing a liquid agent through the converging section, and mixing the gas with the liquid agent in the diverging section.

[0010] The method may draw the gas from air in an ambient source surrounding the nozzle. In one embodiment, the nozzle utilized is adjustable to vary the flow of both the gas and the liquid agent. The flow of gas passes through a first outlet and the flow of liquid agent passes through a second outlet, and an area of the first outlet may be one to ten times larger than an area of the second outlet. In a particular embodiment, an area of the first outlet is four times larger than an area of the second outlet.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011]

FIG. 1 is an elevated side view of a fire extinguisher employing a nozzle according to the present invention.

FIG. 2 is a sectional view of the nozzle of FIG. 1 showing a first portion and a second portion that together form a venturi stage within the nozzle.

FIG. 3 is a further sectional view of the nozzle of FIG. 2 which illustrates two outlets from the first portion.

DETAILED DESCRIPTION

[0012] The invention comprises a nozzle and method of mixing a gas with a liquid to facilitate evaporation of the liquid using the nozzle.

[0013] The nozzle described hereinafter facilitates mixing utilizing first and second portions. The first portion has two inlets. One inlet allows the gas to communicate through a first passageway. The second inlet allows the liquid agent to communicate with a cavity that surrounds the first passageway. The second portion of the nozzle is adjustable fastened to a distal end of the first portion of the nozzle and has a second passageway that communicates with both the first passageway and the cavity.

[0014] Effective mixing of the fluids leading to rapid evaporation of the liquid agent evaporation (gasification of the liquid agent in 0.5 meters after discharge) is achieved by the design of the first portion and second portion. Without as described herein, the liquid agent would form a cohesive stream many meters long, with little gasification. More particularly, the first and second portions form a venturi stage with a converging section adjacent the outlet of the cavity and a diverging section distal to the outlet of the first passageway and the outlet of the cavity. The venturi stage allows liquid agent to entrain with the air and accelerates the flow of the mixture of liquid agent and air from the nozzle to achieve a desired length of discharge. The second portion of the nozzle is adjustable relative to the first portion to change the size of the outlet from the cavity, and thereby, regulate the flow of the liquid agent. Thus, the nozzle can be adjusted to achieve a desired discharge speed and length based upon the type of enclosure the nozzle will be applied in. For example, if the enclosure has restricted space or obstructions, the nozzle can be adjusted to restrict the flow of agent for a smaller discharge. In larger spaces the nozzle can be opened for a more rapid discharge and greater length of discharge.

[0015] FIG. 1 shows a portable fire extinguisher 10 with a nozzle 12 according to the present invention. Although illustrated on a portable device, the nozzle described is equally applicable to other fire suppression apparatuses and systems including ceiling mounted remote tank suppression systems. In addition to nozzle 12, fire extinguisher 10 includes a releasing mechanism 14, a hose 16, and a canister 18. In the embodiment shown, releasing mechanism 14 is of conventional design and has a handle 20, an actuating lever 22, and a ring pin 24. The nozzle 12 includes a first portion 26 and a second portion 28. The first portion 26 includes an inlet 30 and the second portion 28 includes an outlet 32.

[0016] Hose 16 is connected to nozzle 12 at a first end and at a second end to releasing mechanism 14. Releasing mechanism 14 is mounted to canister 18 and acts to regulate the flow of compressed agent from canister 18 through hose 16. Nozzle 12 itself is constructed of first portion 26 and second portion 28. Second portion 28 is adjustably joined with first portion 26 by methods such as threads, sliding adjustment, or other known means. This configuration allows second portion 28 to be adjustable relative to first portion 26 to achieve a desired discharge (size and flow composition). Although described as adjustable herein, second portion 28 can be fixed relative to first portion 26 as needs dictate. This would allow nozzle 12 to be preset to certain applications.

[0017] As fire extinguisher 10 is a portable device, handle 20 allows the individual to carry the fire extinguisher 10 to locations experiencing a fire. Hose 16 and nozzle 12 allow the individual to direct the flow of fire suppressing agent at the fire. Ring pin 24 acts to prevent accidental discharge of agent.

[0018] The fire suppressing agent is housed in canister 18. The agent can be any fire suppressant capable of evaporating in a gas. In one embodiment, agent comprises a suitable Halon replacement. When actuating lever 22 of releasing mechanism 14 is actuated a valve is opened and compressed liquid agent is rapidly discharged through hose 16. Once free of the canister, the pressure upon the liquid agent decreases and the agent begins to gasify becoming a gas/liquid mixture. The mixture (hereinafter called a liquid because it contains a liquid portion) flows through hose 16 to nozzle 12 and enters first portion 26.

[0019] As will be discussed subsequently, liquid agent passes through a venturi stage within nozzle 12 and mixes with ambient air that enters nozzle through inlet 30. Ambient air (gas) is pulled through nozzle 12 by the pressure differential created by liquid agent and discharged from first portion 26 radially inward of liquid agent. Thus, the liquid agent surrounds or partially surrounds the ambient air (gas) upon mixing within nozzle 12. The advantage of this arrangement is that evaporation of the liquid agent can occur on both the radially inner portion of the gas/liquid stream (i.e. within the gas/liquid stream) as well at the outer radial boundary of the gas/liquid stream. The arrangement of the air introduced within the liquid agent stream provides for improved gasification (i.e. evaporation in less than 0.5 meters) and hence the improved nozzle performance.

[0020] Although described in reference to ambient air from the enclosure surrounding the nozzle 12, nozzle 12 can utilize virtually any type of gas including gas from a contained source. Venturi stage allows liquid agent to entrain with the air and accelerates the flow of the mixture of liquid agent and air from nozzle 12 to achieve a desired length of discharge. In one embodiment, the entrained mixture of liquid agent and air is discharged from outlet 32 as a turbulent flow facilitating rapid evaporation of the remaining liquid agent. Such a turbulent flow is possible because air stream is volumetrically much larger (one to ten times) than liquid agent stream. It is understood that the embodiment of nozzle 12 illustrated and described is exemplary and in other embodiments various aspects of nozzle 12 such as inlet 30 can have different configurations, sizes and locations.

[0021] FIG. 2 shows a cross-section of nozzle 12. In addition to inlet 30, first portion 26 includes a housing 34, a member 36, a cavity 38 contained within the housing 34, a second inlet 40, a first passageway 42, a first outlet 44, and a second outlet 46. In addition to outlet 32, second portion 28 includes a second passageway 48. The second passageway 48 includes a first region 50, a throat 52, and a second region 54. Second portion 28 and first portion are disposed to create a venturi stage 56 that includes a converging portion 58 and a diverging portion 60.

[0022] In the embodiment shown in FIG. 2, second portion 28 includes threads on its outer surface that are provided to be selectively secured to a distal end of first portion 26 by complementary threads 62. Housing 34 extends about portions of second portion 28 and member 36 (i.e., housing 34 partially receives portion 28 and member 36). Member 36 is connected to housing 34 and has a semi-conical shape that terminates into a generally cylindrical shape. The member 36 includes a hollow interior that traverses each of the semi-conical and cylindrical shapes. Member 36 has a cross-sectional area that decreases from an inlet side to an outlet side. Member 36 extends from a base portion of housing 34 to allow inlet 30 to be exposed to ambient air A. Housing 34 is hollow and has cavity 38 therein into which member 36 extends. Cavity 38 surrounds member 36 and extends to second portion 28. Thus, cavity 38 is formed by housing 34 and member 36, with member 36 forming an inner wall of cavity 38.

[0023] Second inlet 40 is configured to be coupled to hose 16 (FIG. 1) and allows liquid agent S to enter cavity 38 from hose 16 (FIG. 1). In the embodiment shown, second inlet 40 is about generally half of the inner diameter of inlet 30. Cavity 38 is separated from first passageway 42 by member 36. First passageway 42 is generally coextensive with the length of member 36 to communicate with inlet 30 and first outlet 44.

[0024] Second outlet 46 for first portion 26 comprises the outlet for cavity 38. Second outlet 46 is disposed outward of and is located around first outlet 44. First outlet 44 and second outlet 46 interface with and are received in second passageway 48 of second portion 28. Thus, second passageway 48 communicates with first outlet 44 and second outlet 46. Second passageway 48 extends the length of second portion 28 from outlet 32 to cavity 38.

[0025] Second passageway 48 has regions with different geometry. First region 50 extends from outlet 32 proximally toward first portion 26. First region 50 has a tapered flow surface with an angle θ that is offset from a centerline axis C_L of nozzle 12. In one embodiment, flow surface is offset by between 10° and 40° from the centerline axis C_L. First region 50 is tapered to facilitate expansion of the air/agent mixture. Expansion causes a pressure drop in the mixture which results in evaporation of the liquid agent. Taper angle θ also affects the length of discharge, and therefore, can be varied based upon desired application of nozzle 12.

[0026] First region 50 ends at throat 52 which comprises a region of constriction where second passageway 48 has a smallest diameter. As shown in FIG. 2, throat 52 is positioned downstream of and communicates with first outlet 44 and second outlet 46. Second region 54 extends from throat 52 and has a radius which increases the cross-sectional diameter of second passageway 48 adjacent cavity 38 near outlet side of member 36. In the embodiment shown in FIG. 2, second region 54 is disposed within or adjacent to the second outlet 46 of cavity 38.

[0027] Venturi stage 56 is formed by the disposition of conically shaped member 36 and second portion 28. Venturi stage 56 is characterized by converging portion 58 with a region of decreasing cross-sectional area adjacent and up to second outlet 46 of cavity 38. Diverging portion 60 is disposed downstream and distal of second outlet 46.

[0028] In operation, when releasing mechanism 14 (FIG. 1) is actuated, liquid agent S flows from hose 16 to cavity 38 through second inlet 40. Liquid agent S passes through converging portion 58 to second outlet 46. While passing through converging portion 58 and diverging portion 60, liquid agent is subject to the venturi effect. As a result of this effect, the velocity of the liquid agent S (and the velocity of ambient air A drawn through first passageway 42 by the pressure differential caused by the flow of liquid agent S) is increased. This increased velocity allows nozzle 12 to achieve desired discharge lengths.

[0029] Mixing of liquid agent S and air A takes place downstream and distal to first outlet 44 and second outlet 46 in second passageway 48. In one embodiment, first outlet 44 is sized in relation to second outlet 46 to achieve a turbulent flow in the resulting entrained mixture. Turbulent flow in the mixture can be achieved in embodiments where the area of first outlet 44 is between one and ten times larger than the area of second outlet 46. A turbulent flow helps to facilitate rapid evaporation (gasification within about 0.5 meters after discharge) of liquid agent. Thus, a turbulent flow is desirable in applications where the enclosure has restricted space or obstructions. Because the length of second portion 28 within first portion 62 is adjustable by threads 62, the area of second outlet 46 can be increased relative to first outlet 44 by rotating second portion 28 in a direction that facilitates a linear movement of second portion 28 toward or away from first portion 26 in order to achieve a selected laminar flow in the resulting mixture of air A and liquid agent S. A laminar flow is desirable in applications where a greater length of throw and a controlled discharge is desired to approach and accurately target a burning object.

[0030] FIG. 3 shows a cross-section of nozzle 12 taken through housing 34 and second portion 28 adjacent the outlet side of member 36. Thus, FIG. 3 illustrates the size of second outlet 46 relative to first outlet 44. In the embodiment shown, the area of first outlet 44 is four times larger than the area of second outlet 46. This configuration achieves a laminar flow in the resulting mixture.

[0031] Although the present invention has been described with reference to preferred embodiments, workers skilled in the art will recognize that changes may be made in form and detail without departing from the scope of the invention.

Claims

1. A nozzle (12) for fire suppression, comprising:

   a first portion (26) having a first passageway (42) with a gas inlet (30) and a gas outlet (44), wherein the first portion (26) has a cavity (38) with a liquid inlet (40) and a liquid outlet (46), the cavity (38) disposed around at least a portion of the first passageway (42) such that the gas outlet (44) is disposed radially inward of the liquid outlet (46) from the cavity (38); and
   a second portion (28) connected to the first portion (26) and having a second passageway (48) with an outlet (32), wherein the second passageway (48) has a first region (50) with an increasing diameter adjacent the outlet (32) and a throat (52) communicating with both the gas outlet (44) of the first passageway (42) and the liquid outlet (46) of the cavity (38).

2. The nozzle of claim 1, wherein the first portion (26) comprises:

   a conically shaped member (36) having a cross-sectional area that decreases from an inlet side to an outlet side, wherein the first passageway (42) extends through the member (36) from the inlet side to the outlet side; and
   a housing (34) connected to and surrounding a portion of the member (36), wherein the housing (34) forms an outer wall of the cavity (38) and a conically shaped outer surface of the member (36) forms an inner wall of the cavity (38).

3. The nozzle of claim 2, wherein the conically shaped member (36) and the second portion (28) form a venturi stage (56) with a converging section (54) adjacent the outlet (46) of the cavity (38) and a diverging section (50) distal to the outlet (46) of the cavity (38).

4. The nozzle of any preceding claim, wherein the second passageway (48) has a second region (54) with an increasing diameter, and wherein the second region (54) is disposed within or adjacent to the outlet of the cavity (38).

5. The nozzle of any preceding claim, wherein the second portion (28) is adjustable relative to the first portion (26) such that the area of the outlet (46) of the cavity (38) can be varied.

6. The nozzle of any preceding claim, wherein the outlet (44) of the first passageway (42) is between one and ten times larger than the outlet (46) of the cavity (38).

7. The nozzle of claim 6 wherein the outlet (44) of the first passageway (42) is four times larger than the outlet (46) of the cavity (38).

8. The nozzle of any preceding claim, wherein the inlet (30) to the first passageway (42) communicates with a gas that is passed through the nozzle as a gas flow.

9. The nozzle of claim 8, wherein the inlet (40) of the cavity (38) allows a liquid agent to enter the cavity (38).

10. A fire suppression device employing the nozzle of any of the preceding claims.

11. A method of entraining a liquid in a gas to facilitate evaporation of the liquid, comprising:

    providing a nozzle (12) with a venturi stage (56) having a converging section (54) upstream of a diverging section (50);
    flowing a gas stream through the nozzle (12) to a gas outlet (44) adjacent the diverging section (50);
    flowing a liquid agent stream through the converging section (54) to a liquid outlet (46) disposed radially outward of the gas outlet (44); and
    mixing the gas stream with the liquid agent stream in the diverging section (50), wherein the liquid agent stream initially mixes with the gas stream at an outer radial portion of the gas stream.

12. The method of claim 11, further comprising drawing the gas from air in an ambient source surrounding the nozzle (12).

13. The method of claim 11 or 12, wherein the nozzle (12) has a second portion (28) that is adjustable relative to a first portion (26) to vary the flow of both the gas and the liquid agent.

14. The method of claim 13, wherein the flow of gas passes through a first outlet (44) and the flow of liquid agent passes through a second outlet (46), and wherein an area of the first outlet (44) is one to ten times larger than an area of the second outlet (46).

15. The method of claim 13, wherein the flow of gas passes through a first outlet (44) and the flow of liquid agent passes through a second outlet (46), and wherein an area of the first outlet (44) is four times larger than an area of the second outlet (46).

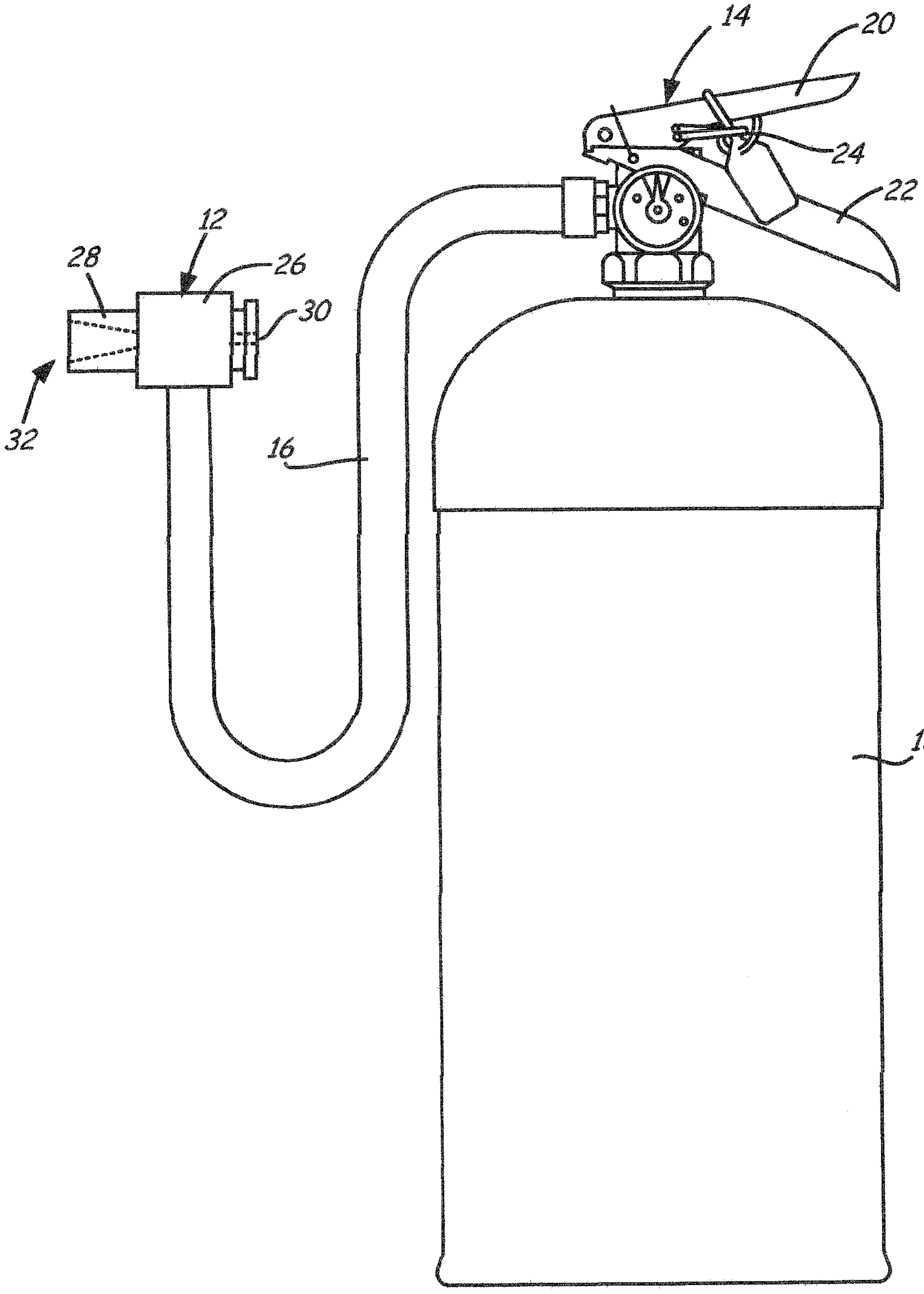

FIG. 1

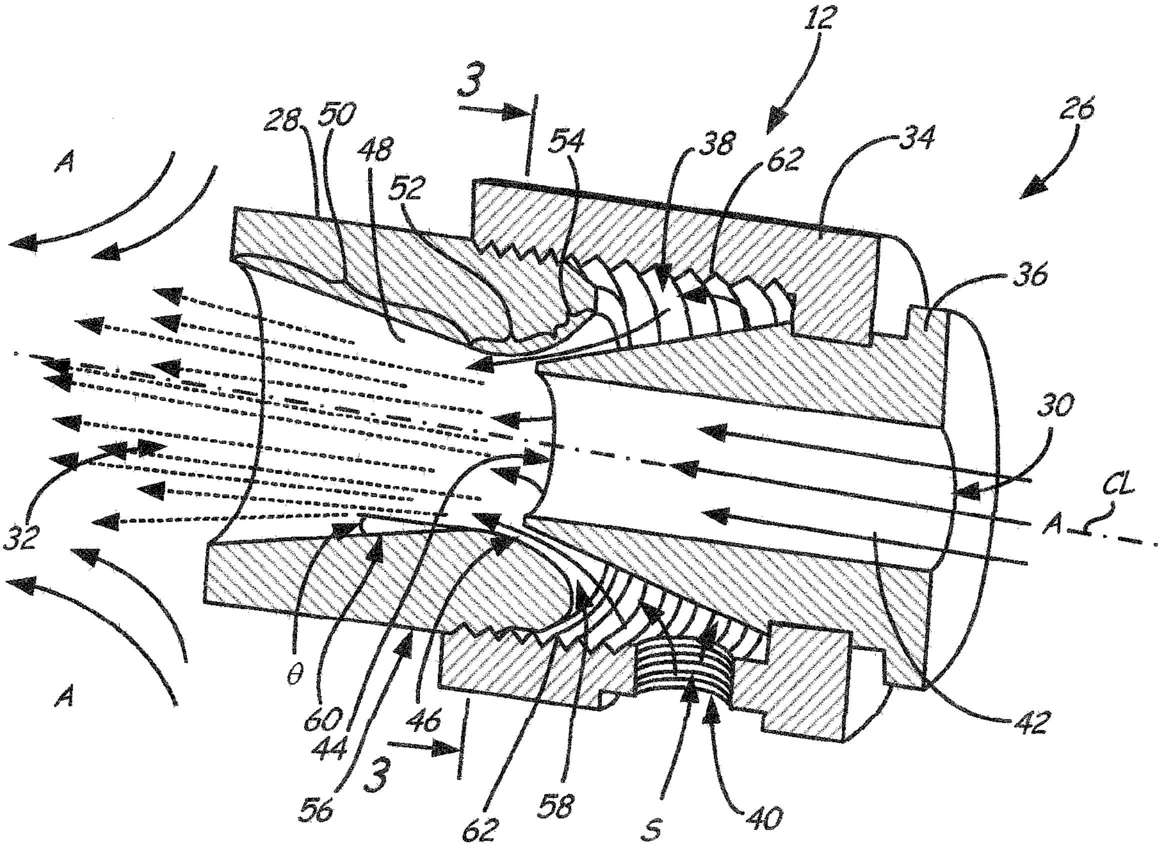

FIG. 2

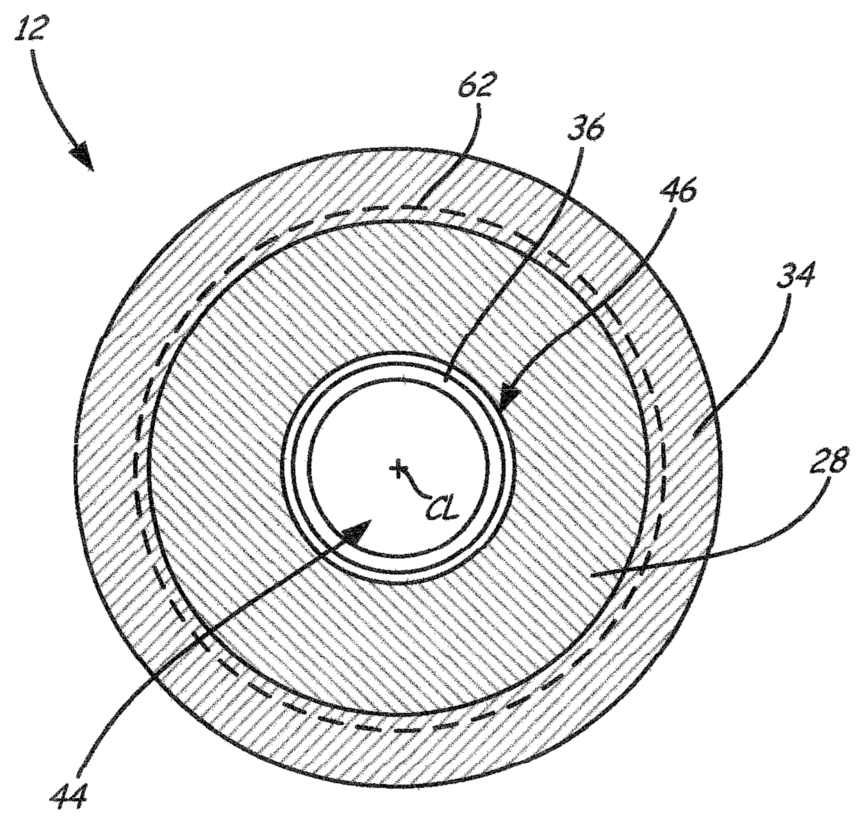

FIG. 3

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EUROPEAN SEARCH REPORT

Application Number
EP 12 17 1219

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2008/245898 A1 (WOLFE JOSEPH E [US]) 9 October 2008 (2008-10-09) * abstract; figures * -----	1-15	INV. A62C31/03 A62C5/00 A62C99/00
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A	US 3 188 009 A (MISCOVICH JOHN A) 8 June 1965 (1965-06-08) * the whole document * -----	1-15	

TECHNICAL FIELDS SEARCHED (IPC)
A62C

The present search report has been drawn up for all claims

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Place of search	Date of completion of the search	Examiner
The Hague	28 November 2012	Vervenne, Koen

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 12 17 1219

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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28-11-2012

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