(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 860 486 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
09.12.2015 Bulletin 2015/50

(51) Int Cl.:
F41H 9/06 *(2006.01)*

(21) Application number: **14163988.0**

(22) Date of filing: **09.04.2014**

(54) **Fog-generating device comprising a movable wall in a reservoir**

Nebelerzeugungsvorrichtung mit einer beweglichen Wand in einem Behälter

Dispositif de génération de brouillard comprenant une paroi mobile dans un réservoir

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **11.10.2013 EP 13188319**
30.12.2013 PCT/EP2013/078112
21.03.2014 BE 201400193
25.11.2013 EP 13194330

(43) Date of publication of application:
15.04.2015 Bulletin 2015/16

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to a fog-generating device comprising: a propellant gas; a reservoir comprising a movable wall and a fog-generating material; and a heat exchanger; wherein said propellant gas drives said movable wall to expel the fog-generating material from the reservoir to the heat exchanger. The present invention also provides a removable housing for such a device.

BACKGROUND TO THE INVENTION

[0002] Fog-generating devices are used in several applications. They are used in entertainment for creating a specific mood or enhancing visual lighting effects. During the training of emergency and military personnel, they are used to simulate fire. In addition, they are used in security systems to disorient intruders and to hide valuables from them.

[0003] Typically, a fog-generating device creates fog by driving a fog-generating substance through a heat exchanger; upon which the fog-generating substance is converted into the vapour phase that is ejected at the exit [end] of the heat exchanger. Dependent upon the atmosphere in which said vapour is being ejected; the vapour may condense upon expansion into tiny liquid droplets suspended in the air as an aerosol, with the formation of a fog.

[0004] The capacity at which fog can be generated is of crucial importance when the device is used as a security device. For example, in the case of a burglary, the fog-generating device should fill the room with fog within a few seconds. In such case, valuables are immediately obscured from the sight of the intruder, and he will quickly try to escape by leaving the room. When fog is generated too slowly, the thief may use the additional seconds to quickly grasp valuables before leaving. Most often, a pump is used to drive fog-generating liquid from a reservoir to a heat exchanger. However, in said case, the time needed to convert all the fog-generating liquid to fog is dependent on the capacity of the pump, i.e. its ability to deliver a given flow within a given time at given pressure. Fog-generating device are often powered by standard voltage batteries, further restricting the capacity of such pumps. In addition, high-capacity liquid pumps would lead to too high product prices. Therefore, utilization of pumps to drive fog-generating liquids from the reservoir to the heat-exchanger seriously restricts the fog output of those fog-generating devices.

[0005] WO03001140 addresses this problem by dissolving a liquefied propellant gas (partly fluorinated hydrocarbons) in the fog-generating liquid in a reservoir. When fog needs to be generated, a normally closed valve (switch) between the reservoir and the connected heat exchanger is opened. Expansion the liquefied propellant gas expands to its gas phase and drives the fog-generating liquid from the reservoir to the heat exchanger, thereby improving the capacity at which fog can be expelled from the device. In addition, after closure of the valve, remaining fog-generating liquid in the heat exchanger is partly removed due to the expansion of propellant gas dissolved in the fog-generating liquid.

[0006] WO2008132113 provides another fog-generating device, wherein this time compressed gas is used as a propellant to drive fog-generating liquid from a reservoir to a heat exchanger. Due to the pressure in the vessel, the fog-generating liquid itself also contains dissolved compressed gas. In the heat exchanger, the gas that is dissolved in the liquid expands, which leads to turbulence and improves fog generation.

[0007] A drawback of prior art fog-generating devices, especially devices wherein a propellant gas is used to drive fog-generating liquid from a reservoir to a heat exchanger, is the limited degree of freedom for orienting the device. Although orientation of the exit from where the fog is blown is often crucial, e.g. for concealing particular parts of the room in first instance, prior art devices don't allow much freedom as in certain positions the fog-generating device will simply not work, or fog-generating liquid will spill out of the reservoir, thereby damaging the device or leaving insufficient liquid in the reservoir for proper functioning.

[0008] Thus, there is a continued need for fog-generating devices that allow to fill a room more quickly with fog, as well as by leading to a quicker start of fog generation as by expelling higher volumes of fog per second. In addition, there is a need for devices that allow a larger degree of freedom for orienting the devices during transport and installation. Furthermore, there is a need for fog-generating devices that can be easily set-up and does not require a skilled technician to come on-site or sending the device to a facility for refilling the device with fog-generating material after the device has been initiated.

[0009] Furthermore, an often-encountered problem with fog-generating devices is that, upon switching off the fog generating fluid flow, the heat exchanger is cut off from pump pressure or propellant gas pressure. The pressure in the heat exchanger drops to atmospheric ambient pressure. Consequently, an amount of fog generating fluid is not driven out and remains in the heat exchanger. The high temperature in the heat exchanger and incoming oxygen causes decomposition of the fog generating fluid remaining inside the heat exchanger. Some components resulting from this decomposition are very corrosive and damage the inside of the heat exchanger.

[0010] WO2008132112 addresses this issue and provides means for purging the heat exchanger after the fog-generating fluid flow has been switched off. Purging is realised either by addition of a separate gas purging unit (such as a pump or separate gas vessel), or by addition of means to divert propellant gas from the top of the reservoir through a separate channel and valves to the heat exchanger. However, in both instances, a com-

plicated construction, involving additional valves and/or tubing, is required.

[0011] Therefore, there is a need for fog-generating devices with purging means that are less complex to produce.

[0012] It has been found that the fog-generating device and the removable housing of the present invention provide a solution to the above-mentioned problems.

SUMMARY OF THE INVENTION

[0013] The present invention provides a fog-generating device comprising:

- a propellant gas;
- a reservoir comprising a movable wall and a fog-generating material; and
- a heat exchanger;

wherein said propellant gas drives said movable wall to expel the fog-generating material from the reservoir to the heat exchanger.

[0014] As soon as the propellant gas is allowed to expand (e.g. due to the opening of a valve), expansion will drive the movable wall, which presses the fog-generating material out of the reservoir to the heat exchanger.

[0015] The fog-generating device of the invention may further comprise depressurizing means. These allow residual propellant gas to escape, thereby reducing the pressure inside the fog-generating device, preferably to atmospheric pressure. In a particular embodiment, the depressurizing means also allow the purging of the heat exchanger.

[0016] In one embodiment, the reservoir is present in a removable housing that that can be removed from the remainder of the fog-generating device that comprises the heat exchanger, and the propellant gas. In a further embodiment the propellant gas is present in a removable housing that that can be removed from the remainder of the fog-generating device that comprises the heat exchanger, and the reservoir. In another embodiment .the reservoir and the propellant gas are each independently present in a removable housing that can be removed from the remainder of the fog-generating device that comprises the heat exchanger. In a particular embodiment, the reservoir and propellant gas are present in a (common) removable housing that can be removed from the remainder of the fog-generating device that comprises the heat exchanger. Preferably, the propellant gas is a liquefied gas, such as partly halogenated hydrocarbons, or a compressed gas, such as compressed CO_2. In particular the propellant gas is kept at a pressure of at least 6 bar.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] With specific reference now to the figures, it is stressed that the particulars shown are by way of example and for purposes of illustrative discussion of the different embodiments of the present invention only. They are presented in the cause of providing what is believed to be the most useful and readily description of the principles and conceptual aspects of the invention. In this regard no attempt is made to show structural details of the invention in more detail than is necessary for a fundamental understanding of the invention. The description taken with the drawings making apparent to those skilled in the art how the several forms of the invention may be embodied in practice.

Fig. 1: Removable housing according to the invention, with detail of particular **depressurizing means.**
Fig. 2 and 3: Detail of depressurizing means according to particular embodiments.
Fig. 4 to 7: Particular embodiments of the fog-generating device of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0018] As used herein "expelling fog" or similar terms by a fog-generating device, generally refers to the process wherein a fog-generating substance (hereinafter also referred to as a fog-generating material) is driven through a heat-exchanger, with the conversion of said fog-generating substance into the vapour phase that is ejected at the exit [end] of said heat exchanger.

[0019] As used herein "fog" refers to liquid droplets suspended in the air. In particular, fog as used herein reduces visibility to less than 5 meter, more in particular less than 2 meter. Such fog can be used to obscure e.g. valuables from intruders. It is to be noted that e.g. oil-based smoke generators are unsuitable for indoor purposes, as they impact the health of habitants and intruders and leave trace residues after the floating smoke has been cleared. Therefore, the fog (and hence the fog-generating material) as used herein, does not correspond to the smoke generated using oil-based smoke generators.

[0020] As used herein "a fog generating material" or "a fog generating substance" generally refers to any material or combinations of materials, that can be vaporized when fed through a heat exchanger. When exiting the heat exchanger into the atmospheric pressure and normal ambient temperature and additional coming into contact with the moisture and dust particles [in the outside air] the vapour condenses into tiny liquid droplets suspended in the air as an aerosol, with the formation of a visible fog. In a preferred embodiment, the fog-generating material is a fluid, such as a gel or a liquid, in particular a liquid, more in particular a polyol-containing liquid or gel. Suitable water-based polyol-containing liquids are well-known to the skilled person. For example, they may be an aqueous solution comprising a glycol and/or a glycerol.

[0021] As described before, the present invention provides a fog-generating device comprising a reservoir comprising a movable wall and a fog-generating material.

A propellant gas drives the movable wall. Therefore, independent of the orientation, the movable wall will be driven by propellant gas to expel the fog-generating material from the reservoir since the fog-generating material will always be in contact with and flow to the exit of the reservoir. This allows for a complete degree of freedom when positioning the fog-generating device, which is often crucial to direct generated fog towards valuables or the expected entry of intruders. More in particular, the movable wall may slidably move to drive the fog-generating material from the reservoir to the heat exchanger. As an example, the movable wall may be a movable, slidable wall within the reservoir, such as a piston. When propellant gas is allowed to expand at one side of this wall, the wall moves to expel the fog-generating material situated on the other side of the wall from the reservoir towards the heat exchanger. In another embodiment, the movable wall can move elastically. For example, the fog-generating material may be present in or around a compressible packaging, such as an elastic bag. When propellant gas is allowed to expand on the other side of the packaging, the compressible packaging is compressed or expanded, thereby moving the wall of the packaging and expelling the fog-generating material from the reservoir. It is thus an object of the present invention to provide the use of such a reservoir or housing comprising a movable wall in a fog-generating device, in particular in a fog-generating device comprising a heat exchanger.

[0022] The fog-generating device further comprises a flow controller. In inactive form, the flow controller prevents that fog-generating material is expelled from the reservoir. Various types of flow controllers are known to the skilled person and suitable for the fog-generating device of the present invention. For example, a valve can be used to block outflow of fog-generating material from the exit of the reservoir, such as the closing means as described herein. Such a valve may be a valve which can be switched between an on-off position, or it may be a valve that can be activated non-reversibly (such as a bursting disc that is at least partially destroyed when activated). In particular, said valve is activated mechanically, thermally or chemically, such as by intermetallic and/or pyrotechnic reactions.

[0023] The propellant gas may be present in a separate vessel or it may be present in the same reservoir containing the fog-generating material. If the propellant gas is not located in the reservoir containing the fog-generating material, the flow controller can be located between a vessel comprising the propellant gas and said reservoir. For example, a valve may be used to block outflow of a propellant gas from a vessel to the reservoir. Once the valve is activated, propellant gas enters the reservoir and drives the movable wall, thereby expelling the fog-generating material from the reservoir to the heat exchanger. Said flow controller may also be connected to the movable wall. Such a flow controller blocks movement of the movable wall. Upon activation of the flow controller, e.g. breakage of the connection to the movable wall, the movable wall is driven by means to drive the movable wall, e.g. a compressed gas located outside or inside the reservoir. In a preferred embodiment, the flow controller is located at the exit of the reservoir, preventing outflow of the fog-generating material. This is especially preferred if the reservoir comprising the fog-generating material also comprises at least part of the propellant gas.

[0024] The skilled person is well aware on how to select propellant gases for the fog-generating device of the present invention. The movable wall in the reservoir provides a barrier between the fog-generating material and the propellant gas. The present invention allows for the construction of a fog-generating device comprising propellant gases that would otherwise have a negative impact on the fog-generating material, the fog-generating device, and the environment. Indeed, if no depressurizing means are present, after expansion the propellant gas can be kept sealed on one side of the movable wall, preventing contact with e.g. the heat exchanger and preventing its escape in the surroundings. Nonetheless, preferably, non-toxic propellant gases are used. Suitable propellant gases include liquefied propellant gases, such as partly halogenated hydrocarbons, or compressed propellant gases, such as an inert gas (e.g. nitrogen), noble gas (e.g. helium, neon or argon), compressed air or CO_2, or mixtures thereof.

[0025] In a particular embodiment, gas purges the heat exchanger after the fog-generated material has been converted to fog. It has been found that purging the heat exchanger prevents negative effects of residues of fog-generating material that remain in het heat exchanger. These residues that remain in the hot heat exchanger may lead to bad smells, corrosion and dry matter build-up. In particular, sufficient propellant gas is used, so that a higher gas volume is available than is strictly necessary for driving the fog-generating material from the reservoir to the heat exchanger. After the fog-generating material has been driven through the heat exchanger, propellant gas keeps flowing through the heat-exchanger, thereby purging it.

[0026] The fog-generating device of the invention may comprise any known heat-exchanger to heat the fog-generating material. However, it has been found by the present inventor that the fog-generating device and the removable housing of the present invention act synergistically with the heat exchanger as described in Belgian patent application BE2014/0194. It appears that the device of the invention comprising the movable wall allows for a higher output compared to prior art devices. As soon as the flow controller allows the flow of fog-generating material, said material is nearly instantaneously expelled from the reservoir. Prior art heat exchangers have a difficulty to cope with such a high flow of fog-generating material, causing "spitting" of material that has not been transformed to its gas phase. Evidently, one may construct the fog-generating device to limit the outflow, e.g. by adapting the resistance at the exit of the reservoir, in the liquid connection means, or at the entrance of the

heat exchanger. However, this also limits the fog outflow. In contrast to prior art heat exchangers, the heat exchanger described in BE2014/0194 allows for converting a high flow of fog-generating material to its gas phase without the formation of cold channels that cause "spitting". Therefore, in a preferred embodiment, the device and housing of the present invention is combined with the heat exchanger of BE2014/0194.

[0027] In another particular embodiment, the fog-generating device of the present invention or the removable housing therefore further comprises depressurizing means. Depressurizing means allow the escape of gas from the device so that the pressure inside the device is reduced and becomes closer to atmospheric pressure. Depressurizing means allow for the safer handling and recycling of the device and especially removable housings of the present invention. Depressurizing means may be constructed so that they will function automatically and/or they may be constructed to be initiated manually. Depressurizing means can e.g. be a valve that is to be switched manually. In a particular embodiment, depressurizing means are constructed in such a manner that the pressure in the device is released automatically during or after the fog-generating process. In a particular embodiment, the fog-generating device of the present invention is constructed to activate said depressurizing means after a predetermined amount of fog-generating material has been expelled. In another particular embodiment, the pressure is released upon removal of the removable housing from the fog-generating device. For example, the depressurizing means comprise a valve that is automatically opened when the removable housing is disconnected from the fog-generating device. In a preferred embodiment, the depressurizing means are constructed in such a manner that pressure in the device is released when substantially all fog-generating material has been expelled from the reservoir. Besides being beneficial to the safety when handling and recycling, the depressurizing means can be constructed in such a manner that gas that is released from the device during such depressurizing can be used for purging the heat exchanger. In this embodiment, after substantially all the fog-generating material has been expelled from the reservoir, the propellant gas can be expelled from the housing to the heat exchanger, thereby purging the heat exchanger. For example, the reservoir may contain depressurizing means (present as a groove in the wall of the reservoir) which are located in close proximity to the exit of the reservoir. When substantially all of the fluid has been expelled from the reservoir, the movable wall is located at the groove. Propellant gas is present at a high pressure and can escape from the housing through the groove. Thereby, the pressure inside the housing is reduced towards the atmospheric pressure. Escaped gas enters the liquid connection means towards the heat exchanger, thereby purging the heat exchanger, providing the benefits described above. In another particular embodiment, the depressurizing means comprise a pressure-sensitive seal. The movable wall will push the fog-generating material out of the reservoir upon propellant gas expansion. Once the movable wall contacts the end of the reservoir (and the depressurizing means are located in close proximity to the exit of the reservoir), the pressure inside the emptied reservoir will rupture the pressure-sensitive depressurizing means or a certain position of the movable wall invokes a mechanical puncture of the movable wall as depressurizing means. From that moment, gas from inside the reservoir can escape through the depressurizing means towards the heat exchanger, thereby purging said heat exchanger. In a further embodiment the present invention provides the use of such reservoir or removable housing comprising depressurizing means in a fog-generating device, in particular in a fog-generating device comprising a heat exchanger.

[0028] Furthermore, the fog-generating device of the present invention may comprise liquid connection means to allow a liquid connection between the reservoir containing fog-generating material to the inlet of the heat exchanger. The liquid connection means may take a variety of forms, to suit the present applications. For example, it may comprise a conduit in the form of a tube or a hollow needle, an aperture, or a slit in a membrane. The conduit may be arranged such that no appreciable flow can occur under gravity alone. In this way, controlled delivery of the fog-generating material can be achieved. The conduit may, for example, comprise a small aperture, or a tubular portion with a small bore, such that surface tension of the material inhibits flow. Alternatively, or additionally, the conduit may comprise two-way valve means, arranged to prevent fluid flow unless the pressure difference across it exceeds a certain value. In particular, the liquid connection means ensure a liquid-tight connection through which the fog generating material can run, from the reservoir to the heat exchanger.

[0029] The removable housing of the present invention allows the housing to be removed from and reconnected to the remainder of the fog-generating device that comprises the heat exchanger. Therefore, in particular, the removable housing of the present invention does not comprise a heat exchanger. In another particular embodiment, the removable housing of the present invention comprises fixation means, which connect the removable housing to the remainder of the fog-generating device. Such fixation means allow the removable housing to remain connected to the remainder of the device, despite the high pressures in the housing. In a preferred embodiment, the fixation means are present in close proximity to exit where through the fog-generating material is expelled from the reservoir. In a further embodiment, the fixation means are located close to the liquid connection means. In an even further embodiment, the fixation means are part of the liquid connection means.

[0030] After a fog-generating device has been used, only the insertion of a small removable housing of the invention is needed to get a functional fog-generating device. Whereas in prior art devices, often a whole new

fog-generating device needed to be transported, thanks to the present invention only small cartridges need to be transported. Furthermore, a user can easily store spare removable housings in case a replacement is needed. The fool-proof replacement allowed by the removable housings of the present invention allows a non-skilled user to replace the removable housing himself. In prior art devices, servicing an emptied fog-generating device would require replacement of the whole device, necessitating disconnecting the device from the security system, something that can only be done by a skilled technician.

[0031] Particular embodiments of the invention will be described in more detail with reference to the figures. The movable wall (2) is in particular situated between the fog-generating material (3) and the propellant gas (1), such as shown in figure 1, in a liquid-tight manner. In other words, said wall operates as a plunger in a shaft (in the present instance the outer perimeter of the reservoir (4) comprising the fog-generating fluid) and drives the fog-generating material (3) from the reservoir (4) towards the heat exchanger (9). Consequently, in a particular embodiment, said movable wall (2) further comprises sealing means (11) to prevent fluid leakage between said plunger and the shaft. Said sealing means can be any suitable sealant, including a sealing gel, one or more sealing rings or a sealing plunger head. Such sealing rings and sealing plunger head can be made from any suitable material known in the art, such as for example, but not limited to plastic, metal or elastomer. When the device or removable housing as represented in the figures would be inverted compared to the showing in the figures, the fog-generating device will work as efficiently. The separation means allow the fog-generating material to be always in contact with the exit of the reservoir (7), which can be connected to the liquid connection means (8) towards the heat exchanger (9), even when tilted. Thanks to the construction of the device or removable housing (6) in this manner, the fog-generating device can also be oriented in any direction. This allows for a much larger degree of freedom when positioning the fog-generating device, which is often crucial to direct generated fog towards valuables or the expected entry of intruders.

[0032] As explained herein, in a particular embodiment excess propellant gas (1) is used and said excess gas can be used, either directly or indirectly, to purge the heat exchanger and remove non-ejected vapour out of the heat exchanger into the ambient air. To enable said purging, the movable wall optionally comprises depressurizing means (5). As for example shown in Figure 1, depressurizing means may be present as a groove (5a) in the reservoir. When the movable wall has expelled substantially all the fog-generating fluid from the reservoir, it's sealant mean (11) is located at the groove, thereby allowing excess gas to escape from the reservoir and enter in the liquid connection means towards the heat exchanger, thereby purging said heat exchanger. In another embodiment, the depressurizing means comprise a puncture region (5b), such as shown in figure 2. The puncture region is preferably located in the movable wall. A puncturing part (5c) is present in the fog-generating device, preferably in the reservoir itself, to puncture the puncture region. The puncturing part may e.g. be a sharp point or a plug that can puncture the puncture region. As shown in the embodiment in figure 2, when the movable wall has expelled substantially all of the fog-generating material from the reservoir, the puncture region contacts the puncturing part and is punctured by it when the movable wall continues to move towards the exit. The puncture allows for propellant gas to be expelled from the reservoir to the heat exchanger. Evidently, other constructions of the puncture region and puncturing devices are suitable as well, e.g. a puncturing part connected to the movable wall that punctures a puncture region at a wall of the reservoir, thereby creating an opening that allows expelling propellant gas from the reservoir. This embodiment wherein the depressurizing means comprise a puncturing part (5c) present in the fog-generating device are particularly suitable in case the movable wall can move elastically, such as for example when the fog-generating material is present in or around a compressible packaging, such as an elastic bag. In yet another embodiment, such as shown in Figure 3, said depressurizing means may comprise a pressure sensitive sealing (5d). The pressure-sensitive sealing is preferably located in the movable wall. In the non-activated situation, the pressure on both sides of the movable wall is substantially identical and the pressure-sensitive sealing prevents the flow of propellant gas or fog-generating material through the movable wall. However, when substantially all of the fog-generating material has been expelled from the reservoir, the pressure at the exit side of the movable wall will drop to atmospheric pressure, while the pressure from the propellant gas will remain high. Due to the high pressure difference between both sides of the pressure-sensitive sealing, the sealing will rupture. This allows for the propellant gas to be expelled through the depressurizing means, towards the heat exchanger.

[0033] As described above, the propellant gas may or may not be located in the reservoir comprising the fog-generating material and the movable wall. In a preferred embodiment, the propellant gas is at least partially comprised in the reservoir, such as shown in figure 1. However, the propellant gas may also be present in a separate vessel, such as shown in figures 4 to 7. In a particular embodiment, the vessel is removable from the remainder of the device. In particular, when the vessel comprising the propellant gas (e.g. compressed CO_2, N_2O, nitrogen, ...) is connected to the device, its sealing is opened, for example by a vessel-puncturing part (13). A flow controller (7) controls, directly or indirectly, the flow of the fog-generating material from the reservoir to the heat exchanger. For example, the flow controller may control the flow of the propellant gas to the movable wall, such as shown in figure 4. As long as the flow controller prevents the outflow of the propellant gas from the vessel, outflow

of fog-generating material (3) from the reservoir (4) is prevented as well, e.g. by a pressure-sensitive sealing at the exit of the reservoir, as shown in figure 4. If the flow controller allows outflow of the propellant from the vessel, the pressure in the reservoir increases and ruptures the pressure-sensitive sealing at the exit of the reservoir (e.g. if the pressure in the reservoir reaches 8 bar or higher). The propellant gas now drives the movable wall to expel the fog-generating material from the reservoir to the heat exchanger (9). Examples of flow controllers include a valve, such as a normally closed valve (NC valve) or a one-shot valve. Preferably, the flow controller used in the device and housing of the invention is a one-shot valve which is activated or ruptured due to the melting of part of the valve.

[0034] The flow controller (7) may also be located at the exit of the reservoir, such as shown in figures 5 and 6. In this embodiment, the propellant may exercise pressure on the movable wall as soon as it is connected to the fog-generating device. As shown in figure 5, in a particular further embodiment, the flow controller comprises a plug that blocks the exit of the reservoir. As soon as the plug is released, the pressure on the movable wall drives said wall to expel the fog-generating material from the reservoir to the heat exchanger. In another further embodiment, the flow controller is a one-shot valve. Preferably, the flow controller is the one-shot valve described in Belgian patent application BE2014/0193, which is hereby incorporated by reference. As shown in figure 6, the flow controller may also comprise a reservoir exit puncturing part, which can puncture a puncture region at the exit of the reservoir to allow outflow of fog-generating material. Evidently, the flow controller may also be located in the liquid connection means (8) to prevent the flow of fog-generating material from the reservoir to the heat exchanger (9), as shown in figure 7. It will be apparent to the skilled person that the description of the flow controller and its location are exemplary and are not to be read as limiting to the invention. The skilled person is well aware about different flow controllers and valves that can be used to block and allow the flow of fog-generating material at a specific timing. Evidently, a combination of flow controllers, such as described herein, can be used, e.g. redundantly.

[0035] The present invention also provides the use of a fog-generating machine or removable housing as described herein for generating fog. In addition, the present invention provides the use of a fog-generating machine or removable housing as described herein for protecting against burglars and intruders. In addition, the present invention provides a method for generating fog, said method comprising:

a) providing a reservoir (4) comprising a movable wall (2) and a fog-generating material (3), wherein said reservoir is connected to a heat exchanger (9);
b) using the force of the expansion of propellant gas (1) to drive said movable wall (2), thereby expelling the fog-generating material (3) from the reservoir (4) to the heat exchanger (9); and
c) generating fog by heating said fog-generating material (3) in said heat exchanger (9).

[0036] The fog-generating material will be transformed to its gas phase in the heat exchanger, which will condense when it is expelled at the exit (12) of the device, thereby forming a thick mist, e.g. to obscure valuables and/or disorient an intruder.

[0037] As apparent from the foregoing method for generating fog, there is no need for the removable housing comprising the reservoir to be present within the same device comprising the heat exchanger. Provided liquid connection means are present between the reservoir exit and the inlet of the heat exchanger the forgoing method can be used. As such the liquid connection means may take a variety of forms, to suit the present applications, such as for example a rigid or flexible tubular connection.

Claims

1. A fog-generating device comprising:

- a propellant gas (1) comprising a liquefied propellant gas or a compressed propellant gas;
- a reservoir (4) comprising a movable wall (2) and a fog-generating material (3); and
- a heat exchanger (9);

wherein said propellant gas drives said movable wall to expel the fog-generating material from the reservoir to the heat exchanger.

2. The fog-generating device of claim 1, wherein at least part of the propellant gas (1) is present in the reservoir (4).

3. The fog-generating device of any one of the previous claims, further comprising depressurizing means (5).

4. The fog-generating device according to claim 3, which is constructed to activate said depressurizing means (5) after a predetermined amount of fog-generating material has been expelled from said reservoir.

5. The fog-generating device according to claim 3 or 4, wherein said depressurizing means (5) are located in a wall of said reservoir (4).

6. The fog-generating device according to any one of claims 3 to 5, which is constructed to expel the propellant gas (1) through said depressurizing means (5) to the heat exchanger (9), thereby purging the heat exchanger.

7. The fog-generating device according to any one of the previous claims, wherein said reservoir (4) and/or propellant gas (1) is comprised in a removable housing (6) that can be removed from the remainder of the fog-generating device that comprises the heat exchanger (9).

8. A removable housing (6) for a fog-generating device according to any one of claims 1-7, said removable housing comprising a movable wall (2), a propellant gas (1) on a first side of said movable wall, and a fog-generating material (3) on the other side of said movable wall wherein said propellant gas comprises a liquefied propellant gas or a compressed propellant gas.

9. The fog-generating device of any one of claims 1 to 7, or the removable housing according to claim 8, wherein said propellant gas (1) is a partly halogenated hydrocarbon or a compressed gas selected from the group consisting of an inert gas such as nitrogen; a noble gas such as helium, neon or argon; air; or CO_2.

10. The fog-generating device any one of claims 1 to 7, or the removable housing according to claim 8, wherein the propellant gas (1) is kept at a pressure of at least 6 bar.

11. The fog-generating device of any one of claims 1 to 7, or the removable housing according to claim 8, wherein said fog-generating material (3) is a polyol-containing liquid.

12. A method for generating fog, said method comprising:

    a) providing a reservoir (4) comprising a movable wall (2) and a fog-generating material (3), wherein said reservoir is connected to a heat exchanger (9);
    b) using the force of the expansion of propellant gas (1) to drive said movable wall, thereby expelling the fog-generating material from the reservoir to the heat exchanger; and
    c) generating fog by heating said fog-generating material in said heat exchanger

    wherein said propellant gas comprises a liquefied propellant gas or a compressed propellant gas.

Patentansprüche

1. Ein nebelerzeugendes Gerät, das die folgende Elemente umfasst:

    • einem Treibgas (1), wobei das besagte Treibgas ein verflüssigtes oder verdichtetes Treibgas enthält;
    • einem Vorratsbehälter (4) mit einer beweglichen Wand (2) und einem nebelerzeugenden Material (3); und
    • einem Wärmetauscher (9);

    wobei das besagte Treibgas die besagte bewegliche Wand treibt, um das nebelerzeugende Material von dem Vorratsbehälter in den Wärmetauscher auszustoßen.

2. Das nebelerzeugende Gerät von Anspruch 1, wobei sich wenigstens ein Teil des Treibgases (1) in dem Vorratsbehälter (4) befindet.

3. Das nebelerzeugende Gerät gemäß einem der vorstehenden Ansprüche, wobei das betreffende Gerät zusätzlich über ein Mittel zur Druckentlastung verfügt (5).

4. Das nebelerzeugende Gerät gemäß Anspruch 3, wobei das betreffende Gerät so konstruiert ist, dass das besagte Mittel zur Druckentlastung (5) aktiviert wird, wenn eine im voraus bestimmte Menge des nebelerzeugenden Materials aus dem besagten Vorratsbehälter ausgestoßen worden ist.

5. Das nebelerzeugende Gerät gemäß den Ansprüchen 3 oder 4, wobei das besagte Mittel zur Druckentlastung (5) in einer Wand des besagten Vorratsbehälters (4) untergebracht ist.

6. Das nebelerzeugende Gerät gemäß einem der Ansprüche 3 bis 5, wobei das betreffende Gerät so konstruiert ist, dass das Treibgas (1) durch das Mittel zur Druckentlastung (5) in den Wärmetauscher (9) ausgestoßen wird, was die Reinigung des Wärmetauschers bewirkt.

7. Das nebelerzeugende Gerät gemäß einem der vorstehenden Ansprüche, wobei der besagte Vorratsbehälter (4) und / oder das besagte Treibgas (1) in einem abnehmbaren Gehäuse (6) untergebracht sind, das von dem verbleibenden, den Wärmetauscher (9) umfassenden nebelerzeugenden Gerät entfernt werden kann.

8. Ein abnehmbares Gehäuse (6) für ein nebelerzeugendes Gerät gemäß einem der Ansprüche 1 bis 7, wobei das besagte abnehmbare Gehäuse eine bewegliche Wand (2), ein auf der einen Seite der besagten beweglichen Wand angebrachtes Treibgas (1) und ein nebelerzeugendes Material (3) auf der anderen Seite der besagten beweglichen Wand umfasst; und wobei das besagte Treibgas ein verflüssigtes oder verdichtetes Treibgas enthält.

9. Das nebelerzeugende Gerät gemäß einem der Ansprüche 1 bis 7, oder das abnehmbare Gehäuse gemäß Anspruch 8, wobei es sich bei dem besagten Treibgas (1) um teilweise halogenierten Kohlenwasserstoff oder ein verdichtetes Gas aus der folgenden Gruppe handelt: Schutzgase wie z.B. Stickstoff; Edelgase wie z.B. Helium, Neon und Argon; Luft; oder CO_2.

10. Das nebelerzeugende Gerät gemäß einem der Ansprüche 1 bis 7, oder das abnehmbare Gehäuse gemäß Anspruch 8, wobei das Treibgas (1) unter einem Druck von mindestens 6 bar gehalten wird.

11. Das nebelerzeugende Gerät gemäß einem der Ansprüche 1 bis 7, oder das abnehmbare Gehäuse gemäß Anspruch 8, wobei es sich bei dem besagten nebelerzeugenden Material (3) um eine Polyol-haltige Flüssigkeit handelt.

12. Eine Methode zur Erzeugung von Nebel, die folgende Elemente umfasst:

a) einen Vorratsbehälter (4) mit einer beweglichen Wand (2) und einem nebelerzeugenden Material (3), wobei der besagte Vorratsbehälter mit einem Wärmetauscher (9) verbunden ist;
b) einer Verwendung der Kraft des sich ausdehnenden Treibgases (1) zur Verschiebung der beweglichen Wand, um das nebelerzeugende Material aus dem Vorratsbehälter zum Wärmetauscher auszustoßen; und
c) die Erzeugung von Nebel durch Erwärmung des besagten nebelerzeugenden Materials in dem besagten Wärmetauscher;

wobei das besagte Treibgas ein verflüssigtes oder verdichtetes Treibgas enthält.

Revendications

1. Un dispositif de génération de brouillard comprenant :

• un gaz propulseur (1) comprenant un gaz propulseur liquéfié ou un gaz propulseur comprimé ;
• un réservoir (4) comprenant une paroi mobile (2) et une matière génératrice de brouillard (3) ; et
• un échangeur de chaleur (9) ;

dans lequel ledit gaz propulseur pousse ladite paroi mobile pour l'expulsion de la matière génératrice de brouillard du réservoir vers l'échangeur de chaleur.

2. Le dispositif de génération de brouillard de la revendication 1, dans lequel au moins une partie du gaz propulseur (1) est présente dans le réservoir (4).

3. Le dispositif de génération de brouillard de l'une quelconque des revendications précédentes, comprenant encore des moyens de dépressurisation (5).

4. Le dispositif de génération de brouillard selon la revendication 3, qui est construit pour activer lesdits moyens de dépressurisation (5) après qu'une quantité déterminée de matière génératrice de brouillard a été expulsée dudit réservoir.

5. Le dispositif de génération de brouillard selon la revendication 3 ou 4, dans lequel les moyens de dépressurisation (5) sont localisés dans une paroi dudit réservoir (4).

6. Le dispositif de génération de brouillard selon l'une quelconque des revendications 3 à 5 qui est construit pour expulser le gaz propulseur (1) à travers lesdits moyens de dépressurisation (5) vers l'échangeur de chaleur (9), ainsi purgeant l'échangeur de chaleur.

7. Le dispositif de génération de brouillard selon l'une quelconque des revendications précédentes, dans lequel ledit réservoir (4) et/ou le gaz propulseur (1) sont compris dans un boîtier détachable (6) qui peut être retiré du reste du dispositif de génération de brouillard qui comprend l'échangeur de chaleur (9).

8. Un boîtier détachable (6) pour un dispositif de génération de brouillard selon l'une quelconque des revendications 1 à 7, ledit boîtier détachable comprenant une paroi mobile (2), un gaz propulseur (1) sur un premier côté de ladite paroi mobile et une matière génératrice de brouillard (3) sur l'autre côté de ladite paroi mobile, dans laquelle ledit gaz propulseur comprend un gaz propulseur liquéfié ou un gaz propulseur comprimé.

9. Le dispositif de génération de brouillard de l'une quelconque des revendications de 1 à 7, ou le boîtier détachable selon la revendication 8, dans lequel le gaz propulseur (1) est un hydrocarbure partiellement halogéné ou un gaz comprimé sélectionné parmi le groupe constitué d'un gaz inerte tel que l'azote ; un gaz rare tel que l'hélium, le néon ou l'argon ; de l'air ; ou du CO_2.

10. Le dispositif de génération de brouillard de l'une quelconque des revendications de 1 à 7, ou le boîtier détachable selon la revendication 8, dans lequel le gaz propulseur (1) est conservé à une pression de 6 bar minimum.

11. Le dispositif de génération de brouillard de l'une quelconque des revendications de 1 à 7, ou le boîtier

détachable selon la revendication 8, dans lequel ladite matière génératrice de brouillard (3) est un liquide contenant un polyol.

12. Un procédé pour la génération de brouillard, ledit procédé comprenant :

a) la fourniture d'un réservoir (4) comprenant une paroi mobile (2) et une matière génératrice de brouillard (3), où ledit réservoir est connecté à l'échangeur de chaleur (9) ;
b) l'utilisation de la force d'expansion du gaz propulseur (1) pour pousser ladite paroi mobile, ainsi expulsant la matière génératrice de brouillard du réservoir vers l'échangeur de chaleur ; et
c) la génération de brouillard en chauffant ladite matière génératrice de brouillard dans ledit échangeur de chaleur ;

où ledit gaz propulseur (1) comprend un gaz propulseur liquéfié ou un gaz propulseur comprimé.

Fig. 1

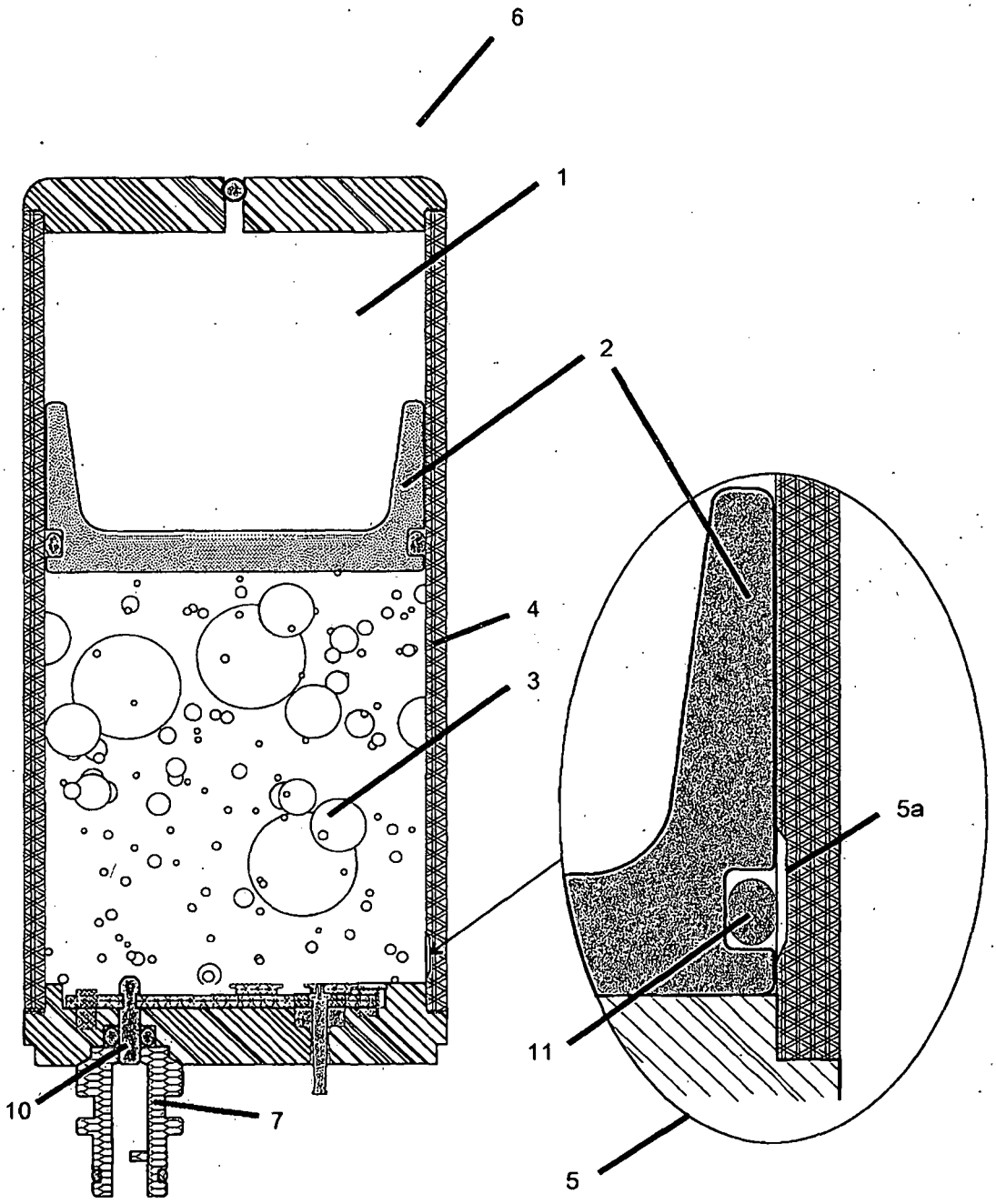


Fig. 2

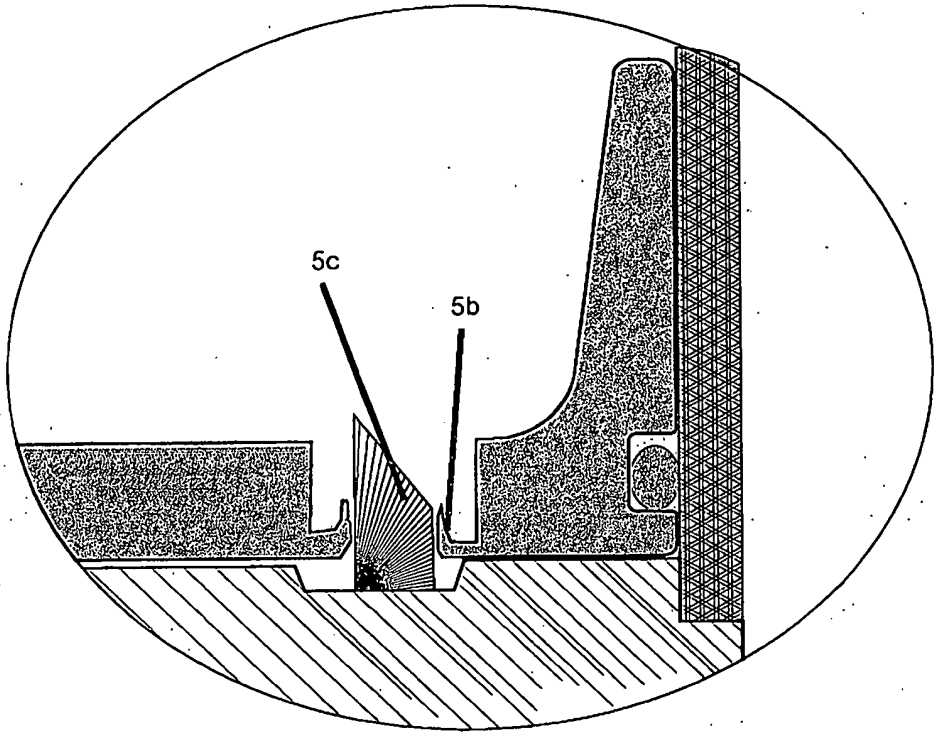


Fig. 3

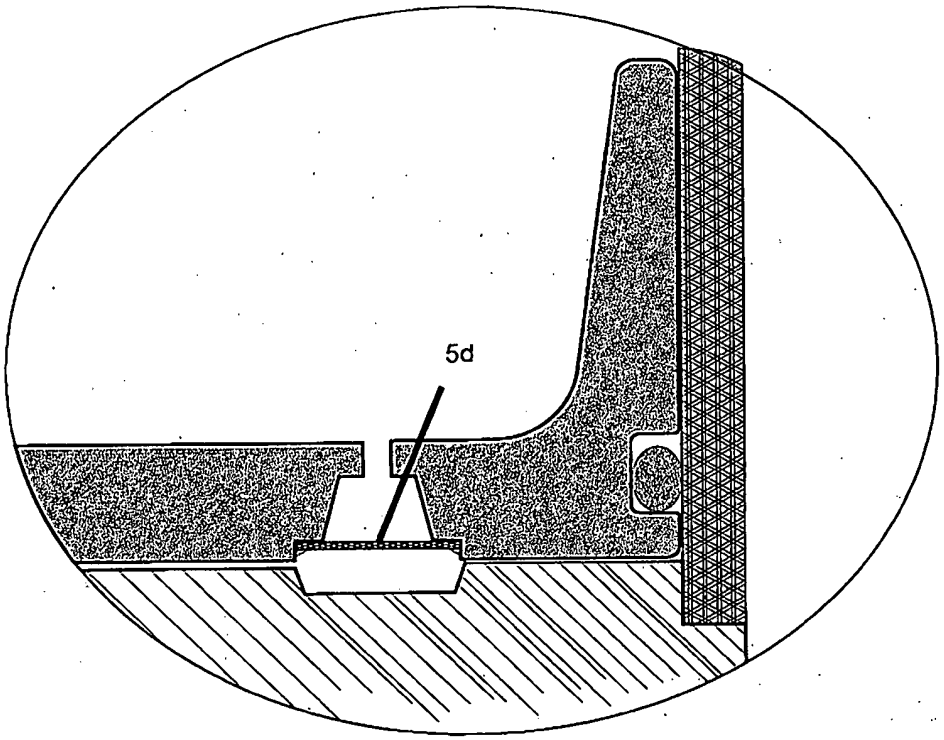


Fig. 4

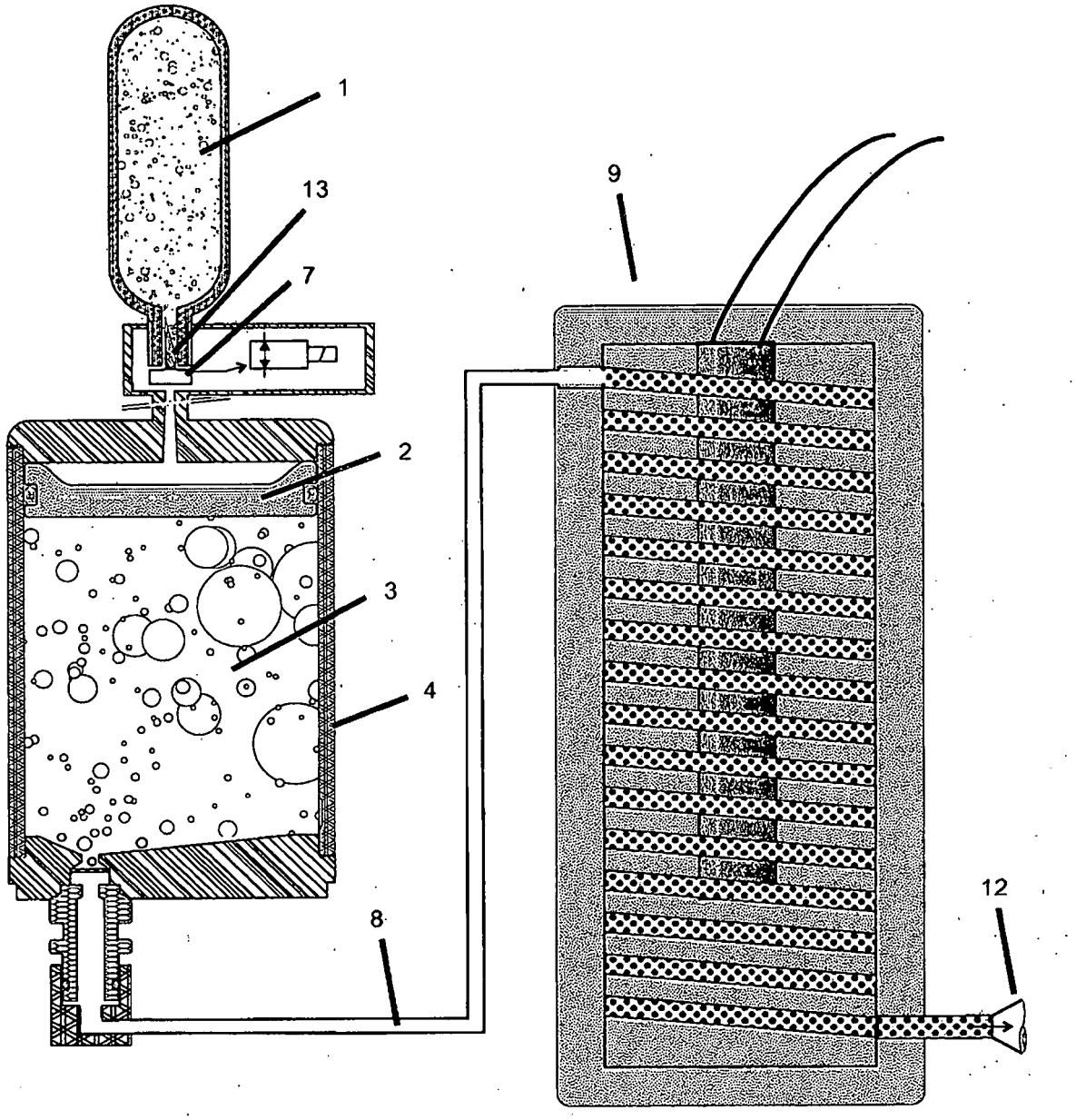


Fig. 5

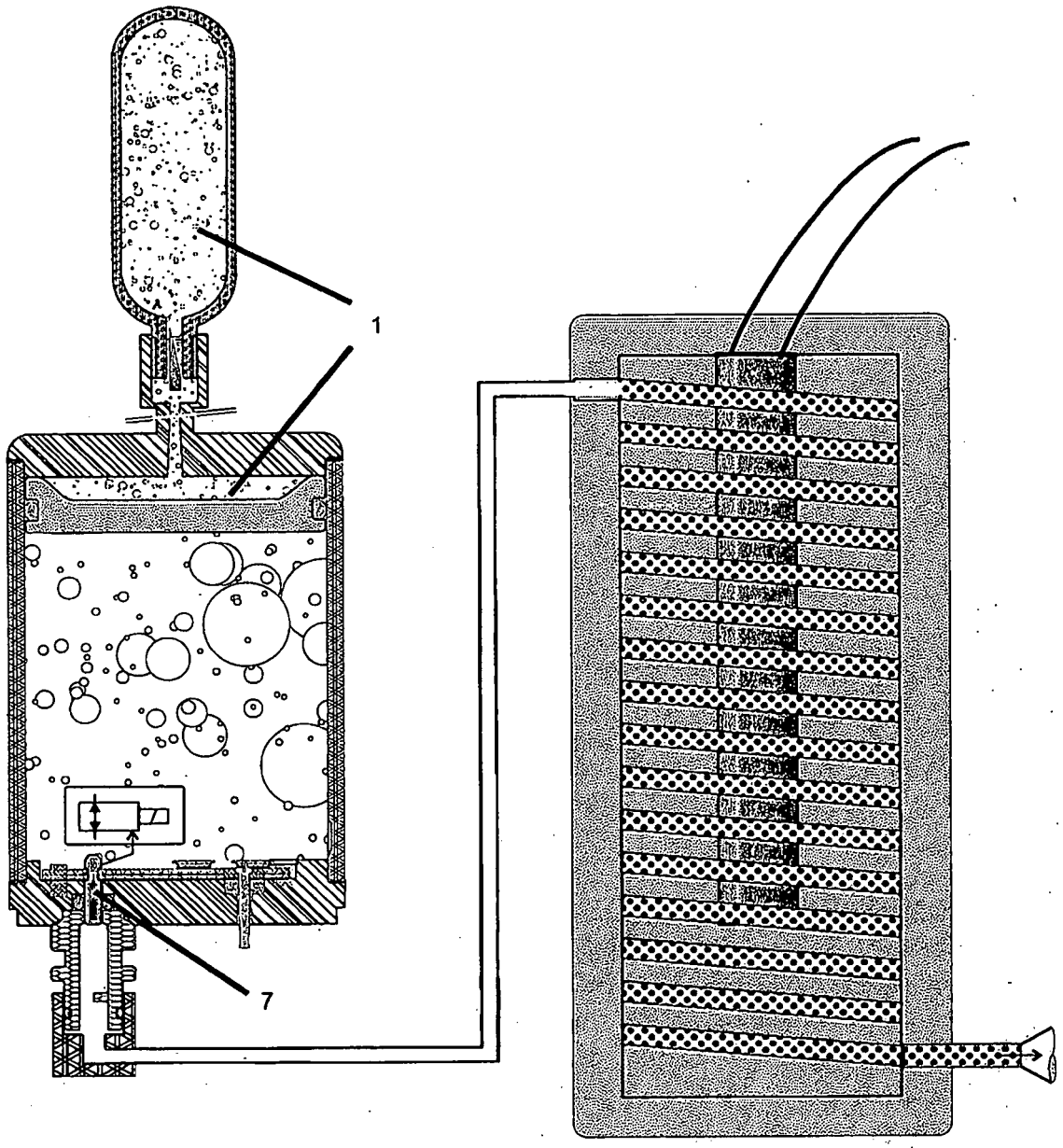


Fig. 6

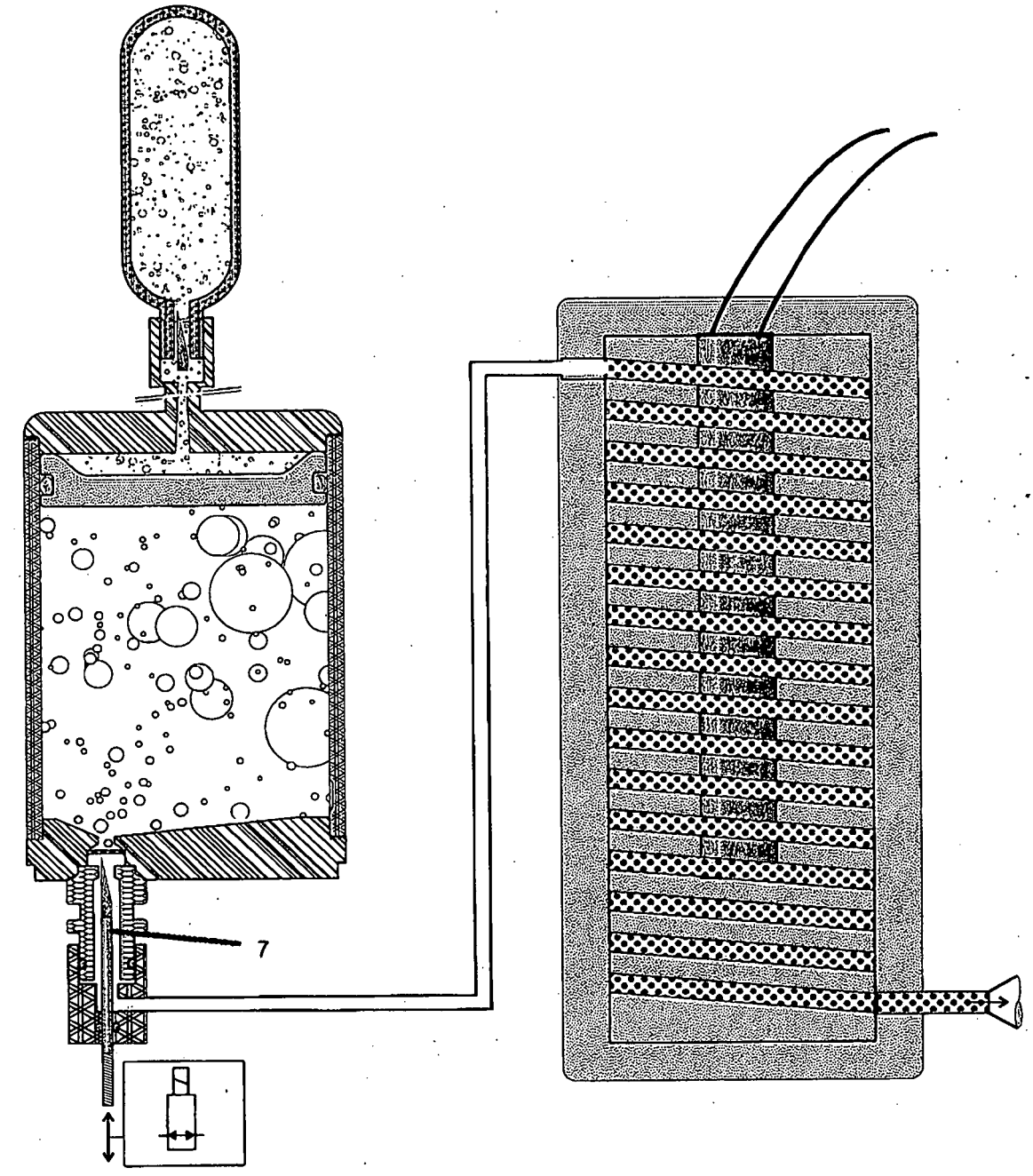
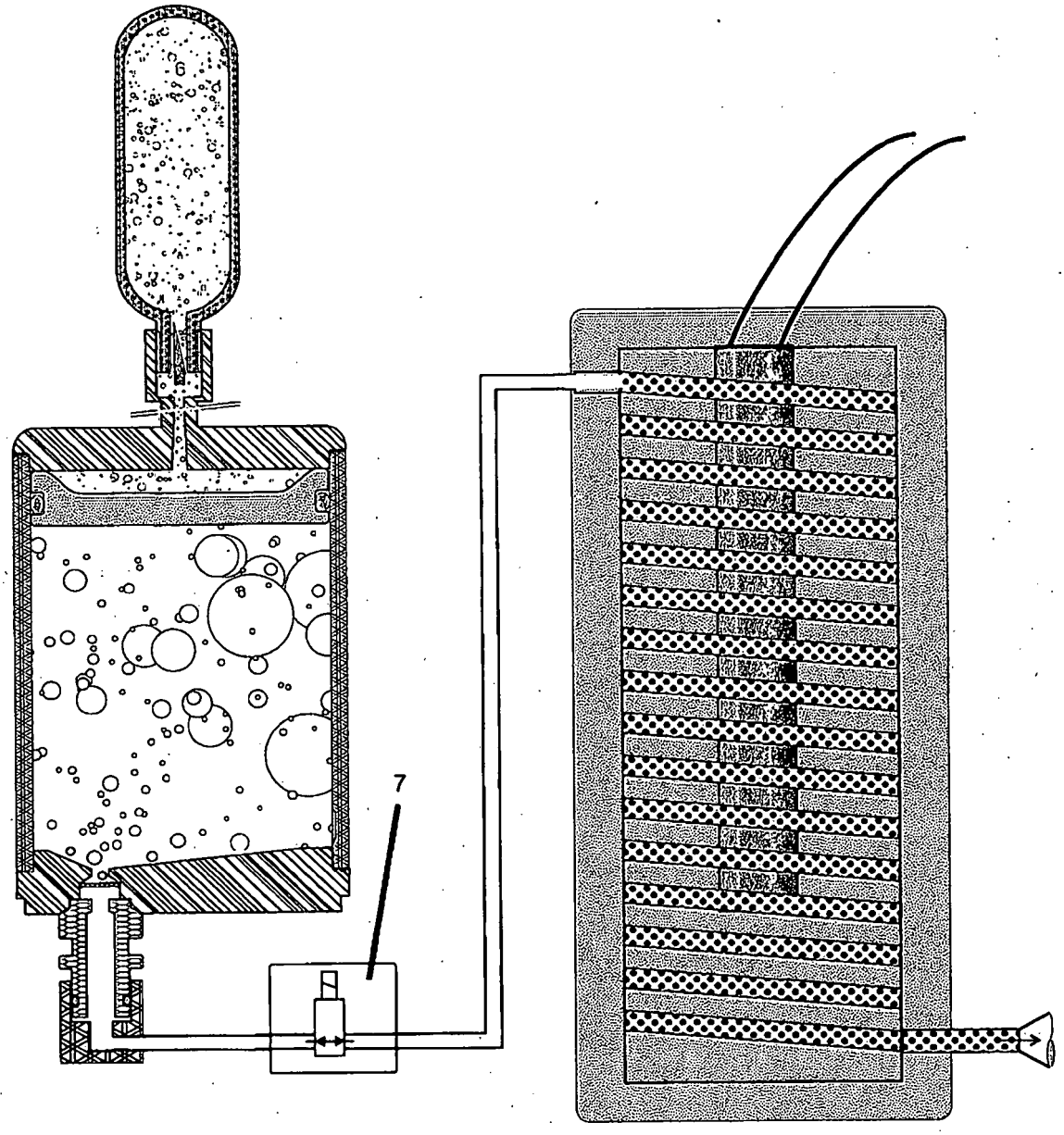


Fig. 7



REFERENCES CITED IN THE DESCRIPTION

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