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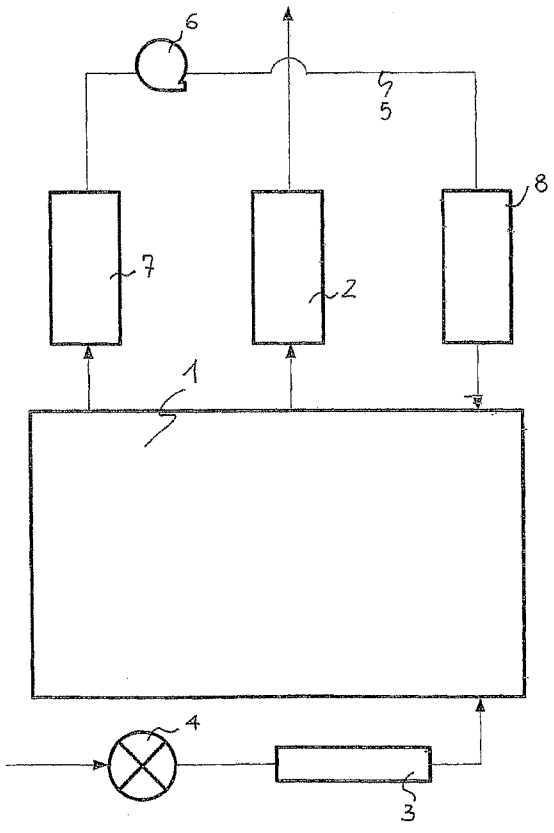
(54) Title: PROCESS AND APPARATUS FOR DISINFECTION-STERILIZATION WITH GASEOUS OZONE



(57) Abstract: The present invention refers to a process of disinfection- sterilisation through exposure to gaseous ozone and to a related apparatus for the actuation of the process comprising: an electric ozone generator (3); means (4) suitable for forcing a flow of air through the ozone generator; a treatment chamber (1) having an inlet connected to the outlet of the ozone generator and a vent outlet; a first filter (2) housed in the vent outlet containing a filtering material suitable for abating and/ or reconverting the ozone into oxygen, for venting into the atmosphere a flow of air free of ozone of flow rate substantially equal to that forced into the chamber; a conduit (5) outside the chamber, wherein at least one fan is housed through which the gaseous content inside the chamber is circulated; a second and a third filter (7,8) both containing a filtering material suitable for abating and/ or reconverting the ozone contained in the circulating gaseous flow into oxygen, which are housed in the conduit respectively upstream and downstream of the fan; means for separately activating and stopping the electric ozone generator (3) and the circulation fan (6).

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Title: Process and apparatus for disinfection-sterilisation with gaseous ozone.

DESCRIPTION

Field of application

The present invention refers, in its most general aspect, to the technical field of disinfection-sterilisation by means of exposure to gaseous ozone.

More in particular, the invention relates to a process of disinfection-sterilisation which uses ozonised air, in the sense that at least one aliquot of the diatomic oxygen present in a flow of ambient air is transformed into ozone (i.e. from O_2 to O_3) so that the latter can exert a biocide action.

The invention also relates to an apparatus for the actuation of the aforesaid process.

Prior Art

The biocide properties of ozone are known: ozone gas is in fact a strong oxidant and in contact with the cells produces a breach in the cell membranes, breaking them and consequently exerting a similar oxidising and devastating action within the cytoplasm, causing the target organism to die.

For this reason, ozone's toxicity is well known, both by contact (weak toxicity) and by inhalation (severe toxicity), owing to the fact that ozone does not discriminate among "good" and "bad" organisms.

This imposes strict limits of concentrations in the air that is inhaled, that are set by national and over national legislations.

Processes that employ ozone for disinfecting or sterilising chirurgical tools and other implements are known and involve the immersion of the object to be treated in water in which ozone gas is dissolved, at atmospheric pressure or superatmospheric pressure.

These processes have showed clear drawbacks including that related to the neutralisation of residual ozone that could easily be released in the atmosphere and inhaled, as well as that of a reduced effectiveness of the

treatment itself due to the presence of corpuscles in the water solution, which interact with the ozone and "divert" the gas limiting its action of disinfection-sterilisation, for example of surgical or dental tools and implements.

With regard to the first of the aforesaid drawbacks, it should be noted that such drawback occurs at the opening, for example, of a tub in which the hygienising treatment of solid objects has been carry out by immersion in ozone-saturated water, both at atmospheric pressure and, even more so, at superatmospheric pressure.

To increase the concentration of ozone available for the disinfection-sterilisation, the prior art has made available processes which employ a flow of ozonised air obtained by means of an electrostatic generator.

Crossing one such generator, a flow of ambient air, i.e. a mixture containing essentially diatomic oxygen and diatomic nitrogen, is converted into a flow of ozonised air comprising a high concentration of ozone, orders of magnitude higher than the concentration which ozone reaches when dissolved in water.

In fact, given that a good generator can convert nearly all of the oxygen (diatomic oxygen O_2) present in the ambient air into ozone (triatomic oxygen O_3), and the percentage of oxygen present in the air being about 20% by weight, it is easily understood how very high concentrations of ozone can be reached.

Nevertheless, in such processes, although there is an improved biocide action attained by virtue of a greater ozone concentration, the problem of an effective neutralisation of the residual ozone remains substantially unsolved, in particular without comprising the sterility of the objects which have been subjected to disinfection-sterilisation treatment.

It should be noted, for a disinfection-sterilisation process which occurs for example in a treatment chamber, that even a minimal insertion of organic material (thus also of ambient air, since it comprises impurities of organic nature) inside the treatment chamber could nullify the attained sterilisation.

The ozone is also heavier than air, that is of the gases that compose the ambient air mixture, which essentially comprise diatomic nitrogen and diatomic oxygen, and therefore the ozone tends to stagnate on the bottom of a confined space in which it is introduced.

Moreover, it should also be considered that in processes of the aforesaid type in which the disinfection-sterilisation is carried out in a closed system, it is necessary to resort to a periodic exchange of the air contained, for example, in the treatment chamber, so to restore the oxygen content consumed in oxidative reactions.

Therefore, the processes for disinfection-sterilisation of objects by means of exposure to gaseous ozone made available by the prior art have encountered drawbacks which remain unsolved to the present day, due either to an unsatisfactory disinfection-sterilisation action, or to an unacceptable dispersion in the air of residual ozone, necessary in order to safely access the confined space where the disinfection-sterilisation treatment was carried out, and also to the risk of recontamination of the hygienised material which is present following the removal and/or abatement of the residue ozone.

Having verified this, the Applicant has carried out preliminary experimentation which has confirmed the outstanding effectiveness of ozonised air's bactericide, fungicide, virustatic, viricide and sporicide action, related to the ozone concentration in the atmosphere inside a treatment chamber and to the time that the objects to be disinfected-sterilised remain in contact with the ozonised air.

Having confirmed the biocide effectiveness of the ozonised air in the above-described sense, the object of the present invention was to make available a process of disinfection-sterilisation of solid objects and/or material of variable nature by means of exposure to gaseous ozone, capable of overcoming the drawbacks mentioned above with reference to the prior art.

Summary of the invention

In brief, the present invention makes available a process of the aforesaid type, and an apparatus for actuating such process, capable of making a

satisfactory or rather total disinfection-sterilisation of the objects to be hygienised which is at the same time capable of ensuring an absolute safety of use and is moreover economically advantageous.

With safety of use it is intended here that the process according to the present invention prevents any dispersion or introduction of ozone into the atmosphere, both during and at the end of the process, as the substantial absence of residual ozone is ensured in the space where the disinfection-sterilisation treatment was carried out, and the contents of such space remain hygienised even after the removal and/or total abatement of the residual ozone.

In the context of certain embodiments, the present invention makes available a process of disinfection-sterilisation by means of exposure to gaseous ozone by means of a non-pressurised confinement apparatus, comprising the steps of:

forcing an air flow through an electric generator, converting into ozone at least part of the oxygen contained in the air flow with the obtainment of a flow of ozonised air;

conveying said flow of ozonised air exiting said generator into a treatment chamber until a predetermined concentration of ozone is reached in said chamber, said predetermined ozone concentration being maintained in said chamber for a predetermined time period with disinfection-sterilisation of the contents therein, while a volume of air free of ozone, essentially corresponding to the supersaturation volume of conveyed ozonised air, is vented through a vent opening connected to a first abatement and/or reconversion filter of the ozone;

stopping said flow of ozonised air conveyed in said chamber and making the gaseous mixture contained inside the chamber circulate through an external conduit by means of a circulation fan housed in said external conduit, abating and/or reconverting the ozone present in said gaseous mixture into oxygen by means of a second and a third filter of abatement and/or reconversion of ozone into oxygen, said second and third filter being respectively positioned upstream and downstream of said fan, in which said circulation is carried out for a period of time sufficient to deplete the ozone content of said gaseous mixture.

In the context of other embodiments, the present invention makes available an apparatus for actuating the aforesaid process, comprising

an electric generator of ozone having an inlet and an outlet for an air flow, at least part of the oxygen contained in the inlet air flow being converted into ozone in the outlet air flow;

means suitable for forcing an air flow through said ozone generator;

a treatment chamber having an inlet connected to the outlet of the ozone generator and a vent outlet;

a first filter housed in said vent outlet, containing a filtering material suitable for abating and/or reconverting the ozone into oxygen, for venting into the atmosphere a flow of air free of ozone which is substantially equal to that forced into said chamber;

a conduit outside said chamber in which at least one fan is housed, through which the gaseous content inside said chamber is circulated;

a second and a third filter, both containing a filtering material suitable for abating and/or reconverting the ozone contained in the circulating gaseous flow into oxygen, said second and third filter being housed in said conduit respectively upstream and downstream of said fan;

means for separately activating and stopping said electric generator of ozone and said circulation fan.

Preferably, the present invention also provides means suitable for detecting the aforesaid predetermined concentration of ozone (effective concentration) directly interacting with the aforesaid treatment chamber, which can be one or more of the following: a biological indicator of disinfection-sterilisation, an electronic meter of ozone concentration, a chemical detector of ozone concentration.

Still preferably, the aforesaid means suitable for detecting the concentration of ozone can be provided in direct contact with the atmosphere inside the treatment chamber, in the sense of being internally arranged therein, preferably at an upper portion of the chamber, or they can be positioned in a housing outside the treatment chamber, insulated

from the outside environment and in fluid communication with the chamber itself.

According to the invention, it is moreover possible to provide means suitable for detecting the aforesaid ozone concentration both inside and outside the treatment chamber.

It is important that the aforesaid means suitable for detecting the predetermined concentration of ozone are visible from outside the treatment chamber even when positioned therein, and that they are easily accessible from outside the chamber when they consist, for example, of a chromatic indicator (chemical detector) supported on a suitable strip which changes colour when a predetermined ozone concentration is reached, and which is therefore detachable from the apparatus in order to be substituted after use, as will be clearer in the following description.

Essentially, the apparatus according to the present invention allows to carry out the present process in a continuous manner, or for a theoretically unlimited time while ensuring an absence of emissions and dispersions of ozone in the environment and an exceptional safety.

Further characteristics and advantages of the present invention will be clearer from the detailed description, accompanied by several embodiments of an apparatus for disinfection-sterilisation by biocide action of gaseous ozone according to the invention, made here below with reference to the attached drawings, provided as illustrative and non-limiting.

Brief description of the drawings

In such drawings:

Figure 1 is a functional diagram of an apparatus for disinfection-sterilisation of objects by means of exposure to gaseous ozone, inserted inside a suitable treatment chamber according to the first embodiment of the invention.

Figure 2 is a functional diagram of the apparatus for sterilisation of figure 1 according to an alternative embodiment of the invention.

Figure 3 is a functional diagram of the apparatus for sterilisation of figure 1 according to a further alternative embodiment of the invention.

Detailed description of the invention

With reference to the embodiment illustrated in figure 1, an apparatus for disinfection-sterilisation of objects by means of exposure to gaseous ozone comprises a treatment chamber indicated in its entirety with 1 (disinfection-sterilisation chamber) equipped respectively with an inlet opening of an ozonised air flow and a vent opening of a respective air flow free of ozone.

The treatment chamber 1 is moreover accessible by means of a reclosable cover or shutter, not shown in the figures, through which the objects (or solid material) to be disinfected-sterilised are internally arranged.

At the aforesaid vent opening of the chamber 1, the apparatus according to the present invention comprises a first filter 2 containing material suitable for abating the ozone content by a chemical oxidation reaction of the same filtering material and/or by catalytic reconversion of the ozone into oxygen, so that the gaseous mixture moving in such first filter 2 leaves the treatment chamber 1 with a nearly zero ozone concentration value.

The disinfection-sterilisation apparatus moreover comprises an electrical ozone generator 3 connected with the chamber 1, means suitable for forcing a flow of air through the ozone generator 3 which are indicated overall with 4 and a circulation conduit 5 outside the chamber 1, which makes a closed path exiting from and entering into the same chamber 1, and which makes a non-pressurised confinement space of the ozone with the treatment chamber 1.

The apparatus according to the invention is also equipped along the circulation conduit 5 and inside it with at least one fan 6 and at least two other filters entirely similar to the first above-considered filter 2, respectively corresponding to a second filter 7 arranged upstream of the fan 6 and a third filter 8 arranged downstream of the fan 6.

In accordance with two alternative embodiments of the invention

illustrated in figures 2 and 3, the present apparatus also comprises means suitable for detecting a predetermined concentration of ozone (effective concentration) reached inside the chamber 1, which are directly interacting with the treatment chamber and can be housed inside the chamber 1 as shown in figure 2, or outside the chamber 1 as illustrated in figure 3, or housed both inside and outside the chamber 1, the latter embodiment not shown in the figures.

In particular, such means suitable for detecting an effective concentration of ozone, here also defined as detection means, can consist of a biological indicator 10 of disinfection-sterilisation and/or of an electronic meter 11 of ozone concentration and/or of a chemical indicator 12 of ozone concentration, which can be provided in the present apparatus individually, in pairs or all three at the same time.

It should be said that whatever the size of the treatment chamber 1, in order to obtain a reliable disinfection-sterilisation (hygienisation), the treatment itself must be conducted at a so-called effective ozone concentration, which must be maintained for a time sufficient to perform and complete a biocide action.

The presence of the aforesaid detection means therefore permit to verify, in the treatment chamber 1, if the ozone concentration has reached this effective value.

As described above, the means suitable for detecting the effective concentration of ozone can be arranged inside or outside the treatment chamber 1.

In the first of the aforesaid cases, such detection means are preferably housed at an upper portion of the chamber 1, since the saturation with ozone occurs from the bottom towards the top, so that one such positioning of the means suitable for detecting the concentration of ozone permits to verify the actual attainment of the effective concentration in the space in which the disinfection-sterilisation occurs, hence also in the most inaccessible regions of the treatment chamber.

Advantageously, the detection means can moreover be closed in a suitable housing inside the chamber 1, placed in fluid communication with the

same chamber 1, for example by means of holes, as is illustrated in the example of figure 2 in which a housing inside the chamber 1 is schematised in its entirety with 13.

Preferably, such housing 13 is made so to be directly accessible from outside the chamber 1, for example by means of a shutter, so that also the detection means arranged therein can be easily accessible from outside the chamber 1 for a possible repair, maintenance or substitution, as will be clearer from the following description.

In the second of the two cases, on the other hand, that is, when the detection means are arranged outside the chamber 1, a housing 13a is always provided, closed and sealed with respect to the outside environment but in fluid communication with the treatment chamber 1, for example by means of a conduit or connection tube, in which detection means are arranged as indicated in figure 3.

In this case, the treatment chamber 1, the recirculation conduit 5, the external housing 13a of the detection means and the connection tube constitute an isobaric and non-pressurised confinement space of the ozone.

In accordance with the invention, as biological indicator 10 of disinfection-sterilisation, spores are advantageously employed which are innocuous for human beings and animals in general, for example spores comprising the type Geobacillus Stearothermophilus and/or similar bacilli, supported on suitable detachable strips, which therefore can be substituted after every use.

The detachable strips, after exposure of the ozonised air, are taken and inserted in a culture medium, in which they incubated for 48 hours at 30°C.

The negative growth attests the positive results of the disinfection-sterilisation treatment according to the process of the invention.

If instead the means suitable for detecting the attainment of an effective concentration are constituted by the electronic meter 11 as previously anticipated, it should be said that this is preferably of the type equipped

with a display for the reading of the data with scale indicator.

The display must therefore be visible whatever the arrangement of the electronic meter 11, hence, if it is inside the chamber 1 the latter provides at least one transparent window portion, from which it is possible to read the display, as a transparent portion is provided in the possible housing 13 inside the chamber 1 or 13a outside the treatment chamber 1.

The electronic ozone meter functions as an "electronic-chemical nose" and moreover comprises, in addition to the already cited sensor and display, also electrical connection cables between these which must be insulated from possible contact with the ozonised air.

For such reason, the electronic meter 11 can be advantageously made even with only the sensor inside the treatment chamber 1, for example by means of threaded screw coupling and air-sealed, so to detect inside the chamber 1 without there being an external escape of gas, while the display and the entire electrical connection part can be arranged outside the treatment chamber 1, this embodiment not being represented in the figures.

If detection means are constituted by or also comprise a chemical detector 12, this will be of the type for example with one or more test paper type strips of suitable material supporting (for example imbibed) respective substances which change colour upon the attainment, achieved for a predetermined time period, of predetermined ozone concentrations (contact time).

It should be remember, as anticipated above, that the above-described means suitable for detecting an effective ozone concentration can be provided individually or in all possible combinations, both in number and in arrangement (inside the treatment chamber with or without housing, or outside the treatment chamber 1 with housing).

The combination comprising all three of the aforesaid means described above has the advantage of offering a control on the ozone concentration inside the chamber 1 which is extremely safe and precise, in the sense that while each detection means is individually and autonomously efficient for the purpose, the information obtained from the contemporaneous use

of the three aforesaid detection means permit a mutual control of the same and an integration of information with an absolute certainty of a total and effective hygienisation of the objects destined for the disinfection-sterilisation process according to the invention.

Thus for example the electronic meter detects the attainment of the effective ozone concentration, the chemical detector with the colour change confirms the attainment of such concentration and signals that this was maintained for an effective time period (sufficient for the colour change), and the biological indicator, if there is further need, ensures with a negative test that a total biocide action of ozone has been completed.

With regard to the use of the above-described apparatus, and in accordance with the present process, it should be said that after having positioned the objects or material inside the treatment chamber 1, the aforesaid means are driven which are suitable for forcing an air flow through the ozone generator 3, and the same generator is driven.

Such means can be advantageously composed of a diaphragm pump 4, which forces a flow of ambient air through the electric ozone generator 3, whose outlet is connected to the treatment chamber 1 through the aforesaid inlet opening of the chamber 1.

Exiting from the ozone generator 3 there is therefore a flow of ozonised air, obtained as is known by conversion into ozone of at least part of the oxygen present in the ambient air flow forced therein, which enters into the treatment chamber 1 and through the entire confinement space of the ozone accessible to the flow of ozonised air, which also comprises the circulation conduit 5 and possibly the housing of detection means whether provided inside or outside the chamber 1, as well as the possible connection of the outside housing.

In this step, a corresponding flow of gaseous mixture, i.e. of air free of ozone substantially equal to the supersaturation volume of ozonised air, which per unit of time is forced into the treatment chamber 1, exits from the same chamber 1 through the aforesaid vent opening, where the first filter 2 is housed.

Hence, at the attainment of the effective ozone concentration, the

diaphragm pump 4 and the ozone generator 3 are stopped, with the interruption of the flow of air forced into the ozone generator, with the interruption of the generation of the ozone itself, and with the consequent interruption of the ozonised air flow and of any further gaseous supply into the chamber 1 and into the ozone confinement space.

It should be considered that the effective ozone concentration, for example previously determined to be 3 ppm, must be maintained inside the chamber for an effective period of time, for example 20 minutes.

Since it is possible that such ozone concentration inside the chamber 1 diminishes during this time interval, due to the reactions which can be triggered in the disinfection-sterilisation process, one could consider stopping the diaphragm pump and ozone generator also in a moment subsequent to the attainment of the effective ozone concentration, i. e. at the end of the time period considered effective for the hygienising treatment.

In any case, after having stopped the diaphragm pump and the ozone generator and after the time period considered effective has passed, the aforesaid fan is driven so to force the passage of the gaseous mixture inside the chamber still containing ozone through the aforesaid second and third filters, triggering a closed circuit current which recrosses the treatment chamber.

In such conduit 5, the gaseous mixture circulates through the aforesaid second and third filters 7 and 8 in succession, and possibly several times, by means of which the ozone is entirely consumed and/or reconverted into diatomic oxygen in the treatment chamber and in the entire confinement space, as considered above.

With regard to this, it should be added that in the case of the housing 13a outside the treatment chamber, to facilitate the consumption of ozone in the entire confinement space, a further connection conduit can be provided which connects the housing 13a directly with the recirculation conduit 5, in this manner increasingly benefiting the circulatory effect promoted by the fan 6, such embodiment not being shown in the figures.

As described above, such second and third filter 7,8, as well as the

abovementioned first filter 2, contain material suitable for abating in a substantially complete manner the ozone content of the passing gaseous mixture, by chemical oxidation reaction of the same filtering material and/or by catalytic reconversion of the ozone into oxygen.

Such abatement material of the ozone can be an active carbon particulate, rendered substantially not inflammable, such as the product known with the commercial name of "Carulite".

An adequate filtering volume of Carulite was shown to be perfectly effective for ensuring the substantial lack of ozone residues in the filtered air flow, and moreover the Carulite maintains its effectiveness for a long functioning time period.

The abatement material of the ozone can also be a solution of a compound or even a suspension of an ozone-reactive material, in which case the ozonised air that is circulated by the fan 6 is made to bubble through a certain liquid head of the solution or suspension.

Advantageously, following the aforesaid circulation, a concentration of ozone equal to or close to zero can be detected by the aforesaid electronic ozone meter.

Therefore, once the disinfection-sterilisation has ended and any trace of ozone inside the chamber 1 and throughout the confinement space has been eliminated, the fan 6 will also be stopped.

In practice, the residence time of the objects inserted in the treatment chamber, continuously or periodically fed with ozone, i.e. with the flow of ozonised air obtained by maintaining in function or repeatedly commanding the starting of the diaphragm pump 4 and of the electric ozone generator 3, can theoretically be unlimited, permitting the definition of the residence time in the treatment chamber under the biocide effect of gaseous ozone such to ensure a complete disinfection-sterilisation of the objects.

Advantageously, it should be observed that according to the invention, the release into the ambient air of the gaseous mixture inside the treatment chamber which occurs both during the present process by means of the

vent opening of the chamber 1 and after the conclusion of the process with the opening of the chamber 1, does not lead to any environmental insertion or dispersion of ozone.

Moreover, even inside the treatment chamber containing the objects and/or the material to be sterilised, there is no presence of residual ozone, and hence the access to the same chamber is secure.

Even the use of the sterilised objects is safe since the operations which have led to the elimination of the ozone from the treatment chamber have also ensured that no other contamination occurred, for example by placing the objects in contact with the outside air.

The process according to the invention therefore is free of risks, which are reduced to a minimum for the abovementioned reasons and which are reduced also with regard to the actuation of the process itself and to the use of the present apparatus as the ozone is generated at the time of use, avoiding any undesired storing and pressurisation of the ozone and of the entire space wherein it is confined.

It should be added, moreover, that the presence in the circulation conduit of a filter positioned upstream of the fan (the second filter of the apparatus) advantageously permits abating most of the ozone present in the circulating gaseous mixture at the beginning of the conduit itself, increasingly preserving the remaining portion of the conduit, thus the fan and pertaining electrical circuitry, from the strong oxidant action of the ozone, with consequent reduced need for maintenance of the present apparatus.

A further advantage of the invention consists in that the control of the ozone concentration permits to stop the generation of the same at the most appropriate moment, i.e. at the attainment of the effective concentration.

A concentration higher than that effective for the disinfection-sterilisation treatment, which could be variable according to the situation, is in fact strongly undesirable as can be easily understood from the foregoing discussion (the ozone must first be generated and then eliminated).

Thus, limiting the generation of ozone to such concentration signifies a considerable economical advantage, since there are lower costs both for generation and for abatement of the ozone and also lower maintenance costs, since the apparatus is consequently less exposed to the oxidant action of the ozone.

With regard to this, it should be added that in the present apparatus, all of the surfaces and parts of the apparatus according to the present invention which normally must be, or which can be accidentally, in contact with the ozonised air are made of an inert material with respect to the strong oxidant action of the ozone, as for example glass, stainless steel, titanium, metal covered in Teflon, Teflon, nylon, plexiglass and other saturated polymeric materials or in any case with proven resistance at contact with ozone.

Moreover, the electrical parts of the apparatus must be appropriately insulated from any possible contact with the ozone, while each flow connection of the apparatus, as for example that between the ozone generator and the treatment chamber, or that of the external housing of the detection means with the treatment chamber, must be sealed so to avoid gas leaks. The possibility should also be considered of employing gaseous oxygen as gaseous supply for the ozone generator, for example provided by a respective cylinder.

In order to satisfy specific and contingent needs, a man skilled in the art can make numerous modifications to the above-described process and to the apparatus for its actuation in its illustrated and described embodiments, all moreover contained in the scope of protection of the invention as defined by the below-reported claims.

CLAIMS

1. Process of disinfection-sterilisation through exposure to gaseous ozone by means of a non-pressurised confinement apparatus of the ozone, the process comprising:

forcing an air flow through an electric generator (3) converting into ozone at least part of the oxygen contained in the air flow with the obtainment of a flow of ozonised air;

conveying said flow of ozonised air exiting said generator into a treatment chamber (1), up to the attainment in said chamber (1) of a predetermined ozone concentration, said predetermined ozone concentration being maintained in said chamber (1) for a predetermined time period with sterilisation-disinfection of its internal contents, while a volume of air free of ozone, essentially corresponding to the supersaturation volume of ozonised air conveyed inside the chamber (1), is vented from said chamber (1) through a vent opening connected to a first abatement and/or reconversion filter (2) of the ozone;

stopping said flow of ozonised air conveyed into said chamber (1) and making the gaseous mixture contained inside the chamber circulate through an external conduit (5) by means of a circulation fan (6) housed in said external conduit (5), abating and/or reconverting the ozone present in said gaseous mixture into oxygen by means of a second and a third abatement and/or reconversion filter (7,8) of ozone into oxygen, said second and third filter being positioned respectively upstream and downstream of said fan (6), wherein said circulation is carried out for a time period sufficient to deplete the ozone content of said gaseous mixture.

2. Process according to claim 1, wherein said predetermined ozone concentration is detectable by dedicated detection means directly interacting with the aforesaid treatment chamber (1).

3. Process according to claim 1 or 2, wherein said detection means are inside said chamber.

4. Process according to claim 1 or 2, wherein said detection means are

outside said chamber.

5. Process according to any one of the preceding claims, wherein said detection means comprise at least one among: a biological disinfection-sterilisation indicator (10), an electronic meter (11) of ozone concentration, a chemical detector (12) of ozone concentration.

6. Apparatus for disinfection-sterilisation through exposure to gaseous ozone comprising:

an electric ozone generator (3) having an inlet and an outlet for an air flow, at least part of the oxygen contained in the inlet air flow being converted into ozone in the outlet air flow;

means suitable for forcing a flow of air through said ozone generator;

a treatment chamber (1) having an inlet connected to the outlet of the ozone generator (3) and a vent outlet;

a first filter (2) housed in said vent outlet containing a filtering material suitable for abating and/or reconverting the ozone into oxygen, for venting into the atmosphere a flow of air free of ozone of flow rate substantially equal to that forced into said chamber;

a conduit (5) outside said chamber, wherein at least one fan (6) is housed through which the gaseous content inside said chamber (1) is circulated;

a second and a third filter (7,8) both containing a filtering material suitable for abating and/or reconverting the ozone contained in the circulating gaseous flow into oxygen, said second and third filter being housed in said conduit (5) respectively upstream and downstream of said fan (6);

means for separately activating and stopping said electric ozone generator (3) and said circulation fan (6).

7. Apparatus according to claim 6, wherein said means suitable for forcing an air flow through said ozone generator comprise an ambient-air suction diaphragm pump (4).

8. Apparatus according to claim 6 or 7, moreover comprising means

suitable for detecting a predetermined ozone concentration attained in said chamber (1), said means being directly interacting with said chamber.

9. Apparatus according to claim 8, wherein said means suitable for detecting a predetermined concentration of ozone comprise at least one among: a biological disinfection-sterilisation indicator (10), an electronic meter (11) of ozone concentration, a chemical detector (12) of ozone concentration.

10. Apparatus according to claim 8 or 9, wherein said means suitable for detecting a predetermined concentration of ozone are in direct contact with the atmosphere inside said chamber (1).

11. Apparatus according to claim 10, wherein said direct contact occurs at an upper portion of said chamber (1).

12. Apparatus according to claim 9 or 10, wherein said means suitable for detecting an effective concentration of ozone are positioned in a housing (13a) outside said chamber (1), placed in fluid communication therewith.

13. Apparatus according to claim 9, comprising both means suitable for detecting a predetermined concentration of ozone housed inside said chamber and means suitable for detecting a predetermined concentration of ozone housed outside said chamber.

14. Apparatus according to any one of the claims 9-13, wherein said biological indicator (10) consists of spores supported on suitable detachable strips.

15. Apparatus according to claim 14, wherein said spores comprise the Geobacillus Stearothermophilus type and/or similar bacilli which are innocuous for humans.

16. Apparatus according to any one of the claims 9-13, wherein said electronic meter (11) comprises an ozone sensor and a display with scale indicator visible outside said chamber (1).

17. Apparatus according to any one of the claims 9-13, wherein said chemical detector (12) comprises chromatic indicators which change

colour at the attainment of a predetermined ozone concentration, supported on suitable detacable strips.

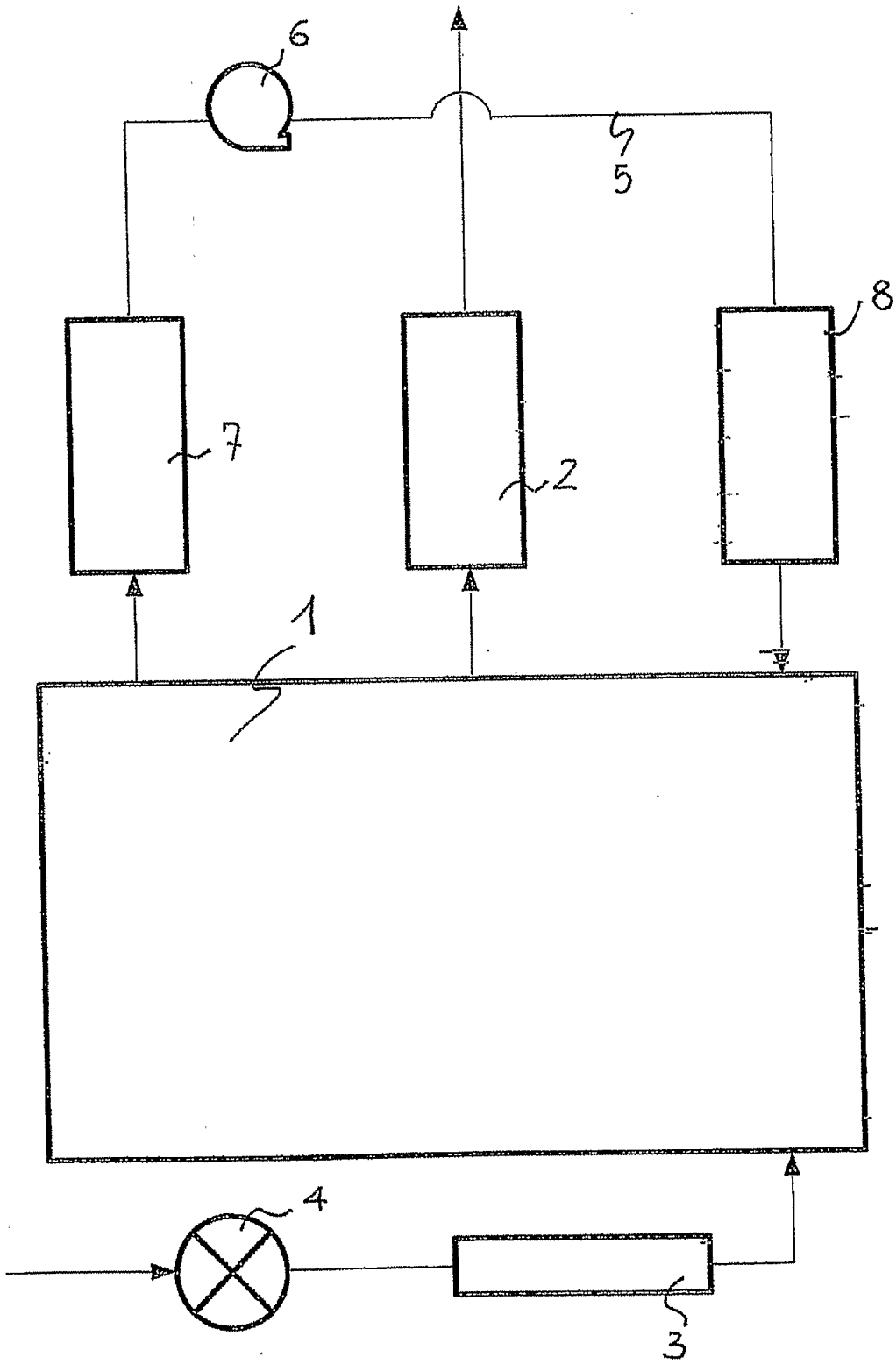

Fig. 1

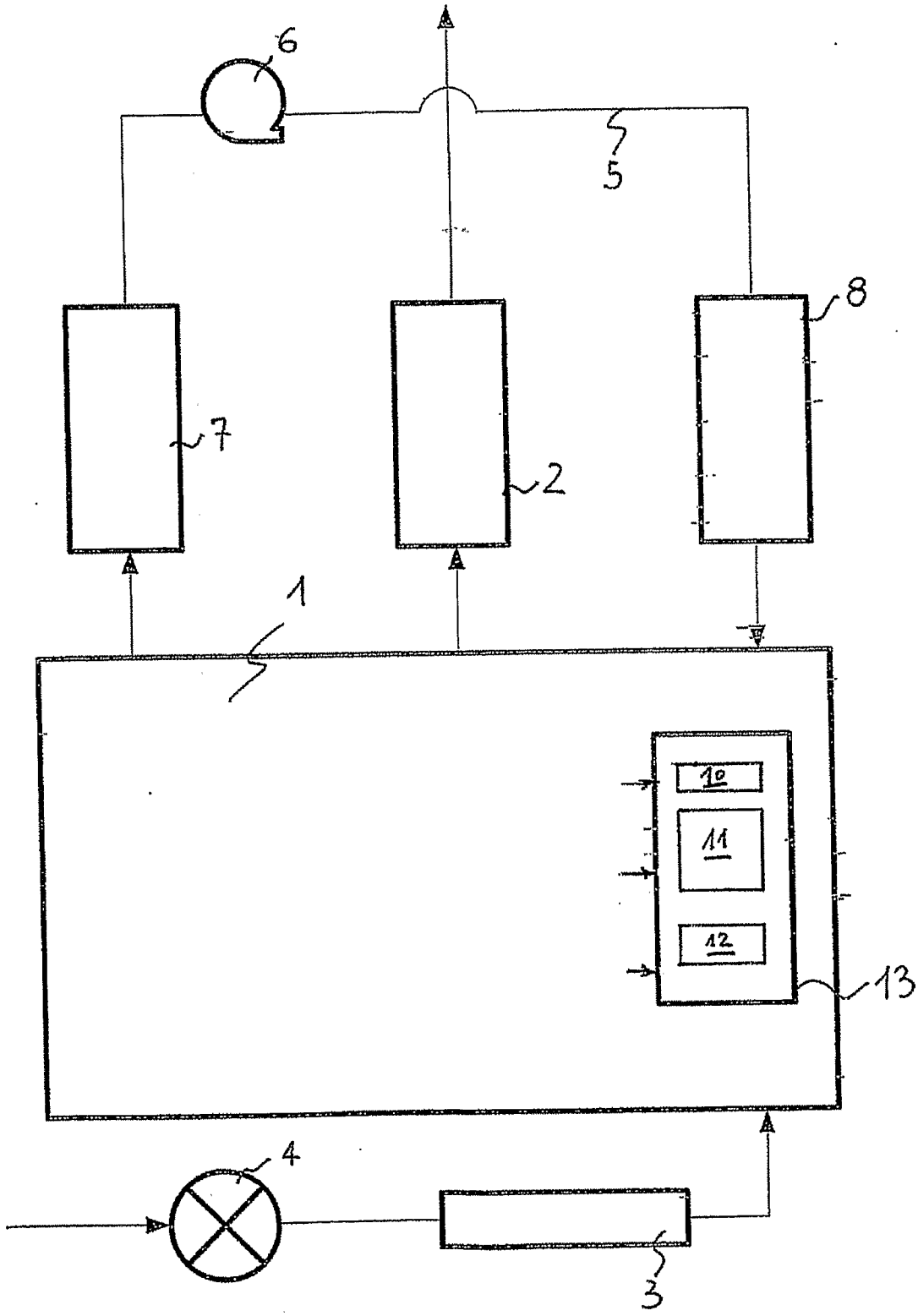

Fig. 2

3/3

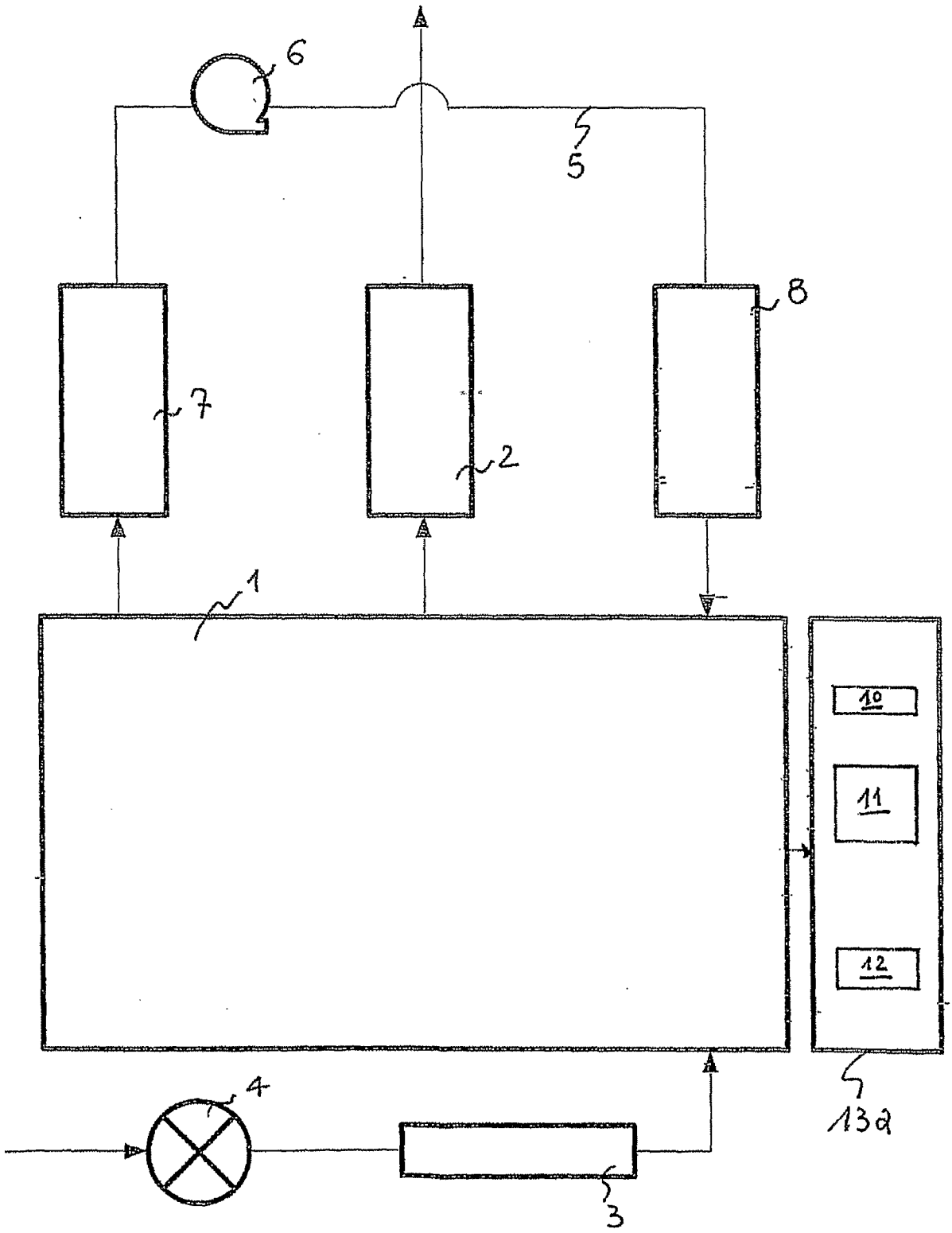

Fig. 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/IT2007/000223

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61L2/20 A61L9/015 C01B13/10 G01N31/22 C12Q1/22
A61L2/28
ADD. A61L101/10
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A61L C01B F24F C12Q G01N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	GB 2 177 020 A (SHINRYO AIR COND SHINRYO AIR COND [JP]) 14 January 1987 (1987-01-14) page 4, line 51 - line 59 page 5, line 50 - line 63; figures 3,6	1,6 2-5,8-13
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[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
6 July 2007	16/07/2007

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Marti, Pedro

INTERNATIONAL SEARCH REPORT

International application No
PCT/IT2007/000223

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2002/022246 A1 (LIN SZU-MIN [US] ET AL) 21 February 2002 (2002-02-21) paragraph [0052] - paragraph [0061] paragraph [0075]; figures 1,10	2-5,8-13
Y	US 2004/161361 A1 (UHM HAN SUP [US] ET AL) 19 August 2004 (2004-08-19) paragraph [0004] paragraph [0010]	2-5,8,9, 14,15
A	FR 2 695 828 A1 (CULTIMAT TECHNOLOGIES [FR]) 25 March 1994 (1994-03-25) the whole document	1-17
A	DE 89 11 158 U1 (CLINICO INFUSIONSTECHNIK GMBH & CO MEDIZINISCHE KUNSTSTOFFPRODUKTE KG,) 2 November 1989 (1989-11-02) the whole document	1-17
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/IT2007/000223

Box II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☒ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-6

Method and apparatus for disinfection-sterilisation of the content inside a treatment chamber using ozone gas.

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2. claims: 7-9

Plant of disinfection-sterilisation by ozone gas of the air of a room hosting living organisms and/or substances intolerant to exposition to ozone employing an apparatus functionally similar to the apparatus of claim 3.

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The common inventive concept linking together both groups is related to the disinfection using ozone. Since this concept in not novel, the different subject-matters are not so linked as to form a single general inventive concept. Therefore, these claims lacks unity within the meaning of Rule 13 PCT.

Note that the expression in claim 3 "apparatus functionally similar to the apparatus of claim 3" is unclear.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IT2007/000223

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