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(54) DEVICE FOR PRODUCING A GAS-LIQUID MIXTURE FOR FIREFIGHTING PURPOSES

(57) A device configured to produce a gas-liquid mixture for firefighting purposes is disclosed. The device comprises a mixing container configured to receive a liquid medium and a pressurized gaseous medium, wherein the mixing container has an outlet for the gas-liquid mixture and a mixing pipe arranged within the mixing container and configured to guide the gas-liquid mixture towards the container outlet. The mixing pipe comprises a wall having a mixing passage configured to introduce the gaseous medium from an outside of the mixing pipe into the liquid medium, when same is guided within the mixing pipe towards the container outlet. The mixing passage has a first cross-sectional area and a portion of the mixing pipe downstream of the mixing passage or of a discharge line downstream of the mixing pipe has a second cross-sectional area. The ratio between the first cross-sectional area and the second cross-sectional area is between 1:4 and 1:25.

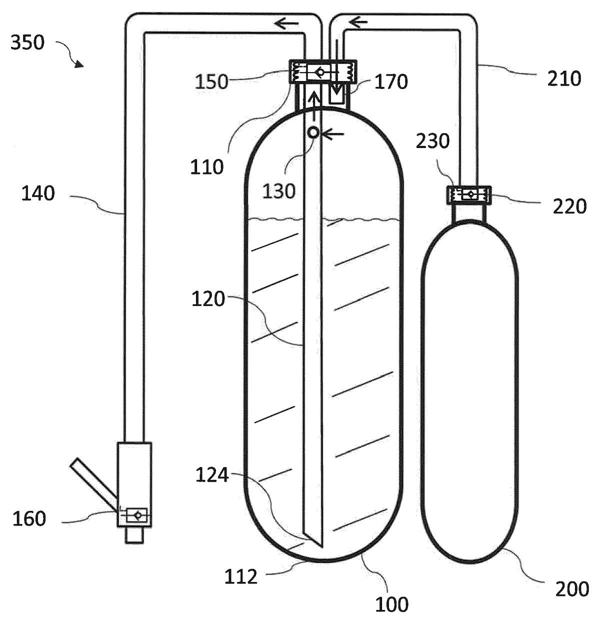

Fig. 7

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Description

Technical Field

[0001] The present disclosure generally relates to the field of firefighting. In particular, a device for producing a gas-liquid mixture for firefighting purposes is presented, wherein the gas-liquid mixture is a mixture of a liquid medium and a pressurized gaseous medium.

Background

[0002] In the field of firefighting, different firefighting techniques are in use depending on the source and the intensity of the fire. A technique that has been increasingly used since the 1990s are Compressed Air Foam Systems (CAFSs).

[0003] Conventional (non-compressed) air foam systems use ambient air to produce a firefighting foam. To this end, the ambient air is sucked into a jet pump of a firefighting device and supplied to a mixture of water and a foaming agent. CAFSs, on the other hand, do not use ambient air to produce the firefighting foam. Instead, pressurized air is introduced into the liquid medium (i.e., the water/foaming agent mixture). Using pressurized air has the advantage that energy losses due to suction of ambient air into a jet pump and the admixing of the ambient air into the liquid medium are avoided. As a result, CAFSs generally have longer jet ranges than systems that use ambient air to produce the firefighting foam.

[0004] CAFSs can be utilized in different configurations. They can be installed in a stationary manner, for example in a building, or permanently on a firefighting vehicle, or they can be used as portable firefighting devices. In the case of stationary and permanently installed CAFSs, the systems can become very complex. It is often possible for such systems to adjust the working parameters such as the mixing ratio of the pressurized air and the liquid medium as well as the air pressure during actuation. Portable CAFSs, on the other hand, typically have fixed working parameters, which enables a quick and untrained use.

[0005] In portable CAFSs with fixed working parameters, the design of the systems in regard to geometric and working parameters is decisive for the area of application and for the fire extinguishing effects of the produced firefighting foam. As such, system design can become challenging in view of partially diverging requirements.

[0006] Common methods for mixing pressurized air with a liquid medium utilize special mixing devices such as dedicated pump arrangements or mixing chambers. The pressurized air and the liquid medium, typically a mixture of water and foaming agent, are introduced into the mixing devices via two separate ports and mixed therein. In this regard, US 6,543,547 B2 discloses a portable firefighting device utilizing a mixing chamber arranged directly before a fire extinguisher gun that works as a nozzle. A twin hose or two separate hoses are used to separately lead a pressurized gas and a fire extinguishing medium to the mixing chamber.

[0007] Known CAFSs with mixing chambers have the disadvantage of a complex design and high material and maintenance costs.

Summary

[0008] There is a need for a device for producing a gas-liquid mixture for firefighting purposes that has a simple and cost-effective design and simultaneously provides preferable firefighting properties.

[0009] A device configured to produce a gas-liquid mixture for firefighting purposes is provided. The device comprises a mixing container configured to receive a liquid medium and a pressurized gaseous medium, wherein the mixing container has an outlet for the gas-liquid mixture and a mixing pipe arranged within the mixing container and configured to guide the gas-liquid mixture towards the container outlet. The mixing pipe comprises a wall having a mixing passage configured to introduce the gaseous medium from an outside of the mixing pipe into the liquid medium, when same is guided within the mixing pipe towards the container outlet, wherein the mixing passage has a first cross-sectional area and a portion of the mixing pipe downstream of the mixing passage, or of a discharge line downstream of the mixing pipe, has a second cross-sectional area. The ratio between the first cross-sectional area and the second cross-sectional area is between 1:4 and 1:25.

[0010] According to one realization, the mixing passage is defined by one or more mixing orifices. The mixing orifices may be arranged linearly one behind the other along a longitudinal axis of the container. The first cross-sectional area may be defined by the total cross-sectional area of the one or more mixing orifices. The mixing orifices can have different shapes (circular, rectangular, etc.). For example, the mixing orifices can be bores drilled into the mixing pipe.

[0011] The first cross-sectional area of the mixing passage may be at least one of larger than 3 mm^2 and smaller than 13 mm^2. The first cross-sectional area may in particular be at least one of larger than 4.5 mm^2 and smaller than 9.1 mm^2. Further, the first cross-sectional area of the passage can be at least one of larger than 5.1 mm^2 and smaller than 7.1 mm^2. Using different sizes of the first cross-sectional area results in different mixing ratios of the pressurized gaseous medium and the liquid medium, when the device is actuated at the same pressure.

[0012] The mixing container can comprise a container bottom opposite to the container outlet and define a longitudinal extension from the container bottom to the container outlet. A first distance between the mixing passage and the container bottom along the longitudinal extension can be at least 5 times, in particular at least 8 times (e.g., more than 10 times) greater than a second distance between the mixing passage and the container outlet along the longitudinal extension. The first distance can be up to 30 times, in particular up to 20 times (e.g., up to 15 times) greater than the second distance. Placing the mixing passage near the container outlet rather than the container bottom ensures that the mixing passage lies above the level of the liquid medium so that the pressurized gaseous medium can flow properly through the mixing passage.

[0013] The second cross-sectional area may be a minimum cross-sectional area of a fluidic passage of the mixture of the liquid medium and the pressurized gaseous medium from the mixing passage to the portion of the mixing pipe downstream of the mixing passage or of the discharge line downstream of the mixing pipe. In particular, the second cross-sectional area may be the cross-sectional area directly downstream of the end of the mixing passage (e.g., adjacent to the point of the mixing orifices that is nearest to the container outlet). In this way, the mixture of the pressurized gaseous medium and the liquid medium will not be restricted in a section downstream of the mixing passage and a constant and steady flow of the mixture can be established. According to one implementation, the second cross-sectional area is at least one of larger than 28 mm^2 (e.g., larger than 40 mm^2) and smaller than 133 mm^2 (e.g., smaller than 60 mm^2). The mixing pipe may have a diameter larger than 3 mm (e.g., larger than 6 mm) and smaller than 13 mm (e.g., smaller than 10 mm)

The mixing pipe may have a third cross-sectional area in a region of the mixing passage. In particular, the third cross-sectional area is defined by the cross-sectional area of the mixing pipe at a point of the mixing pipe where the pressurized gaseous medium is first introduced into the liquid medium (e.g., at the beginning of the first orifice that the liquid medium passes, when flowing inside the mixing pipe towards the container outlet). A ratio between the first cross-sectional area and the third cross-sectional area may be greater than or equal to the ratio between the first cross-sectional area and the second cross-sectional area. In this way, the flow of the liquid medium towards the outlet of the mixing container will not be restricted at the mixing passage and the mixing ratio of the two mediums can be held constant during actuation of the device.

[0014] The mixing pipe can have a straight extension from a first end located in a vicinity of the container outlet to a second end located in a vicinity of the container bottom opposite to the container outlet. The second end can have different shapes. For example, it can be curved or pointed so as to ensure that the liquid medium can flow into the mixing pipe in an unhindered manner.

[0015] The mixing container may have a volume between 3 and 500 liters (e.g., between 8 and 30 liters). The mixing container can be pressure-proof up to at least between 3 and 15 bar.

[0016] The device may further comprises a nozzle configured to discharge the gas-liquid mixture from the device. The nozzle can be a common nozzle known in the field of firefighting and may enable controlled and untrained use of the device. The device can further comprise a control valve configured to control discharging of the gas-liquid mixture. The control valve can be located between the discharge line and the mixing pipe as to control the pressure on the discharge line.

[0017] The device may comprise a pressure tank configured to store the pressurized gaseous medium and a pressure line extending from the pressure tank to the mixing container. In this way, the pressure tank can act as a source of the pressurized gaseous medium. The pressure tank may (e.g., detachably) be connected to the container. The pressure tank can be pressure-proof up to at least between 200 and 450 bar. Further, the device can comprise at least one restriction valve located between the pressure line and an outlet of the pressure tank and configured to controllably release the pressurized gaseous medium from the pressure tank into the mixing container. As a result, the pressure inside the mixing container can be held constant during actuation of the device. For example, the pressure inside the mixing container can be adjusted to lie in the range between 7 bar and 10 bar (e.g., to approximately 8.5 bar) during actuation of the device.

[0018] The gas-liquid mixture may be a foam, in particular when the liquid medium stored in the mixing container is a mixture of water and a foaming agent. The firefighting properties of the foam produced by mixing the pressurized gaseous medium with the liquid medium may depend on the size of the bubbles of the produced foam, since different bubble sizes lead to different ranges of a fire extinguishing jet. Utilizing the device, the size of the bubbles of the produced foam can be controlled via the mixing ratio of the pressurized gaseous medium and the liquid medium as well as the pressure at which the mixture is discharged.

[0019] Also provided is a firefighting method using the device having the geometric design parameters presented herein, such as the first cross-sectional area between 3 mm^2 and 13 mm^2. The method may use any of the working parameters presented herein, such as maintaining the pressure inside the mixing container to lie in the range between 7 bar and 10 bar

Brief Description of the Drawings

[0020] Further features and advantages of the device presented herein are described below with reference to the accompanying drawings, in which:

Fig. 1 illustrates a schematic representation of a first embodiment of a device configured to produce a gas-liquid mixture for firefighting purposes, the device comprising a mixing container and a mixing pipe;

Fig. 2 illustrates a schematic representation of a closure assembly comprising the mixing pipe of

Fig. 1, a control valve and a closure for a mixing container outlet;

Fig. 3 illustrates a schematic representation of a fully operable firefighting device comprising the device of Fig. 1, the closure assembly of Fig. 2 and further comprising a discharge line and a nozzle;

Fig. 4 illustrates a schematic representation of a second embodiment of a device configured to produce a gas-liquid mixture for firefighting purposes, the device comprising an inlet for a pressurized gaseous medium;

Fig. 5 illustrates a schematic representation of an alternative closure assembly for the mixing container of Fig. 4;

Fig. 6 illustrates a schematic representation of a combination of the device of Fig. 4, the closure assembly of Fig. 5 and a pressure tank; and

Fig. 7 illustrates a schematic representation of a second fully operable firefighting device comprising the assembly of Fig. 6, a discharge line and a nozzle.

Detailed Description

[0021] In the following description, for purposes of explanation and not limitation, specific details are set forth in order to provide a thorough understanding of the present disclosure. It will be apparent to one skilled in the art that the present disclosure may be practiced in other embodiments that depart from these specific details.

[0022] Fig. 1 illustrates a schematic representation of an embodiment of a device 50 configured to produce a gas-liquid mixture for firefighting purposes. The device 50 is suitable for use as a CAFS. As such, compressed air can be used as a pressurized gaseous medium that is introduced in a liquid medium to produce the gas-liquid mixture. The liquid medium may be a mixture of water and a foaming agent, as commonly used for firefighting purposes.

[0023] The device 50 comprises a mixing container 100 configured to receive the liquid medium and the pressurized gaseous medium. The mixing container 100 has an outlet 110 for the gas-liquid mixture that is located at a top end of the container 100.

[0024] The mixing container 100 further comprises a container bottom 112 opposite to the container outlet 110. A longitudinal extension of the container 100 is defined from the container bottom 112 to the container outlet 110. The mixing container 100 in the present embodiment has a volume of approximately 4 to 15 liters (e.g., approximately 6 liters). In different embodiments, the mixing container 100 can have different sizes and can thus have different volumes between, for example, 3 and 500 liters. The mixing container 100 can is pressure-proof up to at least between 3 and 15 bar. Depending on its size and weight, the device 50 can be a portable or a stationary device and can be combined with a cart or a firefighting vehicle (not shown in Fig. 1).

[0025] The device 50 illustrated in Fig. 1 further comprises a mixing pipe 120 shown to be arranged within the mixing container 100. The mixing pipe 120 extends from a first end 122 located in a vicinity of the container outlet 110 straight to a second end 124 located in a vicinity of the container bottom 112 opposite to the container outlet 110 and is configured to guide the gas-liquid mixture towards the container outlet 110. The second end 124 illustrated in Fig. 1 is pointed so that the liquid medium can flow into the mixing pipe 120 in an unhindered manner.

[0026] The mixing pipe 120 comprises a wall having a mixing passage 130. The mixing passage 130 is configured to introduce the gaseous medium from outside the mixing pipe 120 into the liquid medium, when same is guided within the mixing pipe 120 towards the container outlet 110, so as to generate the gas-liquid mixture. A first distance d1 between the mixing passage 130 and the container bottom 112 along the longitudinal extension is greater than a second distance d2 between the mixing passage 130 and the container outlet 100 along the longitudinal extension. For example, the first distance d1 can be at least 5 times, in particular at least 8 times greater than the second distance d2. Placing the mixing passage 130 near the container outlet 110 rather than the container bottom 112 ensures that the mixing passage 130 lies above the level of the liquid medium so that the pressurized gaseous medium can properly flow through the mixing passage 130.

[0027] The mixing passage 130 exemplarily illustrated in Fig. 1 is defined by a single mixing orifice 130. Additional mixing orifices are optional and indicated by dashed circles in Fig. 1. In Fig. 1, the mixing orifice 130 is arranged between two optional orifices located along the longitudinal extension of the mixing pipe 120. Hence, the three orifices are arranged linearly one behind the other. Additionally or as an alternative, two or more mixing orifices can be arranged in a circumferential direction of the mixing pipe 120, as shown in Fig. 1. The mixing passage 130 has a first cross-sectional area A_1 and a portion of the mixing pipe 120 downstream of the mixing passage 130 or of an optional discharge line 140 (see Fig. 2) downstream of the mixing pipe 120 has a second cross-sectional area A_2. The ratio between the first cross-sectional area A_1 and the second cross-sectional area A_2 is between 1:4 and 1:25 and in particular between 1:7 and 1:11. In this example, the first cross-sectional area A_1 is defined by the cross-sectional area of the single mixing orifice 130.

[0028] If there are multiple mixing orifices, the first cross-sectional area A_1 is defined by the total cross-sectional area of the multiple mixing orifices. The mixing orifices can have different forms and shapes as long as the above-mentioned ratio between the first cross-sectional area A_1 and the second cross-sectional area A_2 is met. In one example, the mixing orifices are bores provided in the mixing pipe.

[0029] Fig. 2 illustrates a schematic representation of a closure assembly comprising a mixing pipe 120 (similar to the one of Fig. 1), a control valve 150 and a closure for the mixing container outlet 110.

[0030] In the embodiment of Fig. 2, the mixing passage 130 of the mixing pipe 120 is defined by a single mixing orifice 130 with a diameter of approximately 2.7 mm. Thus, the first cross-sectional area A_1 is approximately 5.7 mm^2. The portion of the discharge line 140 shown in Fig. 2 has a diameter of approximately 8 mm. Thus, the second cross-sectional area A_2 is approximately 50.3 mm^2. Consequently, the ratio between the first and the second cross-sectional area A_2 illustrated in Fig. 2 is around 1:9. A change in this ratio will lead to different results when discharging the mixture of the pressurized gaseous medium and the liquid medium, when other working parameters, like the pressure of the gaseous medium in the mixing container 100, are kept constant. For example, a reduction of the size of the first cross-sectional area A_1 to 1.8 mm^2 (corresponding to a single mixing orifice 130 with a diameter of 1.5 mm) will lead to a ratio of around 1:28 between the first and second cross-sectional areas A_1, A_2. This ratio change results in a higher concentration of the liquid medium in the mixture, which could further result in that not all of the foaming agent comprised by the liquid medium will be used to produce foam and thus gets wasted.

[0031] In other embodiments, the first cross-sectional area A_1 of the mixing passage is between 3 mm^2 and 13 mm^2. In particular, the first cross-sectional area A_1 is between 4.5 mm^2 and 9.1 mm^2. In yet another embodiment, the first cross-sectional area A_1 of the passage is between 5.1 mm^2 and 7.1 mm^2. According to these examples, the second cross-sectional area A_2 is between 28 mm^2 and 133 mm^2 so as to provide a ratio between the first and second cross-sectional areas A_1:A_2 between 1:4 and 1:25.

[0032] The mixing pipe 120 has a third cross-sectional area A_3 in a region of the mixing passage 130. A ratio between the first cross-sectional area A_1 and the third cross-sectional area A_3 is greater or equal to the ratio between the first cross-sectional area A_1 and the second cross-sectional area A_2. Therefore, the flow of the liquid medium towards the outlet 110 of the mixing container 100 will not be restricted at the mixing passage 130.

[0033] The control valve 150 illustrated in Fig. 2 is configured to control discharging of the gas-liquid mixture. The control valve 150 can be a common controllable check valve that allows a discharge of the mixture while being actuated and otherwise prevents a discharge of the mixture.

[0034] Fig. 3 illustrates a schematic representation of a fully operable firefighting device 300. The firefighting device 300 combines the features discussed above with reference to Figs. 1 and 2 and further comprises a discharge line 140 and a nozzle 160.

[0035] In the embodiment of Fig. 3, the discharge line 140 is located downstream of the mixing pipe 120 and the control valve 150 is located between the discharge line 140 and the mixing pipe 120. When the control valve 150 is not actuated, the discharge line 140 is not under pressure. This enhances the lifetime of the discharge line 140 and general safety, since a damaged discharge line 140 does not automatically lead to a discharge of the mixture of the pressurized gaseous medium and the liquid medium. Further, since the mixing of the pressurized gaseous medium and the liquid medium takes place upstream of the outlet 110 of the mixing container 100, the discharge line 140 can for example be a simple hose as commonly used with fire extinguishers. A complex and more expensive structure like a double hose is not needed.

[0036] The nozzle 160 is configured to work as a check valve, similar to the control valve 150, and to discharge the gas-liquid mixture from the firefighting device 300 on actuation of the nozzle 160. The nozzle 160 can be a nozzle as commonly known in the field of firefighting. Due to the combination of the control valve 150 and the nozzle 160, an actuation of the control valve 150 leads to a flow of the mixture of the pressurized gaseous medium and the liquid medium into the discharge line 140. A following actuation of the nozzle 160 leads to a discharge of the mixture from the nozzle 160. Hence, an actuation of both, the control valve 150 and the nozzle 160 results in a constant discharge of the mixture from the nozzle 160 over the actuation time, until the liquid medium is fully discharged or until the gaseous medium originally stored in the mixing container 100 is no longer sufficiently pressurized.

[0037] Regarding the fluidic passage of the mixture of the fluid indicated by arrows in Fig. 3, the second cross-sectional area A_2 is a minimum cross-sectional area of the fluidic passage from the mixing passage 130 to the portion of the mixing pipe 120 downstream of the mixing passage 130 and of the discharge line 140 downstream of the mixing pipe 120. Therefore, the mixture of the pressurized gaseous medium and the liquid medium will not be restricted in a section downstream of the mixing passage 130 and a constant and steady flow of the mixture can be established.

[0038] Fig. 4 illustrates a schematic representation of a second embodiment of the device 50 configured to produce a gas-liquid mixture for firefighting purposes.

[0039] In the embodiment of Fig. 4, the device 50 comprises a mixing container 100, a mixing pipe 120 and an inlet 170 for the gas. The mixing container 100 and the mixing pipe 120 have the same features as the ones illustrated in Fig. 1. The inlet 170 for the pressurized gaseous medium is configured so that a source of the pressurized gaseous medium can be fluidically coupled to it.

When the source of the pressurized gaseous medium is fluidically coupled to the inlet 170, the pressure inside the mixing container 100 can be held constant during actuation of the device 50. This results in consistent firefighting properties of the produced foam during actuation of the device 50. The source can be a portable source, for example a commonly known portable gas container. The source can also be a stationarily installed source that can be mounted, for example, in a building or on a firefighting vehicle.

[0040] Fig. 5 illustrates a schematic representation of an alternative closure for the mixing container 100 of Fig. 4. Here, a possible flow of the pressurized gaseous medium is indicated by arrows.

[0041] Fig. 6 illustrates a schematic representation of a combination of the device 50 of Fig. 4, the closure assembly of Fig. 5 and a pressure tank 200.

[0042] In the embodiment of Fig. 6, the pressure tank 200 is configured to store the pressurized gaseous medium. A pressure line 210 extends from the pressure tank 200 to the mixing container 100. Further, a restriction valve 220 is located between the pressure line and an outlet 230 of the pressure tank 200. The restriction valve 220 is configured to controllably release the pressurized gaseous medium from the pressure tank 200 into the mixing container 100. The restriction valve 220 can be a common controllable check valve. In this example, the pressure tank 200 is configured as a source of the pressurized gaseous medium and can be pressure-proof up to at least between 200 and 450 bar. Therefore, the pressure tank 200 is configured to have a small volume in comparison to the mixing tank 100. As a result, the illustrated combination of the mixing container 100 and the pressure tank 200 can still be configured portably.

[0043] Fig. 7 illustrates a schematic representation of a second fully operable firefighting device 350 comprising the assembly of Fig. 6, the discharge line and the nozzle. The device 350 incorporates all of the features described above with reference to Figs. 4 to 6.

[0044] An actuation of the restriction valve 220 results in a flow of the pressurized gaseous medium from the pressure tank 200 through the pressure line 210 to the mixing container 100. An additional actuation of the restriction valve 220 leads to a flow of the gaseous medium through the mixing passage 130 into the liquid medium and to a flow of the liquid medium towards the outlet 110 of the mixing container 100. The pressure of the gaseous medium in the mixing container 100 can be kept at approximately 8.5 bar. The mixture of the pressurized gaseous medium and the liquid medium flows into the discharge line 140 and towards the nozzle 160. An additional actuation of the nozzle 160 then results in a constant and steady discharge of produced foam with consistent firefighting properties over the actuation time or until the liquid medium is discharged.

[0045] The firefighting properties of the foam produced by utilizing one of the fully operable firefighting devices 300, 350 of Fig. 3 and Fig. 7 can be controlled via the mixing ratio of the pressurized gaseous medium and the liquid medium and via the pressure at which the mixture is discharged. Consequently, regarding one type of foaming agent, a combination of the cross-sectional areas and the pressure of the pressurized gaseous medium inside the mixing container 100 determines the properties of the produced foam. If, for example, the ratio of the first cross-sectional area A_1 to the second cross-sectional area A_2 is high (e.g., 1:3 and above) the discharged mixture will contain so much of the pressurized gaseous medium that a resulting jet of the discharged medium will not be continuous. If, for example, the ratio of the first cross-sectional area A_1 and the second cross-sectional area A_2 is low (e.g., 1:28 and below) the discharged mixture will contain so much of the liquid medium that the produced foam will not be homogenous. Further, the pressure of gaseous medium inside the mixing container 100 influences the size of the bubbles of the foam and the range of the resulting jet. In general, a higher pressure leads to smaller bubbles and a longer range of the resulting jet. Simultaneously, a higher pressure increases the possibility of turbulences in the resulting jet. Turbulences can lead to an uncontrollable jet. Therefore, finding the pressure resulting in the longest ranging controllable jet without turbulences can be seen as an optimization problem. The ratio of the first and second cross-sectional areas A_1:A_2 between 1:4 and 1:25, in particular between 1:7 and 1:11, combined with a pressure of the gaseous medium inside the mixing container 100 between 3 bar and 15 bar, in particular between 8 bar and 9 bar, leads to a constant discharge of a homogenous foam with a high range of the resulting jet.

[0046] In in the embodiments discussed above, a constant discharge of a homogenous foam with a high range of the resulting jet is produced by guiding a gas-liquid mixture inside the mixing pipe 120 that is arranged within the mixing container 100 towards the container outlet 110. To produce the gas-liquid mixture, a pressurized gaseous medium is introduced, via the mixing passage 130 comprised by a wall of the mixing pipe 120, from an outside of the mixing pipe 120 into the liquid medium when same is guided within the mixing pipe 120 towards the container outlet 110. The mixing passage 130 has a first cross-sectional area A_1. A portion of the mixing pipe 120 downstream of the mixing passage 130, or a portion of a discharge line 140 downstream of the mixing pipe 120, has a second cross-sectional area A_2. A ratio of the first and second cross-sectional areas A_1:A_2 between 1:4 and 1:25, in particular between 1:7 and 1:11. A pressure of the gaseous medium inside the mixing container 100 is between 3 bar and 15 bar, in particular between 7 bar and 10 bar (e.g., between 8 and 9 bar).

Claims

1. A device (300) configured to produce a gas-liquid mixture for firefighting purposes, the device (300)

comprising:

a mixing container (100) configured to receive a liquid medium and a pressurized gaseous medium, wherein the mixing container (100) has an outlet (110) for the gas-liquid mixture;
a mixing pipe (120) arranged within the mixing container (100) and configured to guide the gas-liquid mixture towards the container outlet (110),

- wherein the mixing pipe (120) comprises a wall having a mixing passage (130) configured to introduce the gaseous medium from an outside of the mixing pipe (120) into the liquid medium when same is guided within the mixing pipe towards the container outlet (110), and
- wherein the mixing passage (130) has a first cross-sectional area (A_1) and wherein a portion of (i) the mixing pipe (120) downstream of the mixing passage (130) or of (ii) a discharge line (140) downstream of the mixing pipe (120) has a second cross-sectional area (A_2), and wherein a ratio between the first cross-sectional area (A_1) and the second cross-sectional area (A_2) is between 1:4 and 1:25.

2. The device (300) according to claim 1, wherein the mixing passage (130) is defined by one or more mixing orifices and wherein the first cross-sectional area (A_1) is defined by the total cross-sectional area of the one or more mixing orifices.

3. The device (300) according to any of the preceding claims, wherein the first cross-sectional area (A_1) of the mixing passage is at least one of larger than 3 mm^2 and smaller than 13 mm^2, and wherein the first cross-sectional area (A_1) is in particular at least one of larger than 4.5 mm^2 and smaller than 9.1 mm^2.

4. The device (300) according to any of the preceding claims, wherein the first cross-sectional area (A_1) of the passage is at least one of larger than 5.1 mm^2 and smaller than 7.1 mm^2.

5. The device (300) according to any of the preceding claims, wherein the mixing container (100) comprises a container bottom (112) opposite to the container outlet (110) and defines a longitudinal extension from the container bottom (112) to the container outlet (110), and wherein a first distance between the mixing passage (130) and the container bottom (112) along the longitudinal extension is at least 5 times, in particular at least 8 times greater than a second distance between the mixing passage (130) and the container outlet (110) along the longitudinal extension.

6. The device (300) according to any of the preceding claims, wherein the second cross-sectional area (A_2) is a minimum cross-sectional area of a fluidic passage for the mixture of the liquid medium and the pressurized gaseous medium from the mixing passage (130) to the portion of (i) the mixing pipe (120) downstream of the mixing passage (130) or of (ii) the discharge line (140) downstream of the mixing pipe (120).

7. The device (300) according to any of the preceding claims, wherein the second cross-sectional area (A_2) is at least one of larger than 28 mm^2 and smaller than 133 mm^2.

8. The device (300) according to any of the preceding claims, wherein the mixing pipe (120) has a third cross-sectional area (A_3) in a region of the mixing passage (130), wherein a ratio between the first cross-sectional area (A_1) and the third cross-sectional area (A_3) is greater than or equal to the ratio between the first cross-sectional area (A_1) and the second cross-sectional area (A_2).

9. The device (300) of any of the preceding claims, wherein the mixing pipe (120) has a straight extension from a first end (122) located in a vicinity of the container outlet (110) to a second end (124) located in a vicinity of a container bottom (112) opposite to the container outlet (110).

10. The device (300) according to any of the preceding claims, wherein the mixing container (100) has a volume between 3 and 500 liters.

11. The device (300) according to any of the preceding claims, wherein the mixing container (100) is pressure-proof up to at least between 3 and 15 bar.

12. The device (300) according to any of the preceding claims, further comprising a nozzle (160) configured to discharge the gas-liquid mixture from the device (300).

13. The device (300) according to any of the preceding claims, further comprising a control valve (150) configured to control discharging of the gas-liquid mixture.

14. The device (300) of claim 13, wherein the control valve (150) is located between the discharge line (140) and the mixing pipe (120).

15. The device (300) according to any of the preceding claims, further comprising

a pressure tank (200) configured to store the pressurized gaseous medium; and
a pressure line (210) extending from the pressure tank (200) to the mixing container (100).

Amended claims in accordance with Rule 137(2) EPC.

1. A device (50) configured to produce a gas-liquid mixture for firefighting purposes, the device (50) comprising:

a mixing container (100) configured to receive a liquid medium and a pressurized gaseous medium, wherein the mixing container (100) has an outlet (110) for the gas-liquid mixture;
a mixing pipe (120) arranged within the mixing container (100) and configured to guide the liquid towards a mixing passage (130) and to guide the gas-liquid mixture from the mixing passage (130) towards the container outlet (110),

- wherein the mixing pipe (120) comprises a wall having the mixing passage (130), wherein the mixing passage (130) is configured to introduce the gaseous medium from an outside of the mixing pipe (120) into the liquid medium when same is guided within the mixing pipe towards the container outlet (110), and
- wherein the mixing container (100) comprises a container bottom (112) opposite to the container outlet (110) and defines a longitudinal extension from the container bottom (112) to the container outlet (110), and wherein a first distance between the mixing passage (130) and the container bottom (112) along the longitudinal extension is at least 5 times, in particular at least 8 times greater than a second distance between the mixing passage (130) and the container outlet (110) along the longitudinal extension; and
- wherein the mixing passage (130) has a first cross-sectional area (A_1) and wherein a portion of (i) the mixing pipe (120) downstream of the mixing passage (130) or of (ii) a discharge line (140) downstream of the mixing pipe (120) has a second cross-sectional area (A_2), and wherein a ratio between the first cross-sectional area (A_1) and the second cross-sectional area (A_2) is between 1:4 and 1:25.

2. The device (50) according to claim 1, wherein
the mixing passage (130) is defined by one or more mixing orifices and
wherein the first cross-sectional area (A_1) is defined by the total cross-sectional area of the one or more mixing orifices.

3. The device (50) according to any of the preceding claims, wherein
the first cross-sectional area (A_1) of the mixing passage is larger than 3 mm^2 and smaller than 13 mm^2, and wherein the first cross-sectional area (A_1) is in particular larger than 4.5 mm^2 and smaller than 9.1 mm^2.

4. The device (50) according to any of the preceding claims, wherein
the first cross-sectional area (A_1) of the passage is larger than 5.1 mm^2 and smaller than 7.1 mm^2.

5. The device (50) according to any of the preceding claims, wherein
the second cross-sectional area (A_2) is a minimum cross-sectional area of a fluidic passage for the mixture of the liquid medium and the pressurized gaseous medium from the mixing passage (130) to the portion of (i) the mixing pipe (120) downstream of the mixing passage (130) or of (ii) the discharge line (140) downstream of the mixing pipe (120).

6. The device (50) according to any of the preceding claims, wherein
the second cross-sectional area (A_2) is larger than 28 mm^2 and smaller than 133 mm^2.

7. The device (50) of any of the preceding claims, wherein
the mixing pipe (120) has a straight extension from a first end (122) located at the container outlet (110) to a second end (124) located in a vicinity of a container bottom (112) opposite to the container outlet (110).

8. The device (50) according to any of the preceding claims, wherein
the mixing container (100) has a volume between 3 and 500 liters.

9. The device (50) according to any of the preceding claims, wherein
the mixing container (100) is pressure-proof up to at least 3 bar.

10. The device (50) according to any of the preceding claims, further comprising a nozzle (160) configured to discharge the gas-liquid mixture from the device (50).

11. The device (50) according to any of the preceding claims, further comprising a control valve (150) configured to control discharging of the gas-liquid mixture.

12. The device (50) of claim 11, wherein the control valve (150) is located between the discharge line (140) and the mixing pipe (120).

13. The device (50) according to any of the preceding claims, further comprising

a pressure tank (200) configured to store the pressurized gaseous medium; and
a pressure line (210) extending from the pressure tank (200) to the mixing container (100), wherein the device (50) comprises an inlet (170) configured to be fluidically coupled to the pressure line (210) so as to provide a fluidic passage between the pressure line (210) and the mixing container (100) in an area between the mixing passage (130) and the container outlet (110).

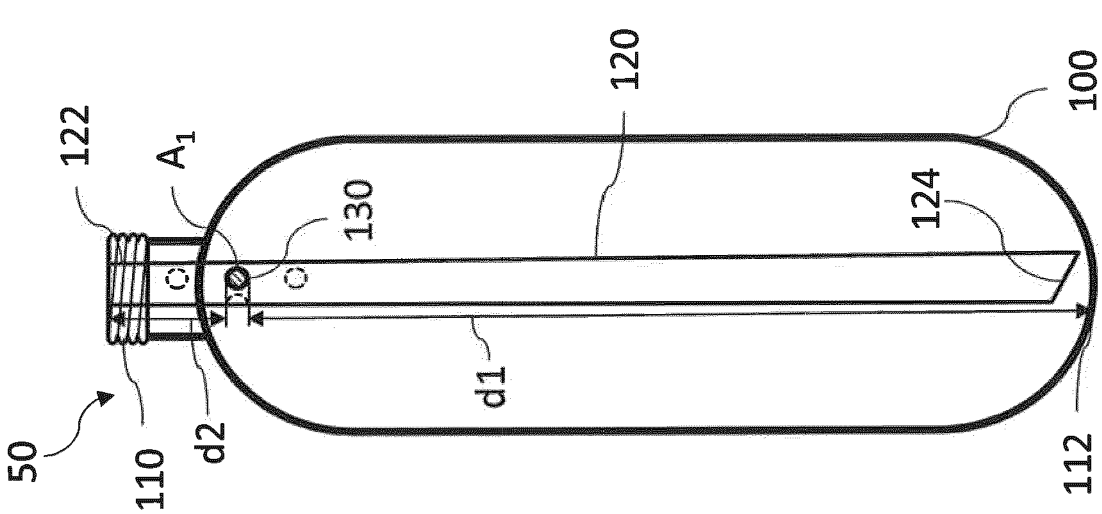

Fig. 1

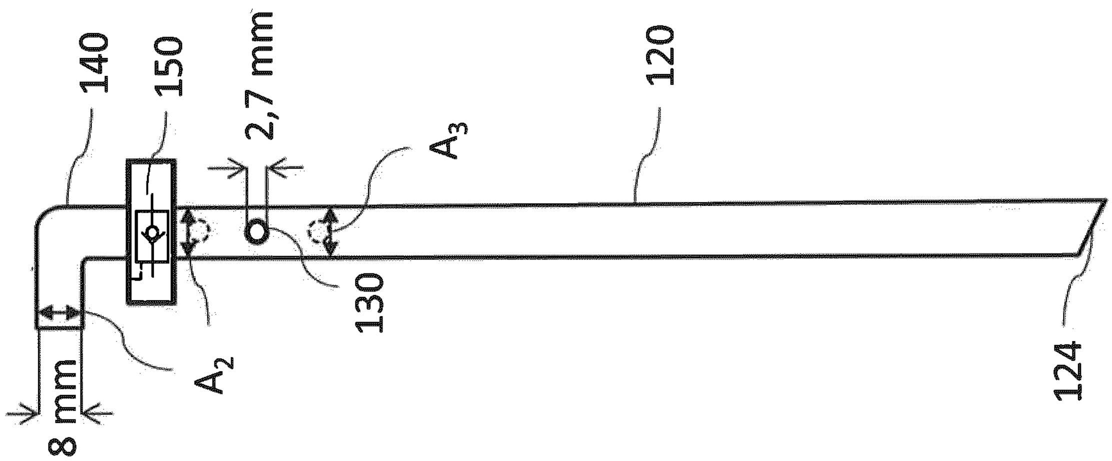

Fig. 2

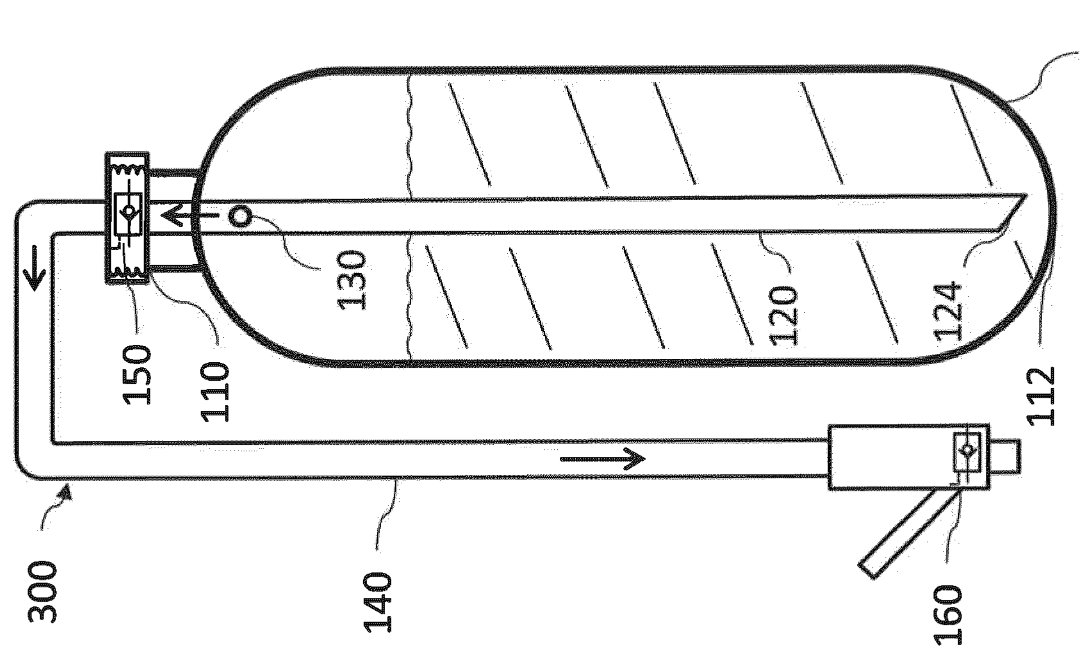

Fig. 3

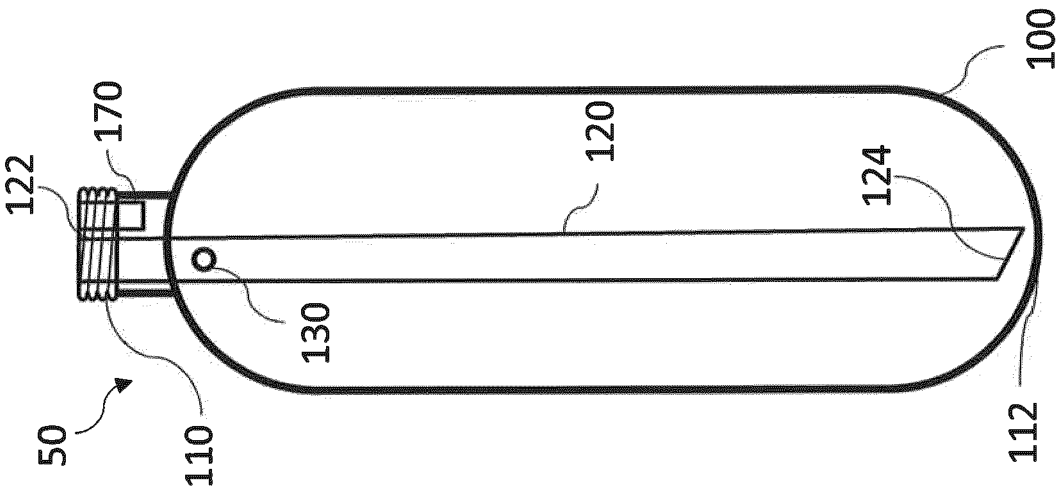

Fig. 4

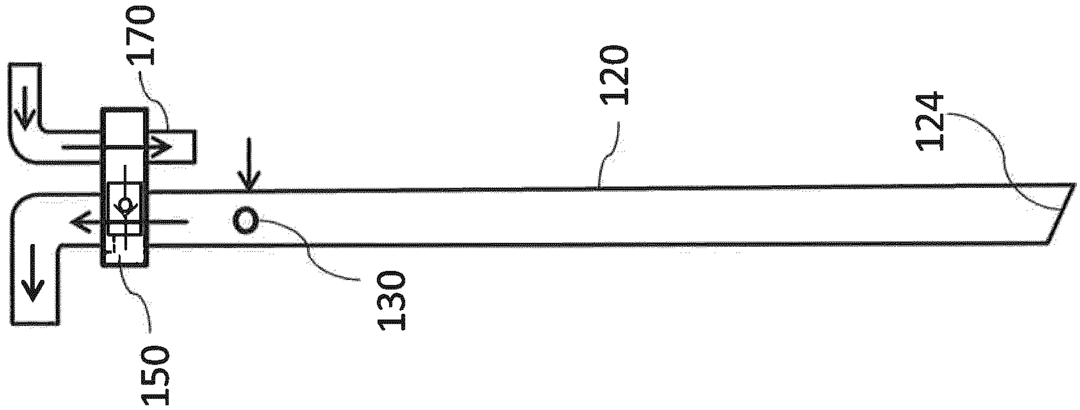

Fig. 5

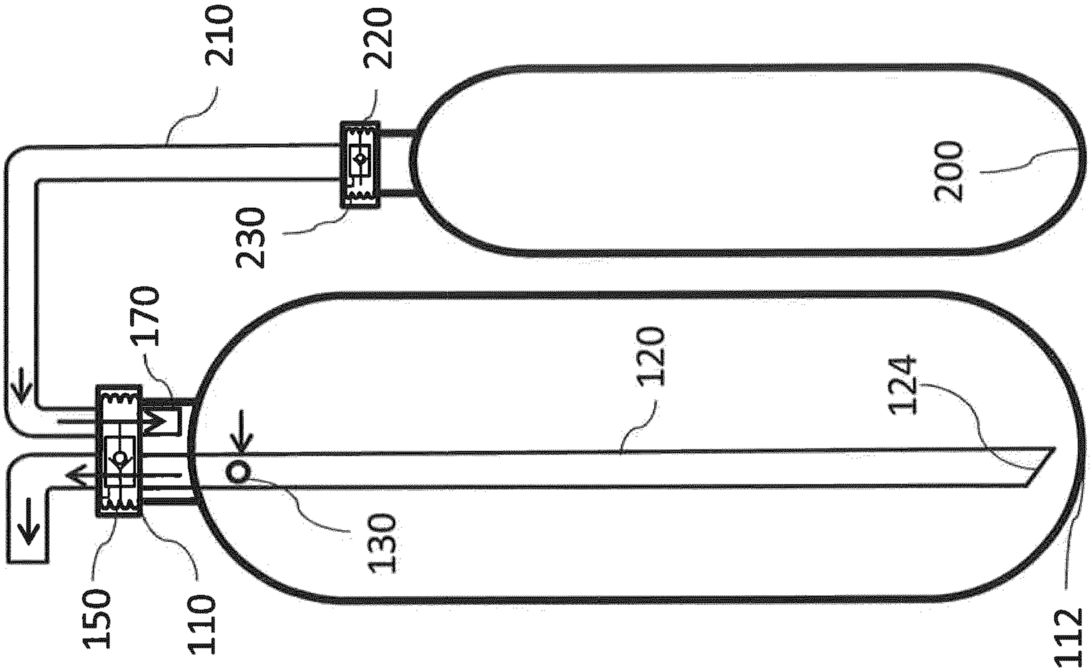

Fig. 6

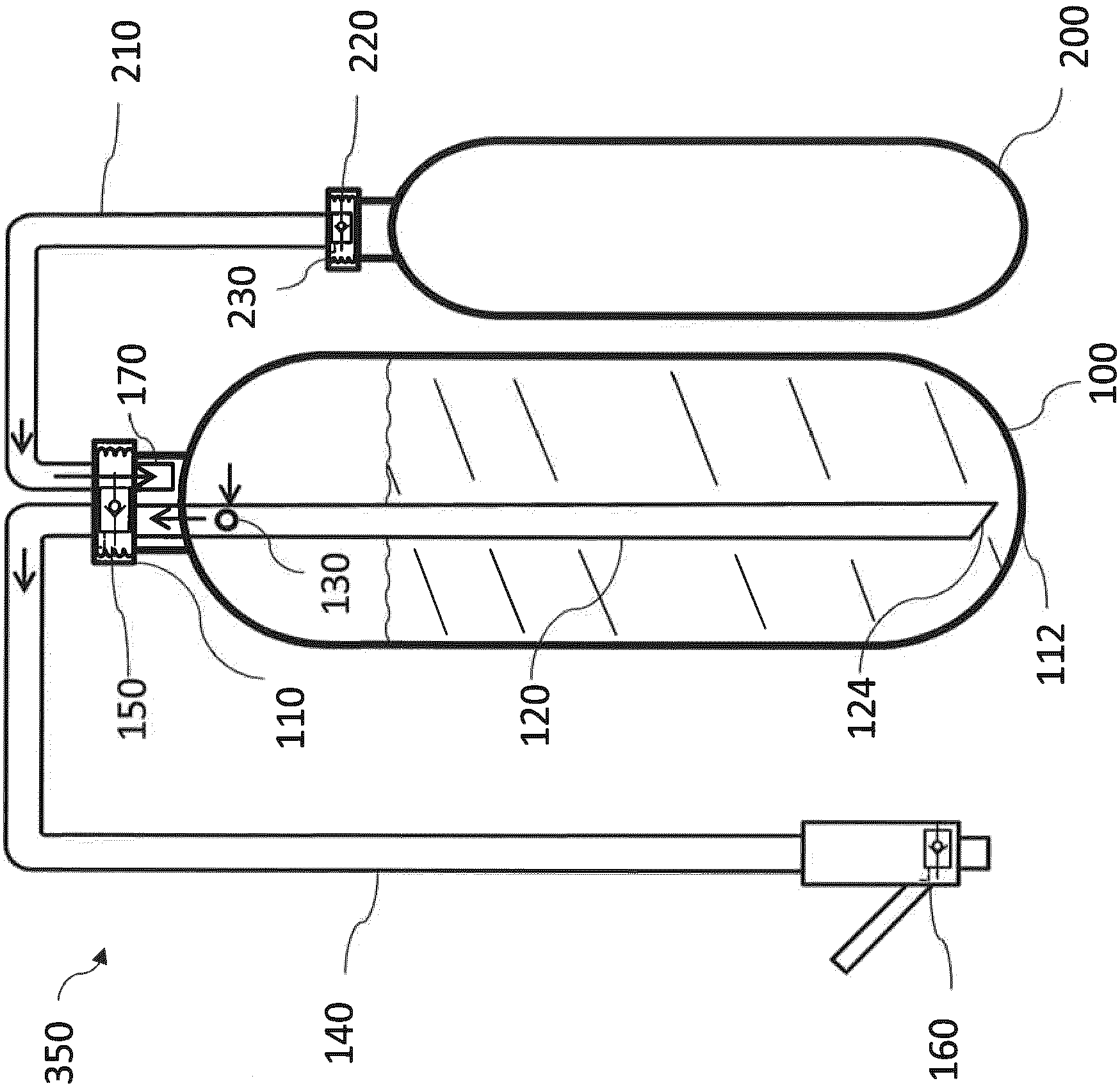

Fig. 7

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EUROPEAN SEARCH REPORT

Application Number
EP 20 16 2046

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X	US 5 992 530 A (SUNDHOLM GOERAN [FI]) 30 November 1999 (1999-11-30) * figures 1-3 * * column 1, lines 6-10 * * column 4, lines 15-40 * * column 4, line 56 - column 5, line 16 * * column 5, lines 21-22,35-41 * * column 5, line 52 - column 6, line 1 * * column 6, lines 11-53 * * column 7, lines 1-5,20-22 * -----	1-15	INV. A62C5/02 A62C13/66 A62C35/02
X	WO 98/09683 A1 (SUNDHOLM GOERAN [FI]) 12 March 1998 (1998-03-12) * figures 1-4 * * page 3, lines 22-27 * * page 4, line 33 - page 4, line 21 * * page 5, lines 9-20 * * page 6, lines 18-19 * -----	1-15	
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1

Place of search	Date of completion of the search	Examiner
The Hague	22 September 2020	Paul, Adeline

CATEGORY OF CITED DOCUMENTS

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