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(54) Title: CLEANING SYSTEM BY MEANS OF ARTIFICIAL MIST

(57) Abstract: The present invention relates to a system, and the method of application thereof, for washing and decontamination comprising nebulizing means (8) of a mixture of at least one first gas and at least one first liquid, and pressurizing means (1) of said first gas, wherein said pressurizing means (1) are in fluid communication with a first pressure-regulating valve (3) and with a second pressure-regulating valve (4), the first pressure-regulating valve (3) being in fluid communication with a first pressurized tank (5) through first inlet means (31) of said first gas, the first pressurized tank (5) being configured to contain the first liquid, and comprising first outlet means (30) of said first liquid to the nebulizing means (8) through a first valve (6), at a first pressure that is greater than atmospheric pressure, and wherein the second pressure-regulating valve (4) is in fluid communication with said nebulizing means (8), and is configured to pressurize the gas at a second pressure that is greater than atmospheric pressure.



CLEANING SYSTEM BY MEANS OF ARTIFICIAL MIST

FIELD OF THE INVENTION

The present invention falls within the field of cleaning and
5 decontaminating air, or other gases or gas mixtures, of contaminants such as
chemical, biological, radiological or nuclear pollutants. It can also be applied to
the decontamination of surfaces or other objects.

STATE OF THE ART

10 Contamination consisting of small particles that float in the atmosphere is
highly detrimental to the health of the population. In particular, the presence of
particles having a diameter of less than 10 microns is strongly related with
respiratory diseases. Heating systems and diesel engines produce particles of
this size; (see, for example, Michael Allaby, "Fog, smog and Poisoned Rain",
15 Facts on File Inc., New York, 2003). Pollen and other allergens are also
classified within this range. Furthermore, the increased use of nanoparticles is a
cause for concern since there is no effective solution for the filtration or
elimination thereof.

It is known that natural mechanisms for removing particles from the
20 atmosphere are dry deposition or sedimentation and sweeping. The first of
these is caused by gravity simply by driving solid particles towards the ground
while the last mechanism occurs when the particles act as condensation nuclei
that generate water droplets, which eventually also fall to the ground. These
raindrops wash other particles and droplets as they fall.

25 However, these natural mechanisms that depend on very particular
weather conditions are often too slow for solving the daily problem in modern
cities given the high rate of particle production. Thus, there is a need in the
state of the art to look for systems for cleaning and decontaminating air or
surfaces.

30 Patent application EP17382293.3 filed on 22 May 2017, describes a
method for cleaning and decontaminating the air based on spraying mist with
devices such as those described in application EP17382233.9 dated 28 April
2017. Said device produces a jet of mist from the supply of a liquid, preferably
water or an aqueous solution, and air, both above atmospheric pressure.
35 Additionally, it has an inlet of a third component, preferably liquid, also under

pressure, for the simultaneous dispersion thereof in order to favor the solubility and/or the decomposition of the pollutants. Non-exclusive examples of the third component are hydrogen peroxide for biological disinfection or nano-structured TiO₂ microparticles for catalysis and/or adsorption of chemical agents. The advantage of the use of mists made up of micrometric-sized droplets as described in EP17382293.3 comes from the greater efficiency of these droplets in capturing polluting particles with respect to other sized droplets when falling due to gravity, in addition to the fact that both the amount of liquid used and the amount of waste generated, are minimized.

Although this system provides satisfactory results, it is still necessary to provide alternative or improved cleaning and decontaminating systems, making a more efficient use of resources.

BRIEF DESCRIPTION OF THE FIGURES

Figure 1 is a schematic representation of the Venturi effect.

Figure 2 describes a system according to the present invention.

Figure 3 describes a system according to the present invention according to one of the embodiments thereof including gas accumulating means (2) for the first gas.

Figure 4 describes a system according to the present invention according to one of the embodiments thereof including the use of a second liquid.

Figure 5 describes a system according to the present invention according to one of the embodiments thereof including several optional systems.

Figure 6 is a detailed view of the first pressurized tank (5) according to one of the embodiments of the invention.

Figure 7 is a schematic representation of the nozzle inserted in a duct thus enhancing the Venturi effect.

Figure 8 is a schematic representation of the system of the invention with housing.

SUMMARY OF THE INVENTION

Thus, the inventor of the present application is working on the decontamination of air and other gases by means of the use of nebulizers. To

this end, mist is created by means of mixtures of liquids and gases that are expelled at high pressures, thus creating mist with approximately micrometric sized droplets. In the search for more and more efficient systems, the researcher has found that it is not only important to provide adequate-sized droplets, and therefore a total pressure at which the appropriate mixture is expelled, but it is also essential that the relative pressure between the gaseous and liquid components be maintained stable during the operation time of the system. The researcher has discovered that small variations in the relative pressures of the different components can significantly affect that size distribution and the amount of droplets generated, and also fundamentally, the speed of the jet, which produces changes in the efficiency of cleaning and decontaminating. The researcher has discovered that maintaining stability in the pressures and, even more so, stability in the relationship between the pressures of the liquid and gaseous components is essential.

Thus, a first aspect of the invention (see Figure 2) is a washing and decontaminating system comprising nebulizing means (8) of a mixture of at least one first gas and at least one first liquid, and pressurizing means (1) of said first gas, wherein said pressurizing means (1) are in fluid communication with a first pressure-regulating valve (3) and with a second pressure-regulating valve (4),

the first pressure-regulating valve (3) being in fluid communication with a first pressurized tank (5) through first inlet means (31) of said first gas, the first pressurized tank (5) being configured to contain the first liquid, and comprising first outlet means (30) of said first liquid to the nebulizing means (8) through a first valve (6), at a first pressure that is greater than atmospheric pressure,

and wherein the second pressure-regulating valve (4) is in fluid communication with said nebulizing means (8), and is configured to pressurize the gas at a second pressure that is greater than atmospheric pressure.

In this way, the same gas (or mixture of gases), preferably air, serves on the one hand to directly feed the nebulizing means (8), and at the same time, the first liquid (or other liquids), the pressure being controlled independently in each case.

A second aspect of the invention is therefore a method for washing and decontaminating which comprises pressurizing a first gas by means of pressurizing means (1), which are in fluid communication with a first pressure-

regulating valve (3) and with a second pressure-regulating valve (4), such that

the first pressure-regulating valve (3) regulates the pressure of the first gas in a first pressurized tank (5) configured to contain a first liquid and comprising first outlet means (30) and first inlet means (31), such that said first liquid is in turn in fluid communication with nebulizing means (8) through a first valve (6), the first liquid being at a first pressure that is greater than atmospheric pressure,

and wherein the second pressure-regulating valve (4) regulates the pressure at which the first gas is fed to said nebulizing means (8), said first gas being at a second pressure that is greater than atmospheric pressure.

In this way, the regulation of the first pressure and the second pressure can be carried out independently by the first pressure-regulating valve (3) and by the second pressure-regulating valve (4), respectively. The pressure at which the first liquid and the first gas are fed to the nebulizing means (8) can be controlled precisely and independently, and they remain constant during the operation of the system.

The system and the method of the invention enable the efficiency of the decontamination to be improved by keeping the relative pressure of the components of the mixture propelled by the nozzle constant, since the use of the first pressure-regulating valve (3) and the second pressure-regulating valve (4) enables the adjustment of different pressures for each component of the nebulizer mixture.

Without serving as a limitation to the invention, the authors believe that propelling mist under pressure through a nozzle produces a beneficial effect that multiplies the effectiveness of the micrometric droplets in their function of cleaning through collision and entrapment of polluting particles by forming a cone that interacts with the surrounding air, suctioning it through the effect of speed (also called the Venturi effect) while at the same time producing a high velocity gradient at the edges and thus facilitating the collision of mist droplets with the particles that are cleaned from the air. The authors believe that the jet also generates turbulences and fluid dynamic instabilities such as Kelvin-Helmholtz instability. Both effects of the jet edge increase the effective cross-section of the liquid droplets in their collision action, as well as the collision rate, making the cleaning action of the jet edge even greater than that of mist deposition due to gravity. Thus, the importance of keeping the relative pressure

of the various components of the mixture stable has been surprising, especially when compared to a system that uses pumps to feed some of the components of the mixture. Therefore, the system of the invention also reduces the number of mechanic or propulsion elements to one or a plurality of gas compressors, without the need for pumps.

It is preferred that the mist produced forms a spiral jet that interacts with the air surrounding it. These particles in the air are then suctioned by the mist cone providing a large velocity gradient. As the mist cone widens micron-sized droplets of the first liquid (e.g. water) collide and aggregate with particles incoming with air. If the size of the droplets of the first liquid which are present in the mist are slightly bigger than the micron-size (e.g. between 2.5 μm and 20 μm), then both droplets of the first liquid and the air-borne particles can efficiently collide and aggregate because of the mist and the dirty air mix swirl created.

The system of the invention enables the stability of the supply of the gases and liquids used for generating the mist. In addition, it allows different pressures for each component to be independently selected, thus being able to adapt the size of the droplets in the mist and the quantity thereof. This provides the system of the invention with enormous flexibility for adapting the characteristics of the generated mist to different pollutants and situations. It also allows the storage of liquids or components for generating mist such that it is easier to control or prevent the spread of Legionellosis or other microorganisms. Another advantage of the invention is that it enables a portable assembly to be created and it is capable of being boarded on vehicles that can be moved to the site of the contamination. It also offers greater reliability by avoiding the use of a mechanical element prone to breakdowns, such as a pumping system.

DETAILED DESCRIPTION OF THE INVENTION

The present invention considers that the term "liquid" encompasses liquids the components of which are completely dissolved, but also liquids with only partially dissolved solutes as well as suspensions.

For reasons of economy, in all the embodiments of the present invention, it is preferable that the compressed gas be air.

The notations "first", "second", third", "fourth", "fifth", etc. are used throughout this document to refer to some of the elements of the invention. For

example, reference is made to a “first valve”, a “second valve”, etc. This notation does not imply any order or prevalence and is used exclusively to unequivocally label an element, and thus distinguish it from other similar elements. This notation, as described below in the different embodiments and
5 examples, enables there to be different combinations of similar elements, regardless of the nomenclature used. For example, one embodiment may include a first valve and a third valve without the need to have a second valve in said embodiment.

The present invention is described below making reference to the figures
10 of the invention by means of examples of specific non-limiting embodiments.

According to an embodiment (see Figure 3), the system of the invention comprises one or a plurality of compressors (1) that supply a first compressed gas, preferably compressed air, to gas accumulation means (2), which in turn supplies the compressed gas in a stable manner to a first pressure-regulating
15 valve (3) and to a second pressure-regulating valve (4). Said first pressure-regulating valve (3) supplies the compressed gas to a first pressurized tank (5), preferably through the upper part thereof. The pressurized liquid is expelled from the first pressurized tank (5) towards the nebulizing means (8) through the first valve (6). The second pressure-regulating valve (4), according to the
20 present invention, is in fluid communication with said nebulizing means (8), preferably through a third valve located in series with said second pressure-regulating valve (4), and is configured to pressurize the gas at a second pressure that is greater than atmospheric pressure. A second valve (13) is located between the first pressure-regulating valve (3) and the first pressurized
25 tank (5), which enables the passage of the first gas, as well as first non-return means (14), to be opened and closed. Thus, closing the first valve (6) and the second valve (13) enables isolating the first pressurized tank during the feeding of the first liquid. Similarly, a third valve (7) is located between the second pressure-regulating valve (4) and the nebulizing means (8), which enables the
30 passage of the first gas, as well as second non-return means (15), to be opened and closed.

The compression means (1) may encompass one or more compressors according to any of the embodiments of the invention. It is a design characteristic that the person skilled in the art can adjust according to the
35 characteristics of the available compressors and the needs of the system

(power, size, etc.).

The first pressurized tank (5) is preferably characterized for having feeding means of the first liquid such that the air supplied by the first pressure-regulating valve (3) enters through the upper part of said tank and pushes the first liquid making it flow towards the nebulizing means (8). Thus, it is preferable that, in any of the embodiments of the present invention, the first inlet means (31) of the first gas be located in the first pressurized tank (5) at a height that is higher than the first outlet means (30).

Said nebulizing means are preferably of the type described in European application EP17382233.9, the contents of which are included in their entirety as a reference. Therefore, preferably, said nozzle combines two or more substances introduced through at least a first inlet and a second inlet and sprays the resulting atomized droplets through an outlet, capable of optimizing the flow rate and the size of the droplets through a modular design based on exchangeable disc-shaped modules. When they are stacked in a hollow cylindrical casing made up of a first casing and a second casing, the plurality of modules make up a first mixing chamber and a second mixing chamber connected through a spiral module. Furthermore, when said stacking occurs, the first inlet is connected to the first mixing chamber, the outlet is connected to the second mixing chamber, and the second outlet may be connected to the first mixing chamber or to the second mixing chamber depending on the configuration selected by the user.

With reference to Figure 6, it is preferable that the feeding means comprise a first feed valve (9) and a first evacuation valve (12). Preferably, said first feed valve (9) is connected to the lower part of the first pressurized tank. This configuration makes it possible to fill the first pressurized tank (5) by opening the supply of the first liquid, for example, by using a pump (10) from a tank of the first liquid (11), or alternatively, from a supply line of the first liquid, such as, for example, a drinking water hose from a sanitary water network (not shown in the figure). Opening the evacuation valve (12), preferably connected to the upper part of the first pressurized tank (5), allows outlet of the gas during filling, thus relaxing the pressure necessary for the supply of the first liquid. In an advantageous embodiment, the system is provided with a second valve (13) located between the first pressure-regulating valve (3) and the first pressurized tank (5). Closing this second valve (13) allows the first pressurized tank (5) to

be made independent during the filling process. Once the filling is complete, the first feed valve (9) and the first evacuation valve (12) are closed, while the second valve (13) is opened, thus pressurizing the first pressurized tank (5) and leaving it ready for actuation by opening the first valve (6).

5 Preferably, any of the embodiments of the invention comprise first non-return means (14) in series with the first pressure-regulating valve (3), preferably at the outlet of the second valve (13), and/or second non-return means (15) in series with the second pressure-regulating valve (4), preferably at the outlet of the third valve (7). These non-return devices prevent backflow
10 from occurring at all times, this being especially important during system connection and disconnection, when there may be liquid pressure but not air pressure.

 Preferably, the system can also be provided with elements that facilitate the actuation and control thereof. Thus, for example, the system of the invention
15 may comprise first remote actuation means (18) in series with the first pressure-regulating valve (3), and/or second remote actuation means (16) in series with the second pressure-regulating valve (4), this actuation being, for example, but not exclusively, electric. Moreover, the system of the invention may comprise first means for measuring the flow rate (19), in series with the first pressure-
20 regulating valve (3), and second means for measuring the flow rate (17), in series with the second pressure-regulating valve (4). In this way, by keeping the first valve (6) and/or the third valve (7) open, the system will activate when opening the first remote actuation means (18) and the second remote actuation means (16). The first remote actuation means (18) and the second remote
25 actuation means (16) may be individual units, for example, solenoid valves, or they may be integrated with the first pressure-regulating valve (3) and the second pressure-regulating valve (4), respectively.

 The system of the invention can therefore provide at least one gas and at least one liquid to the nebulizing means (8). By way of example, a system
30 according to the present invention is described below, in which the nebulizing mixture also includes a second liquid (see Figure 4). According to this embodiment, the system includes a third pressure-regulating valve (23) in fluid communication with the second pressure-regulating valve (4). The third pressure-regulating valve (23) is in fluid communication with a second
35 pressurized tank (20) through second inlet means (33) of said first gas, the

second pressurized tank (20) being configured to contain a second liquid, and comprising second outlet means (34) of said second liquid towards the nebulizing means (8), through a fourth valve (21), at a third pressure that is higher than atmospheric pressure. In this configuration, the system may
5 comprise a fifth valve (24) that enables the flow of the first gas towards the nebulizing means (8) to be selectively interrupted. Alternatively, the second pressurized tank (20) may have filling means that enable it to be filled with the second liquid, which may be a suspension. Said second pressurized tank (20) may comprise second feeding means of the second liquid, which provide the
10 second liquid, while the third pressure-regulating valve (23) interrupts the passage of the pressurized gas when it is closed.

Given that on occasions the second liquid must be applied only for a short time and in relatively small quantities, for example, if it contains substances having catalytic properties, the second pressurized tank (20) may
15 be sufficiently small so that, together with the nebulizing means (8), and the valves (21), (23) and (24), they can make up an assembly capable of being transported by a man or a crane, provided that the pipes supplying the second liquid and the compressed gas are flexible. Said configuration may even comprise the first valve (6), provided that the means for supplying the first liquid
20 from the first pressurized tank (5) are flexible.

Another embodiment of the present invention is described with reference to Figure 5. According to this embodiment, the system comprises pressurizing means (1) of the first gas, which are in fluid communication with the gas accumulation means (2), from where the first gas is distributed at stable
25 pressure to the first pressure-regulating valve (3) and to the second pressure-regulating valve (4), the first pressure-regulating valve (3) being in fluid communication with a first pressurized tank (5) through first inlet means (31) of said first gas, the first pressurized tank (5) being configured for containing the first liquid, and comprising first outlet means (30) of said first liquid towards the
30 nebulizing means (8) through a first valve (6), at a first pressure that is higher than atmospheric pressure. According to this embodiment, a second valve (13) and first non-return means (14) are placed between the first pressure-regulating valve (3) and the first pressurized tank (5). Moreover, the first remote actuation means (18), as well as first means for measuring the flow rate (19), are located
35 between the first valve (6) and the first pressurized tank (5). The first inlet

means (31) of said first gas are located at a height that is higher than the first outlet means (30).

Furthermore, as shown in Figure 5, the compressed gas line comprises similar equipment. Thus, in line with the second pressure-regulating valve (4),
5 second remote actuation means (16), second means for measuring the flow rate (17) and a third valve (7) are located such that the pressure of the gas fed to the nebulizing means (8) is a second pressure that is higher than atmospheric pressure. Second non-return means (15) are located at the outlet of the third valve (7).

10 The embodiment shown in Figure 5 also shows a circuit for feeding a second liquid to the nebulizing means (8), including a third pressure-regulating valve (23) in fluid communication with the second pressure-regulating valve (4). The third pressure-regulating valve (23) is also in fluid communication with a second pressurized tank (20) through second inlet means (33) of said first gas,
15 the second pressurized tank (20) being configured to contain a second liquid, and comprising second outlet means (34) of said second liquid towards the nebulizing means (8), through a fourth valve (21), at a third pressure that is higher than atmospheric pressure. In this configuration, the system may comprise a fifth valve (24) that enables the flow of the first gas towards the
20 nebulizing means (8) to be selectively interrupted. Alternatively, the second pressurized tank (20) may have filling means that enable it to be filled with the second liquid, which may be a suspension. Said second pressurized tank (20) may comprise second feeding means of the second liquid, which provide the second liquid, while the third pressure-regulating valve (23) interrupts the
25 passage of the pressurized gas when it is closed.

Note that regardless of the number of gases and liquids for which it is configured, the system of the invention allows one or more of these elements of the mixture to be blocked as long as at least one gas and at least one liquid are fed to the nebulizing means (8). For example, in the event that the system is
30 configured to provide a first liquid, a second liquid and a first gas (for example the systems described in Figures 4 or 5) it is possible to block the supply of the second liquid so that the mixture fed to the nebulizing means (8) is exclusively comprised of the first liquid and the first gas.

The inlet and outlet means in the present invention are preferably
35 openings in the corresponding tank.

Applications

As mentioned above, the present invention describes a system for washing and decontaminating air, gases, ducts and/or surfaces by means of jets of pressurized mist. The system preferably comprises a plurality of nebulizing means (8), preferably nozzles. However, the system may also have other uses. For example, parallel connection of a plurality of nozzles can produce a mist jet barrier. Other geometries in the distribution of the nozzles can enable the air contained in an entire enclosure to be washed.

Another non-exclusive alternative consists in introducing the nebulizing means (8) into a wider duct (25), for example a tubular duct as shown in Figure 7, such that, through the Venturi effect, it sucks air from the back and propels it, along with the released mist, through the duct while cleaning it. This alternative is very useful for all kinds of ventilation ducts, for example, for a clean air supply or gas scrubbing system characterized by a nozzle that provides a jet of pressurized mist in a duct in the direction of forward flow.

In a non-exclusive alternative configuration, the system has a wall, preferably vertical, and at a certain distance from the nozzle, for collecting waste through the impact of the jet against the same.

A further application of the system described herein are cleaning towers comprising a structure (40) housing at least the nebulizing means (8) in its interior, configured to allow the circulation of air from and to the exterior so that the nebulizing means (8) are placed on a higher portion of the structure (40), and the contaminated air outside is suctioned through the top within the structure (40) by the venture effect, and interacts with the mist cone created by the nebulizing means (8), preferably forming a swirl, and exits already purified the bottom of the structure (40) (see Figure 8).

The energy used for this process can be electrical and therefore quite convenient for green energy with an estimated operation cost of just 0.0015 EURO/m³. This technology therefore provides a unique and effective tool for cleaning air in cities, improving air quality and decreasing respiratory diseases among population in large cities.

An exemplary configuration of these towers comprises a single nebulizing means (8) (e.g. nozzle) or two or more nebulizing means (8) pointing downwards within a grilled structure (40), for example a grilled cylindrical housing. The nebulizing means (8) are placed on a higher portion of

the grided structure, for example at 2-20 meters, e.g. 3 to 8 meters. Means can be added preventing noise propagation and reducing the liquid droplets propagation. Preferably, the system comprises means for recovering and recycling the first liquid (e.g. water) used in the process. Tests of these systems have reduced the PM10 (air-borne Particulate Matter having a particle size of 10 microns) concentration of inlet polluted air from 10,000 particles/m³, approximately equivalent to 4.14 µg/m³, to about 100 particles/m³, i.e. a PM10 of about 0.04 µg/m³. That is, 98.3% of the PM10 have been removed from air. In the case of PM5 and PM2.5 (air-borne Particulate Matter having a particle size of 5 and 2.5 microns, respectively) the result is even better with 99.96 % and 99.99% removed from air respectively.

A further implementation is the use of a plurality of units distributed along the border of the source of pollution –e.g. a highway-. In this case the system of the invention acts as a barrier preventing the dispersion of PM (Particulate Matter) beyond the barrier. If combined with an acoustic barrier, solar panels can be installed on top of the acoustic barrier; they could provide the power needed for the system, being a self-sufficient system independent of the electricity supply. An advantage of this “barrier” configuration is that it will act also as a barrier in case of a toxic cloud that may be caused by a hazardous freight transport accident. Outdoor tests demonstrated a barrier effect reducing the diffusion of PM10 from 1395 particles/m³ to just 35 particles/m³ - corresponding to 97.5 % of reduction. In the same case the results for PM2.5 were of 95.9%.

In an alternative embodiment the system can be made portable.

In short, the system of the invention enables the cleaning of air indoors, outdoors, in ventilation or gas ducts, chimneys etc. with a small amount of liquid.

CLAUSES

CLAUSE 1: A washing and decontaminating system comprising nebulizing means (8) for a mixture of at least one first gas and at least one first liquid, and pressurizing means (1) of said first gas, wherein said pressurizing means (1) are in fluid communication with a first pressure-regulating valve (3) and with a second pressure-regulating valve (4),

the first pressure-regulating valve (3) being in fluid communication with a

first pressurized tank (5) through first inlet means (31) of said first gas, the first pressurized tank (5) being configured to contain the first liquid, and comprising first outlet means (30) of said first liquid to the nebulizing means (8) through a first valve (6), at a first pressure that is higher than atmospheric pressure,

5 and wherein the second pressure-regulating valve (4) is in fluid communication with said nebulizing means (8), and is configured to pressurize the gas at a second pressure that is greater than atmospheric pressure.

10 CLAUSE 2: The system according to clause 1, characterized in that said first inlet means (31) of the first gas are located in the first pressurized tank (5) at a height that is higher than the first outlet means (30).

15 CLAUSE 3: The system according to any one of the preceding clauses, characterized in that it comprises gas accumulation means (2) located between the pressurizing means (1) of the first gas, and the first pressure-regulating valve (3) and the second pressure-regulating valve (4).

20 CLAUSE 4: The system according to any one of the preceding clauses, characterized in that the first pressurized tank (5) comprises means for feeding said first liquid.

25 CLAUSE 5: The system according to any one of the preceding clauses, characterized in that it comprises a second valve (13) located between the first pressure-regulating valve (3) and the first pressurized tank (5).

30 CLAUSE 6: The system according to any one of the preceding clauses, characterized in that it comprises a third valve (7) located between the second pressure-regulating valve (4) and the nebulizing means (8).

 CLAUSE 7: The system according to any one of the preceding clauses, characterized in that it comprises first remote actuating means (18) in series with the first pressure-regulating valve (3).

35 CLAUSE 8: The system according to any one of the preceding clauses,

characterized in that it comprises second remote actuating means **(16)** in series with the second pressure-regulating valve **(4)**.

5 CLAUSE 9: The system according to any one of the preceding clauses, characterized in that the first pressurized tank **(5)** comprises first feeding means of said first liquid.

10 CLAUSE 10: The system according to clause 9, characterized in that said first feeding means comprise a first feed valve **(9)** and a first evacuation valve **(12)**.

CLAUSE 11: The system according to any one of the preceding clauses, characterized in that it comprises first non-return means **(14)** in series with the first pressure-regulating valve **(3)**.

15 CLAUSE 12: The system according to any one of the preceding clauses, characterized in that it comprises second non-return means **(15)** in series with the second pressure-regulating valve **(4)**.

20 CLAUSE 13: The system according to any one of the preceding clauses, characterized in that it comprises a third pressure-regulating valve **(23)** connected in series with the second pressure-regulating valve **(4)**.

25 CLAUSE 14: The system according to clause 13, characterized in that the third pressure-regulating valve **(23)** is in fluid communication with a second pressurized tank **(20)** through second inlet means **(33)** of said first gas, the second pressurized tank **(20)** being configured to contain a second liquid, and comprising second outlet means **(34)** of said second liquid towards the nebulizing means **(8)**, through a fourth valve **(21)**, at a third pressure that is higher than atmospheric pressure.

30 CLAUSE 15: The system according to any one of clauses 13 or 14, characterized in that before the third pressure-regulating valve **(23)** it comprises a fifth valve **(24)** that enables the flow of the first gas towards the nebulizing means **(8)** to be selectively interrupted.

35

CLAUSE 16: The system according to any one of clauses 14 or 15, characterized in that the second pressurized tank (20) comprises second means for feeding the second liquid.

5 CLAUSE 17: The system according to any one of the preceding clauses, characterized in that it comprises first means for measuring the flow rate (19), in series with the first pressure-regulating valve (3), and second means for measuring the flow rate (17), in series with the second pressure-regulating valve (4).

10

CLAUSE 18: The system according to any one of the preceding clauses, characterized in that it has a pressure of between 8 bar and 20 bar.

15 CLAUSE 19: A method for washing and decontaminating, which comprises pressurizing a first gas by means of pressurizing means (1), which are in fluid communication with a first pressure-regulating valve (3) and with a second pressure-regulating valve (4), such that

the first pressure-regulating valve (3) regulates the pressure of the first gas in a first pressurized tank (5) configured to contain a first liquid and comprising first outlet means (30) and first inlet means (31), such that said first liquid is in turn in fluid communication with nebulizing means (8) through a first valve (6), the first liquid being at a first pressure that is greater than atmospheric pressure,

20 and wherein the second pressure-regulating valve (4) regulates the pressure at which the first gas is fed to said nebulizing means (8), said first gas being at a second pressure that is greater than atmospheric pressure.

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CLAIMS

1. A washing and decontaminating system comprising nebulizing means (8) for a mixture of at least one first gas and at least one first liquid, and
5 pressurizing means (1) of said first gas, wherein said pressurizing means (1) are in fluid communication with a first pressure-regulating valve (3) and with a second pressure-regulating valve (4),
the first pressure-regulating valve (3) being in fluid communication with a first pressurized tank (5) through first inlet means (31) of said first gas, the first
10 pressurized tank (5) being configured to contain the first liquid, and comprising first outlet means (30) of said first liquid to the nebulizing means (8) through a first valve (6), at a first pressure that is greater than atmospheric pressure,
and wherein the second pressure-regulating valve (4) is in fluid communication with said nebulizing means (8), and is configured to pressurize
15 the gas at a second pressure that is greater than atmospheric pressure.
2. The system according to claim 1, characterized in that said first inlet means (31) of the first gas are located in the first pressurized tank (5) at a height that is higher than the first outlet means (30).
- 20 3. The system according to any one of the preceding claims, characterized in that it comprises gas accumulation means (2) located between
the pressurizing means (1) of the first gas, and
the first pressure-regulating valve (3) and the second pressure-regulating
25 valve (4).
4. The system according to any one of the preceding claims, characterized in that the first pressurized tank (5) comprises means for feeding said first liquid.
- 30 5. The system according to any one of the preceding claims, characterized in that it comprises a second valve (13) located between the first pressure-regulating valve (3) and the first pressurized tank (5).
- 35 6. The system according to any one of the preceding claims, characterized

in that it comprises a third valve (7) located between the second pressure-regulating valve (4) and the nebulizing means (8).

7. The system according to any one of the preceding claims, characterized
5 in that it comprises first remote actuating means (18) in series with the first pressure-regulating valve (3).

8. The system according to any one of the preceding claims, characterized
10 in that it comprises second remote actuation means (16) in series with the second pressure-regulating valve (4).

9. The system according to any one of the preceding claims, characterized
15 in that the first pressurized tank (5) comprises first feeding means of said first liquid.

10. The system according to claim 9, characterized in that said first feeding means comprise a first feed valve (9) and a first evacuation valve (12).

11. The system according to any one of the preceding claims, characterized
20 in that it comprises first non-return means (14) in series with the first pressure-regulating valve (3).

12. The system according to any one of the preceding claims, characterized
25 in that it comprises second non-return means (15) in series with the second pressure-regulating valve (4).

13. The system according to any one of the preceding claims, characterized
30 in that it comprises a third pressure-regulating valve (23) connected in series with the second pressure-regulating valve (4).

14. The system according to claim 13, characterized in that the third pressure-regulating valve (23) is in fluid communication with a second pressurized tank (20) through second inlet means (33) of said first gas, the second pressurized tank (20) being configured to contain a second liquid, and
35 comprising second outlet means (34) of said second liquid towards the

nebulizing means (8), through a fourth valve (21), at a third pressure that is higher than atmospheric pressure.

15. The system according to any one of claims 13 or 14, characterized in
5 that before the third pressure-regulating valve (23) it comprises a fifth valve (24) that enables the flow of the first gas towards the nebulizing means (8) to be selectively interrupted.

16. The system according to any one of claims 14 or 15, characterized in
10 that the second pressurized tank (20) comprises second means for feeding the second liquid.

17. The system according to any one of the preceding claims, characterized in that it comprises first means for measuring the flow rate (19), in series with
15 the first pressure-regulating valve (3), and second means for measuring the flow rate (17), in series with the second pressure-regulating valve (4).

18. The system according to any one of the preceding claims, characterized in that it has a pressure of between 8 bar and 20 bar.
20

19. A method for washing and decontaminating which comprises pressurizing a first gas by means of pressurizing means (1), which are in fluid communication with a first pressure-regulating valve (3) and with a second pressure-regulating valve (4), such that

25 the first pressure-regulating valve (3) regulates the pressure of the first gas in a first pressurized tank (5) configured to contain a first liquid and comprising first outlet means (30) and first inlet means (31), such that said first liquid is in turn in fluid communication with nebulizing means (8) through a first valve (6), the first liquid being at a first pressure that is greater than atmospheric
30 pressure,

and wherein the second pressure-regulating valve (4) regulates the pressure at which the first gas is fed to said nebulizing means (8), said first gas being at a second pressure that is greater than atmospheric pressure.

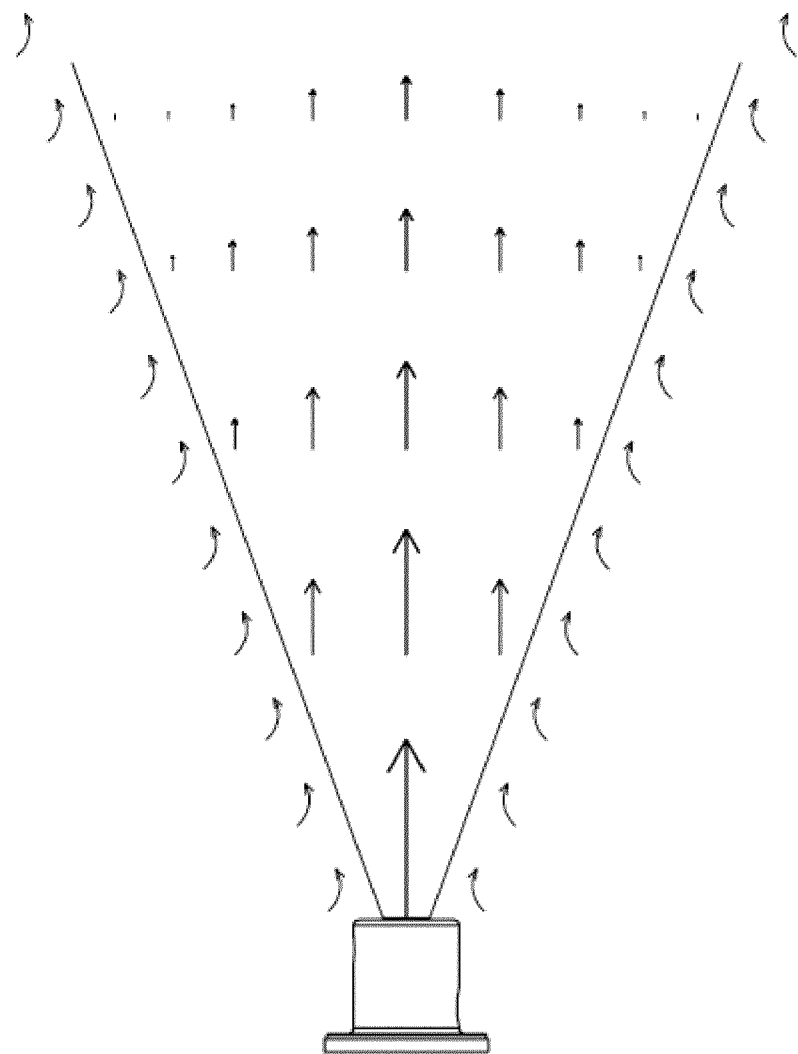


FIGURE 1

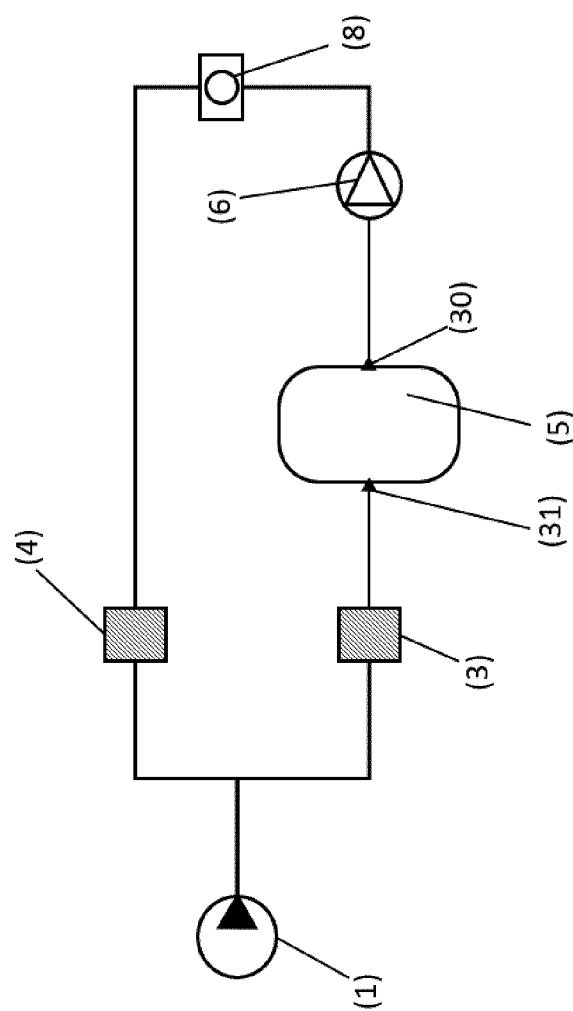


FIGURE 2

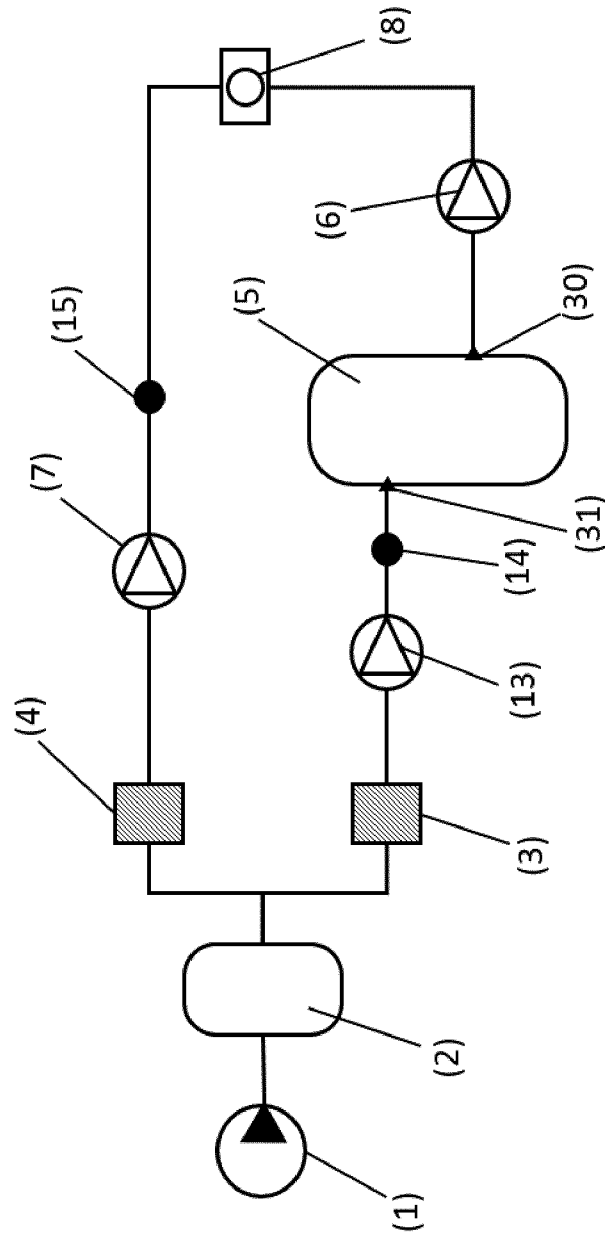


FIGURE 3

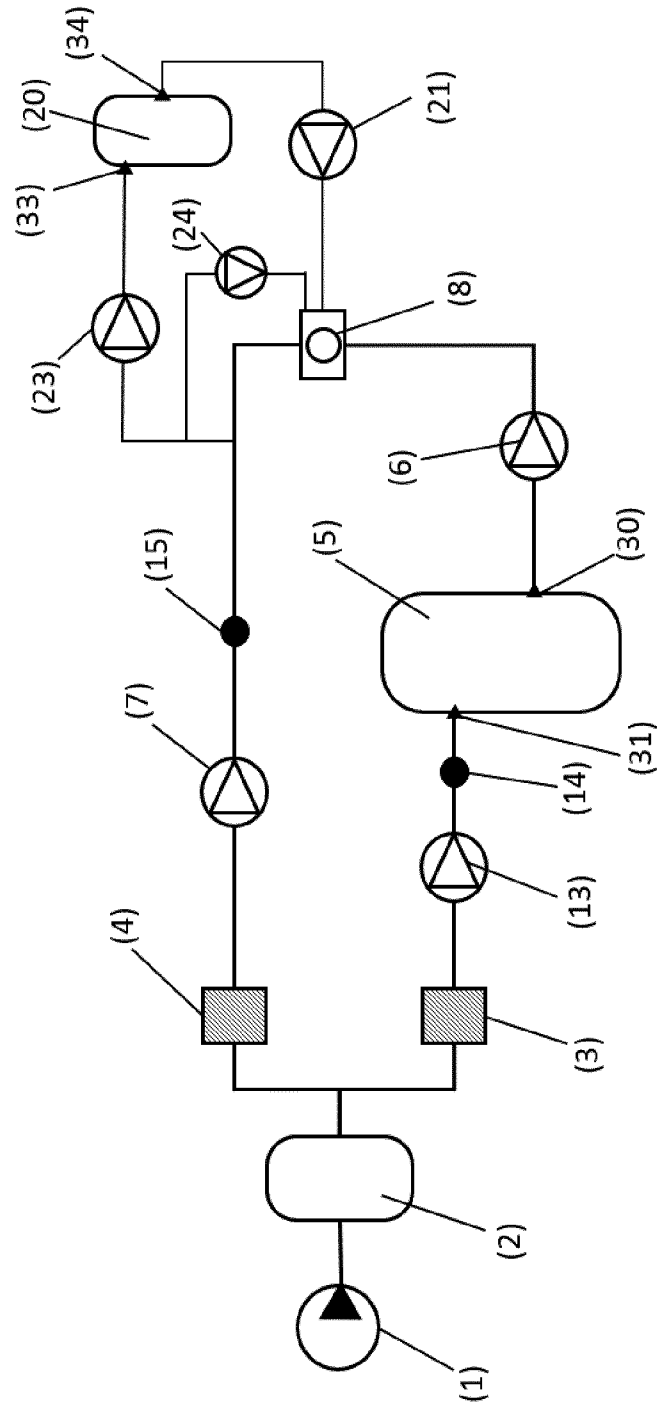


FIGURE 4

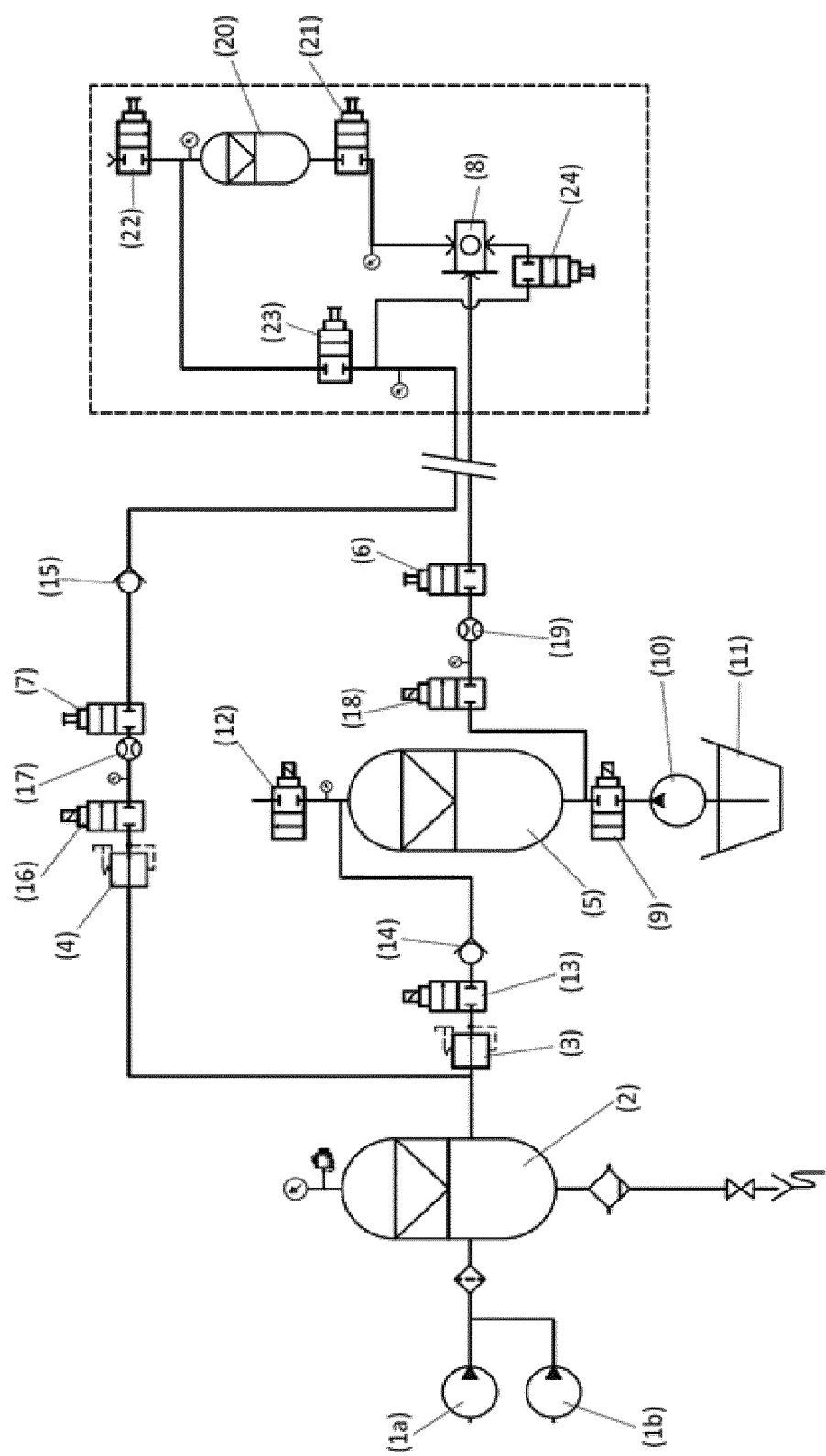


FIGURE 5

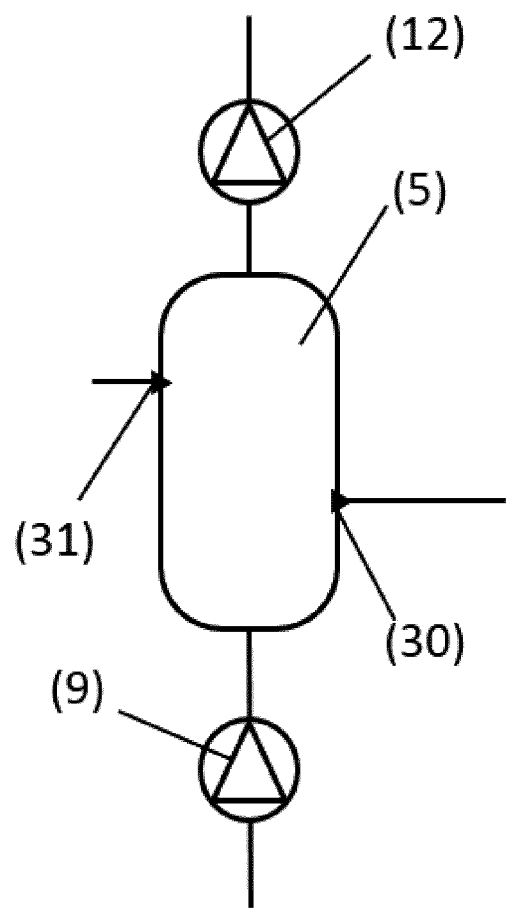


FIGURE 6

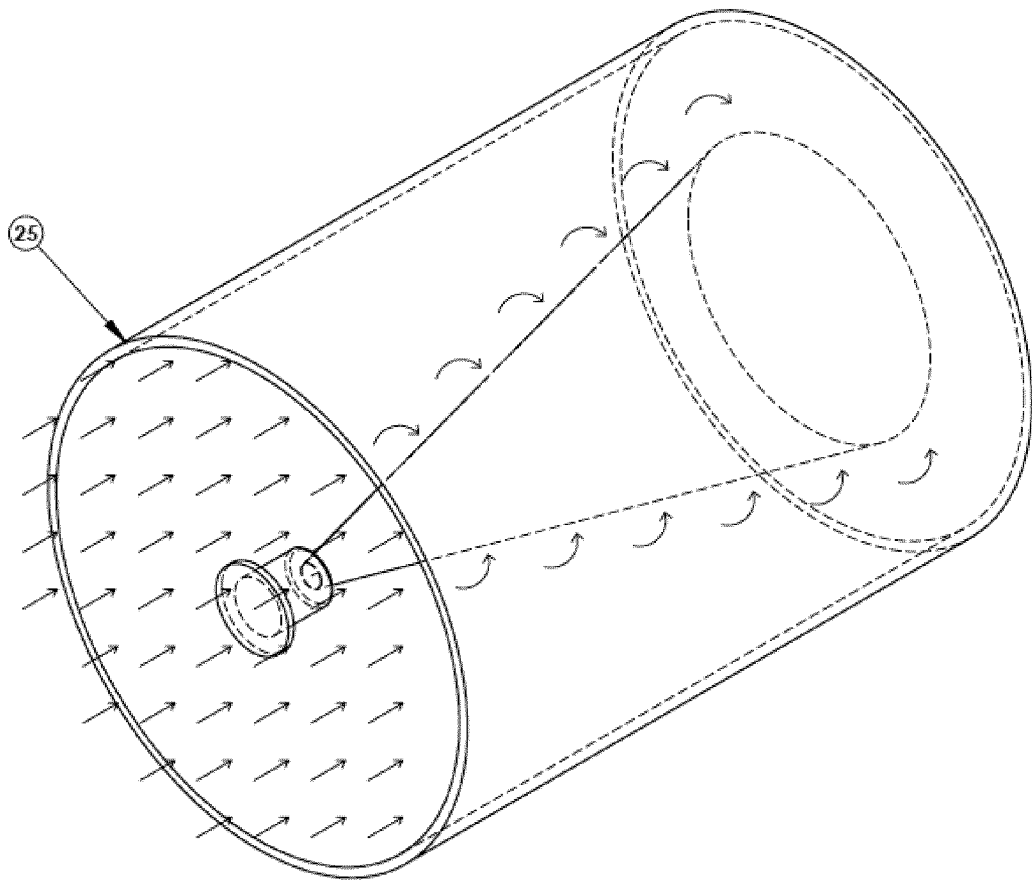


FIGURE 7

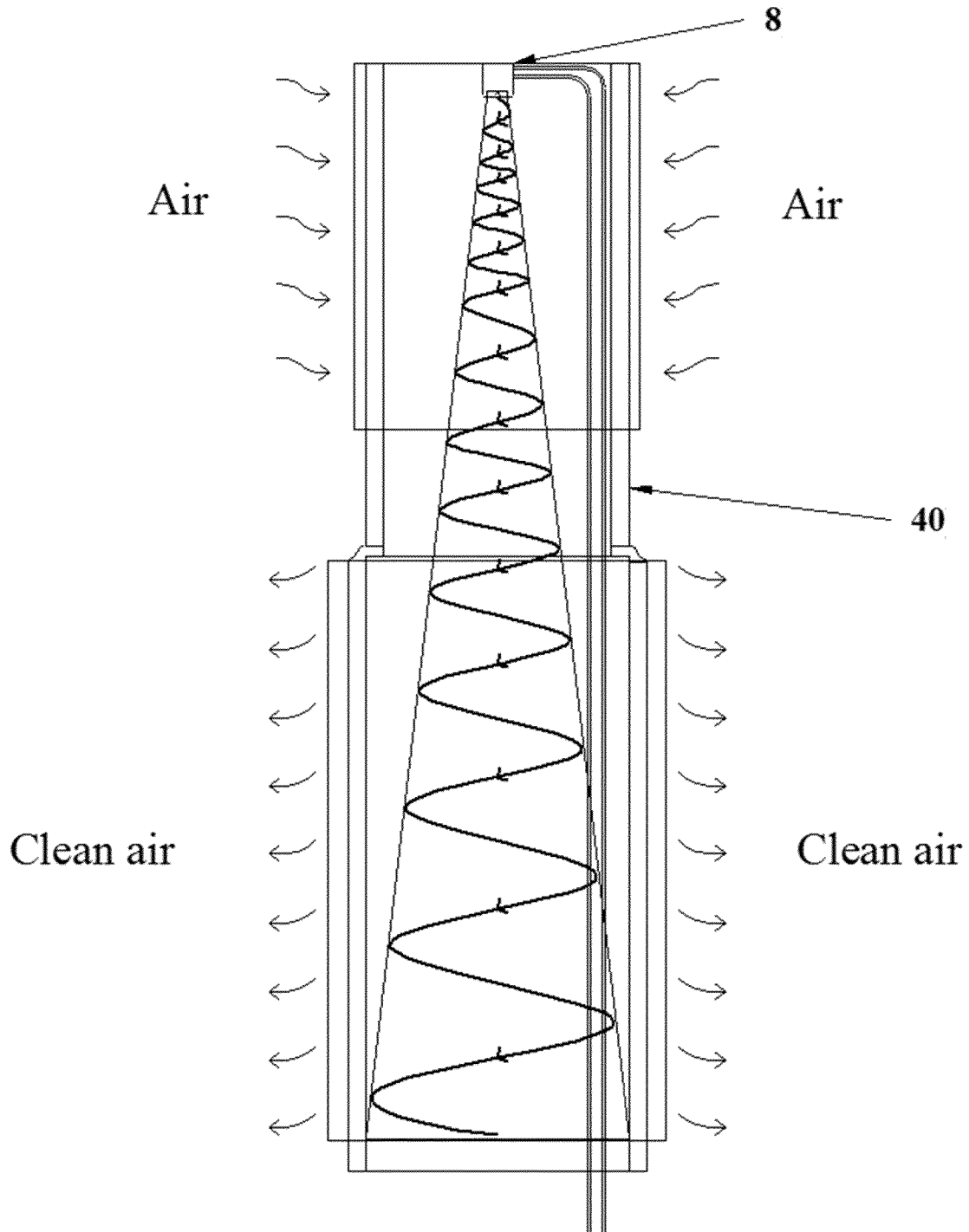


FIGURE 8