

TITLE OF INVENTION: TWO-PHASE FOGGING JET NOZZLE

DESCRIPTION

5 [0001] The present invention relates to the field of producing and propelling a two-phase mixture of at least one gas and a liquid, in particular for extinguishing a fire, cooling equipment, forming a mist. The mixture is made in a nozzle where the interaction of a high-speed stream of gas with a jet of water atomizes droplets of water in the water jet to form a mist of very small or minuscule
10 droplets, thus forming a two-phase mixture of droplets of water mist driven and carried by the stream of gas. When the relative flow rate between the two fluids is high, inertial forces result in the formation of bubbles or droplets.

[0002] Such two-phase mixtures exhibit remarkable cooling performance and
15 limit the damage caused by the water and the fumes by causing low-level, localized wetting, the absence of any surrounding nuisance. These mixtures are produced either by fixed installations arranged for example on the ceiling of an industrial, tertiary or residential building, a tunnel, a cabin of an airplane or a ship, or in the operating compartment/cockpit of an aircraft pilot or an
20 industrial equipment operator, or in facilities installed on industrial sites or in forest facilities, or by portable equipment in the form of fire hoses actuated by a firefighter or by an autonomous motor vehicle.

[0003] The finer the misting and the higher the droplet speed, the higher the
25 kinetic energy of the droplets, and the greater their capacity to penetrate into the center of fire. As the heat exchange surface increases, the cooling and inerting are all the greater. High-pressure water mist also blocks radiant heat. Thus, for example, the temperature may remain tolerable at only a few meters from an 800°C center of fire, and attenuates shock waves caused for example
30 by an explosion.

[0004] The gas supplying the nozzle may be an inert gas, such as nitrogen, carbon dioxide, argon, or simply air, or oxygen.

Prior art

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[0005] PCT patent application W02022/090662 describes an earlier invention by the same inventor. It describes a fire hose supplied by a two-phase supply line, comprising a nozzle, optionally being able to be extended by a variable-geometry ejection tip, with a multifunction control handle and optionally peripheral elements
10 to form, for example, a portable equipment. The system comprises a convergent-divergent mixing chamber directly opening into a deformable tip connected in a sealed manner, without any passage of air coming from outside the nozzle. The aim is to form a mist of water droplets with a section of less than 400 micrometers and preferably less than 90 micrometers, sprayed axially.

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[0006] Patent application US20180264486 relates to a device for single-phase spraying of liquid chemicals including agricultural chemicals, such as pesticides or nutrients, on four sides via a nozzle structure that is rotated so that the liquid chemical spraying device may be located in a flat place such
20 as a ground surface or a desk.

[0007] Patent application WO2021/156125 relates to a single-phase rotary sprayer designed to spray a liquid through a rotating disc. The disc is designed to rotate around the axis centered on the disc center. The liquid
25 applicator is designed to apply a liquid to a surface of the disc. The spray guide assembly partially surrounds the disc. The inner surface of the spray guide assembly is designed to modify the trajectory of all liquids emerging from the outer edge of the disc.

Drawbacks of the prior art

[0008] The aim of the present invention is to enable the spray axis, provided axially in the solution proposed by application W02022/090662, to be flexibly oriented to direct the two-phase jet in a suitable direction independently of the orientation of the device, to enable the direction to be controlled when the device is fixed (mounted on a ceiling or wall, or on a mobile machine), or possibly hand-held.

[0009] The problem is that generating a two-phase jet results in a geometry without axial symmetry of the upstream part, whereas the rotating head solutions proposed by applications US20180264486 and WO2021/156125 relate to single-phase solutions, with a single supply line, arranged axially in relation to the upstream part and in relation to the inlet of the rotating head. It is not possible to adapt a rotating head known from these two prior art documents to a two-phase structure whose axial symmetry exists only at the nozzle, after mixing the two liquid and gaseous phases.

Solution provided by the invention

[0010] The aim of the present invention is to create high-performance spray nozzles, particularly for fire-fighting applications, which can diffuse a two-phase mist.

[0011] To this end, the invention relates to a device for generating a two-phase fluid jet having the features set out in claim 1.

[0012] It comprises a rotary nozzle, characterized in that it comprises:

- a fixed base having:
- a central connector for connecting an inlet of a first phase, opening out at the center of the inner surface of the fixed base,

- a peripheral connector for connecting a second-phase inlet opening at the periphery, in an annular zone, of the inner surface of said fixed base
- a fixed body which is secured to the base and comprises
- a central channel for passage of the first phase,
- 5 • surrounded by a coaxial annular chamber for passage of the second phase,
- a body which is rotatable about an axis corresponding to the longitudinal axis of the fixed body and which has at least one rotating seam arranged in the interface with the fixed body
- the body having a connector for receiving a two-phase diffusion nozzle,
- 10 having a longitudinal axis which is not aligned with the longitudinal axis with the fixed body
- a central channel for supplying the nozzle with said first phase, the port opening out at the upstream face of the body via an opening that opens out in the central channel
- 15 • and at least one peripheral channel which communicates with the coaxial annular chamber for passage of the second phase,
- this body comprising a means for being driven in rotation with respect to the fixed body.

20 [0013] Preferably, said first phase is pressurized air.

[0014] Preferably, said second phase is water.

25 [0015] According to a first embodiment, said means for being driven is constituted by a helical shape positioned in the peripheral duct.

[0016] According to a second embodiment, said means for being driven is constituted by an electric motor mechanically coupled to said rotary body.

30 [0017] According to a third embodiment, said means for being driven is constituted by a hydraulic motor mechanically coupled to said rotary body.

[0018] According to a fourth embodiment, said means for being driven is constituted by a magnetized ring secured to said rotary body, interacting electromagnetically with a peripheral wound stator.

- 5 [0019] According to a fifth embodiment, said means for being driven is a pneumatic or hydraulic motor.

[0020] According to one embodiment, said rotary body comprises at least one nozzle having a main duct that is fed with a pressurized gaseous fluid and
10 opens into a mixing chamber, and at least one secondary duct that is fed by at least one pressurized fluid and opens into said mixing chamber in a direction forming a non-zero angle with the axis of said main duct.

[0021] Advantageously, said mixing chamber has a convergent-divergent
15 cylindrical wall with a constriction defining an opening in the plane perpendicular to the axis of said main duct, the convergent part of said wall having a frustoconical zone in the extension of the axis of said at least one secondary duct, to form a liquid phase fragmentation chamber.

20 [0022] In one variant, the axis of said at least one secondary duct forms an angle of between 2° and 20° with the axis of said main duct.

[0023] In another variant, the axes of the secondary ducts define an angle of between 0° and 60° , preferably $45^{\circ} \pm 10^{\circ}$, with the generatrix of the cone of
25 the convergent part.

[0024] Advantageously, the diameter of said constriction opening is between 0.8 and 1.2 times the diameter of said main duct.

30 [0025] In a particular embodiment, the said nozzle(s) have a mixing chamber forming a so-called Laval nozzle.

[0026] Detailed description of non-limiting embodiments

[0027] The present invention will be better understood from reading the following description, which refers to non-limiting exemplary embodiments
5 illustrated by the appended drawings, in which

- [Fig. 1] Figure 1 shows a front view of a first example embodiment of a device according to the invention
- [Fig. 2] Figure 2 shows a front view of a second example embodiment of a device according to the invention
- 10 • [Fig. 3] Figure 3 shows a cross-sectional view of a device according to the invention
- [Fig. 4] Figure 4 shows a longitudinal cross-sectional view of a device according to the invention
- [Fig. 5] Figure 5 shows a perspective view of a device according to the invention.

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General note

[0028] The description of one of these items naturally extends to subassemblies including this element combined with another element, even if
20 the first element is not described again in detail in the part regarding the detailed description of that other element. Likewise, each of the elements can be used with a complementary element other than that described or even subject of the present patent, the nozzle that is the subject matter of the patent can be extended by a tip other than that proposed by the present patent, and
25 likewise the described tip can be used with nozzles other than those of the present patent. The same applies to all elements in a detailed description.

General principle of the invention

30 [0029] The invention relates to a two-phase fluid generator angularly orientable in oblique directions with respect to the longitudinal axis of an upstream base (10) constituting the supply part with a liquid and with a gas, articulated in

rotation with respect to a downstream rotary body (30), on which is mounted one or more nozzles (40, 45) for diffusing the two-phase jet. The formation of the two-phase jet from a main duct feeding a first fluid phase and one or more secondary ducts feeding a second fluid phase different from the first fluid phase is carried out either in this downstream rotary body (30), or preferably in one or more nozzles equipped with a two-phase mixer mounted on this downstream rotary body (30) transferring each of the fluid phases via two separate ducts.

[0030] The interface between the upstream base (10) and the downstream rotary body (30) is configured to ensure fluid continuity between:

- a. the axial main duct passing through the base (10) and the axial main duct passing through the rotary body (30), inclined to the axis of the base
- b. the secondary duct(s) in the base (10) and the secondary duct(s) in the rotary body (30).

[0031] To this end, the axial main duct passing through the rotary body (30) can be elbow-shaped, with an axial upstream part, in the extension of the axial main duct passing through the base (10), and a downstream part oriented along the longitudinal axis of the nozzle mounted on this rotary body (30), or several downstream parts when the body comprises several nozzles.

[0032] For the secondary duct(s), eccentric with respect to the main duct, an advantageous solution consists in providing an annular groove on the base (10) and/or on the rotary body (30), communicating upstream with the secondary duct(s) of the base and upstream with the secondary duct(s) of the rotary body (30).

[0033] Description of an exemplary embodiment of the nozzle

[0034] [Fig. 1] shows a front view of a first variant with a rotary nozzle (40). The device comprises a base (10) supported by feet (11, 12) for attachment to a plinth or ceiling.

[0035] The fixed part comprising the base (10) and the body (20) have a cylindrical geometry with a longitudinal axis (21). The rotary body (30) is extended by a nozzle (40) whose longitudinal axis (41) forms an angle of approximately 55° degrees to the longitudinal axis (21) of the fixed part. In the example shown, it features a series of axial nozzles (31).

[0036] A rotating part inside the fixed body (20) is fitted with a gear wheel (52) driven by the output pinion (51) of an electric, hydraulic or pneumatic motor. Of course, the drive could also be provided by a chain or belt system.

[0037] [Fig. 2] shows an alternative with two rotary nozzles (40, 45), oriented along axes (41, 42) whose rotation defines a cone coaxial with the longitudinal axis (21).

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Functional description

[0038] The base (10) has two threaded holes (13, 14) for connecting a pressurized water and air supply respectively. The connections are shown on the front face, but one or both could also be provided radially.

[0039] The rotary body (30) is extended by a cylindrical rod featuring two coaxial ducts consisting of an annular longitudinal chamber (32) and a central duct (34) delimited by a cylindrical partition (33). This central duct (34) is designed to supply the nozzle for the arrival of the first phase.

[0040] The annular longitudinal chamber (32) allows the liquid phase that has entered via (13) to flow into the annular distribution chamber.

[0041] The water supply hole (13) opens into an annular distribution chamber (36) formed by a flare in the annular longitudinal chamber (32). This fixed rod (31) is guided relative to the rotary body (30) by a rear bearing (22) and a

front bearing (23). Seals (24 to 26) ensure the leak-tightness of the flow of liquid and gaseous phases, such as water and air.

5 [0042] The head of the moving part (30) has, in the example described, two water diffusion segments (35, 36) in an axial direction and a thread for mounting a nozzle with a central outlet (48) for supplying the fluid of the first phase, in the example described air, and a peripheral outlet (102) for supplying pressurized air. It also features a peripheral duct (49) to supply the nozzle for the arrival of the second phase. The annular longitudinal chamber (32) allows the liquid phase that
10 has entered via (13) and been distributed by an annular distribution chamber (36).

[0043] In the example described, the rotary body (30) is driven by a propeller (50) placed in the water flow, the passage of which creates a rotary movement.

15 **Description of an example nozzle**

[0044] The description of the example nozzle shown in [Fig. 4] is non-limiting. The invention is designed to work with different types of two-phase diffusion nozzles.

20 [0045] The nozzle is crossed by an axial main channel (100) opening into the coaxial mixing chamber (105). Said main channel (100) extends from an eccentric threaded fitting (101) to a ring (104) opening into the mixing chamber (105).

[0046] The ring (104) provides transmission of the two fluids from the head of
25 the rotary body to the mixing chamber (105). It comprises the main channel (100), arranged along the longitudinal axis of the intermediate body and the mixing chamber (105), and one or more secondary ducts (102, 103), typically a bundle of secondary ducts extending from the threaded fitting (101) to the inlet of the mixing chamber (105). These secondary ducts (102; 103) are
30 oriented along axes (113, 114) forming, relative to the longitudinal axis (10), an angle of approximately 10°, typically between 8 and 15°.

[0047] Other configurations may be provided, for example a conical annular chamber extending from the fitting (101) to an annular outlet in the inlet of the mixing chamber (105). This conical chamber can be longitudinally partitioned to ensure the rigidity of the peripheral walls.

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[0048] The mixing chamber (105) forms a tip called a de Laval nozzle. It is formed by a rectilinear duct having a variable section, consisting of a convergent part (106) extended by a divergent part (107) with a constriction (108) between these two parts (106, 107).

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[0049] The convergent part (106) is configured so that an annular region (108) is in the extension of the axes (113, 114) of the secondary ducts respectively (102 to 103).

15 [0050] This configuration is essential for the liquid jet to break against the surface of the convergent part (106) and to atomize the liquid drop flow projected into the central vein in the jet of the gas phase and to create turbulence in the convergent part (107) before being driven by the central vein through the neck (108) in the divergent part (106) of the Laval nozzle.

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Claims

[Claim 1] - A device for generating a two-phase fluid jet comprising at least one rotary nozzle, characterized in that it comprises:

- 5 • a fixed base (10) having:
 - a central connector (14) for connecting an inlet of a first phase, opening out at the center of the inner surface of the fixed base,
 - a peripheral connector (13) for connecting a second-phase inlet opening at the periphery, in an annular zone, of the inner surface of said fixed base (10)
- 10 • a fixed body (20) which is secured to the base and comprises
 - a central channel (34) for passage of the first phase,
 - surrounded by a coaxial annular chamber (32) for passage of the second phase,
 - a body (30) which is rotatable about an axis corresponding to the
- 15 longitudinal axis of said fixed base (10), having at least one rotating seam arranged in the interface with said fixed base (10),
 - the rotary body (30) having a connector for receiving a two-phase diffusion nozzle (40), having a longitudinal axis (41) which is not aligned with the longitudinal axis (21) with the fixed body (20)
- 20 • a central channel (48) for supplying the nozzle with said first phase, opening out at the upstream face of the body via an opening that opens out in the central channel (34)
 - and at least one peripheral channel (49) which communicates with the coaxial annular chamber for passage of the second phase,
- 25 • this body comprising a means for being driven in rotation with respect to the fixed body (20).

[Claim 2] - The device for generating a two-phase fluid jet according to claim 1, characterized in that said first phase is pressurized air.

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[Claim 3] - The device for generating a two-phase fluid jet according to claim 1, characterized in that said second phase is water.

[Claim 4] - The device for generating a two-phase fluid jet according to claim 1 or 2, characterized in that said means for being driven consists of a helical shape positioned in the peripheral duct

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[Claim 5] - The device for generating a two-phase fluid jet according to claim 1, characterized in that said means for being driven is constituted by an electric motor mechanically coupled to said rotary body.

10 [Claim 6] - The device for generating a two-phase fluid jet according to claim 1, characterized in that said means for being driven is constituted by a hydraulic motor mechanically coupled to said rotary body.

[Claim 7] - The device for generating a two-phase fluid jet according to claim
15 1, characterized in that said means for being driven is constituted by a magnetized ring secured to said rotary body, interacting electromagnetically with a peripheral wound stator.

[Claim 8] - The device for generating a two-phase fluid jet according to claim
20 1, characterized in that said means for being driven is a pneumatic or hydraulic motor.

[Claim 9] - The device for generating a two-phase fluid jet according to claim 1,
characterized in that said rotary body comprises at least one nozzle having a main
25 duct (100) supplied with a pressurized gaseous fluid and opening into a mixing chamber (105), as well as at least one secondary duct (102, 103) supplied with at least one pressurized liquid fluid opening into said mixing chamber (105) in a direction forming a non-zero angle with the axis of said main duct.

30 [Claim 10] - The device for generating a two-phase fluid jet according to the preceding claim, characterized in that said mixing chamber (105) has a convergent-divergent cylindrical wall with a constriction (108) defining an opening

in the plane perpendicular to the axis of said main duct, the convergent part (106) of said wall having a frustoconical zone in the extension of the axis of said at least one secondary duct (102; 103), to form a liquid phase fragmentation chamber.

- 5 [Claim 11] - The device for generating a two-phase fluid jet according to the preceding claim, characterized in that the axis (113, 114) of said at least one secondary duct (102; 103) forms with the axis of said main duct (100) an angle of between 2° and 20°.
- 10 [Claim 12] - The device for generating a two-phase fluid jet according to the preceding claim, characterized in that the axes (113, 114) of the secondary ducts (102 to 103) define with the generator of the cone of the convergent part (106) an angle of between 0° and 60° and preferably of $45^\circ \pm 10^\circ$.
- 15 [Claim 13] - The device for generating a two-phase fluid jet according to claim 10, characterized in that the diameter of said opening of the constriction (108) is between 0.8 and 1.2 times the diameter of said main duct.
- 20 [Claim 14] - The device for generating a two-phase fluid jet according to claim 1, characterized in that said nozzle or nozzles have a mixing chamber (105) forming a Laval nozzle.