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(54) Benævnelse: **Indretning til inaktivering og finfiltrering af vira og mikroorganismer i en luftstrøm**

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DESCRIPTION

The Field of the Art

[0001] The invention relates to cleaning air or a gas from microorganisms, viruses, solid and liquid aerosols and more specifically concerns an apparatus for the inactivation and fine filtration of viruses and microorganisms in an air flow.

The Prior Art

[0002] An apparatus for the inactivation and fine filtration of viruses and microorganisms is known according to the patent RU 2026751, this apparatus comprising a high-voltage power supply and, in series along the flow, an air flow pretreatment means, a two-compartment inactivation chamber, and a precipitator, which is embodied as oppositely charged plates made of a high-porosity current-conductive material and arranged in parallel to each other, with plates made of a high-porosity insulating material arranged between the current-conductive plates. Herein, the air flow pretreatment means is formed of oppositely charged current-conductive filtering units, with a plate made of a permeable high-porosity insulating material installed between them, and each compartment of the two-compartment inactivation chamber is embodied as a needle corona electrode and a cylinder non-corona electrode, the two electrodes being arranged coaxially to each other and each being electrically connected to the relevant plate made of a current-conductive filtering material.

[0003] In this apparatus, the air-flow pretreatment means is a coarse filter unit for cleaning an air flow from suspended mechanical particles and practically does not affect the inactivation of viruses and microorganisms. In this connection, the entire burden of the inactivation proper falls on the inactivation chamber, thereby complicating the performance thereof and reducing the efficiency of the inactivation process.

[0004] Document US 2007/137486 A1 concerns a fluid decontamination, filtering and/or purification device comprising an electrostatic pre-filter, a positive plasma generator, a negative plasma generator, a series of active electrostatic filters and a catalyst, arranged in this order in series for sequentially passing through a gaseous fluid like air.

[0005] The object of the invention is to create an apparatus for the inactivation and fine filtration of viruses and microorganisms in an air flow such that an air-flow pretreatment means in this apparatus, apart from scavenging mechanical particles from the flow, performs the preconditioning of bioaerosols that occur in the flow prior to inactivation, thereby providing the most favorable conditions for the operation of the inactivation chamber and precipitator downstream, an improvement of their design, and ultimately an enhancement of the efficiency of the apparatus as a whole.

Disclosure of the Invention

[0006] The object is achieved as follows: an apparatus for the inactivation and fine filtration of viruses and microorganisms in an air flow comprising a high-voltage power supply and, in series along the flow: an air flow pretreatment means formed of oppositely charged current-conductive filtering units with a plate made of a high-porosity permeable insulating material installed between the filtering units; a two-compartment inactivation chamber, each compartment being embodied as a needle corona electrode and a cylinder non-corona electrode, the two electrodes being arranged coaxially to each other and each being electrically connected to a plate made of a current-conductive filtering material; and a precipitator embodied as oppositely charged plates made of a high-porosity current-conductive material and arranged in parallel to each other, with plates made of a permeable high-porosity insulating material arranged between these plates, at least the current-conductive filtering unit of the air flow pretreatment means which is first along the air flow is embodied as a cylinder electrode having a base in the form of a plate made of a permeable porous current-conductive material, this plate being adjacent to the plate made of a permeable high-porosity insulating material, a needle electrode arranged coaxially to the cylinder electrode on the side of the front end thereof, and having its point directed toward the insulating plate, and a plate which is made of a high-porosity current-conductive material and positioned in front of, at a distance from and electrically connected to the needle electrode, wherein the cylinder electrode and the needle electrode are connected to the opposite poles of the power supply.

[0007] Expediently, the two-compartment inactivation chamber is embodied as a single cylinder non-corona electrode inside which a partition made of a permeable high-porosity current-conductive material is installed across the flow. The plate made of a current-conductive filtering material is arranged opposite to each of the free ends of the cylinder non-corona electrode. Herein, the needle corona electrodes of the first compartment and the second compartment of the inactivation chamber have the points thereof directed toward each other and are electrically connected to each other and to the corresponding plate. The needle corona electrodes of the first compartment and the second compartment of the inactivation chamber are electrically connected to the pole of the power supply that is opposite to the pole connected to the needle electrode of the pretreatment means.

[0008] The two-compartment inactivation chamber may be embodied in such a way that the needle corona electrodes of the first compartment and the second compartment of the two-compartment inactivation chamber have their points directed in opposite directions and are installed coaxially to the corresponding cylinder electrodes on the opposite sides of a partition made of a permeable high-porosity current-conductive filtering material, positioned across the flow between the cylinder non-corona electrodes of the first compartment and the second compartment and being insulated from them, and the plates made of a current-conductive filtering material and positioned adjacent to the ends of the cylinder electrodes at the inlet and the outlet of the inactivation chamber are electrically connected to each other and to the current-conductive filtering plate of the pretreatment means that is last along the flow, and the needle corona electrodes are electrically connected to the partition made of a current-conductive filtering material and arranged in between these electrodes.

[0009] In another embodiment of the invention, the two-compartment inactivation chamber may be formed of two in-series arranged cylinder non-corona electrodes and a plate made of a permeable high-porosity current-conductive filtering material being adjacent to the end first along the flow of each of these electrodes, wherein the non-corona electrodes are connected to the opposite poles of the power supply and wherein the needle corona electrodes both have their points directed counterflow wherein the needle electrode of the first compartment is connected to the current-conductive plate that is adjacent to the cylinder electrode of the second compartment and the needle electrode of the second compartment of the inactivation chamber is connected to the current-conductive plate of the precipitator that is arranged immediately following this electrode.

[0010] It is desirable to install a plate made of a permeable high-porosity insulating filtering material between the filtering unit second along the flow of the air flow pretreatment means and the first compartment of the inactivation chamber.

[0011] In a preferred embodiment, the apparatus further comprises at least one more two-compartment inactivation chamber that is an analogue of the first chamber but has the opposite polarity of electrode connection, this chamber being installed in series to the first chamber along the flow, with the direction of the needle corona electrodes of each next inactivation chamber being identical or opposite to the direction of the needle electrodes of the previous chamber.

[0012] It is desirable to install a plate made of a high-porosity insulating material between neighboring current-conductive filtering plates of the previous inactivation chamber and the next inactivation chamber.

[0013] Further, a needle electrode may be electrically connected to the current-conductive plate of the precipitator first along the flow, this needle electrode having its point directed counterflow, wherein a cylinder non-corona electrode is installed coaxially to this needle electrode with a plate made of a current-conductive filtering material being positioned adjacent to the front end (along the flow) of the cylinder electrode, this plate being electrically connected to the needle electrodes of the inactivation chamber last along the flow.

[0014] To the current-conductive plate of the precipitator first along the flow, a cylinder electrode may be connected by one end, and opposite to the other end of this cylinder electrode, one more plate made of a current-conductive filtering material may be installed across the flow, wherein a needle corona electrode positioned coaxially to the cylinder electrode is electrically connected to this plate, has its point directed along the flow, and is connected to the pole of the power supply opposite to the pole connected to the needle electrode of the last compartment (along the flow) of the inactivation chamber.

[0015] For leveling the concentrations of particles to be precipitated, ozone, or ions in the flow, it is desirable to equip the apparatus with at least one flow turbulizer.

[0016] It is advisable to install the turbulizer upstream to the precipitator.

[0017] Further, it is desirable to equip at least one of the current-conductive plates of the precipitator and/or the turbulizer with a coating capable of providing the decomposition of ozone, nitrogen oxide, and/or other harmful gases.

[0018] The material whereof the insulating filtering plates are made may contain a catalyst for catalyzing the decomposition of ozone, nitrogen oxides, and/or harmful gases.

[0019] In a preferred embodiment, the needle corona electrode is embodied as a wire installed inside a metallic pipe coaxially thereto and protruding therefrom.

[0020] It is also desirable to connect at least one of the corona electrodes to the power supply via a resistor the resistance whereof is selected from the limit imposed on the peak consumption current value for the set voltage.

[0021] Preferably, the high-voltage power supply is embodied as having three autonomous leads, wherein one lead is connected to the current-conductive plates of the precipitator and to the current-conductive filtering units and voltage-stabilized and the other two leads are respectively connected to the needle corona electrode and the cylinder non-corona electrode of each respective compartment and are current-stabilized.

[0022] Further preferably, the high-voltage power supply is embodied with a feasibility of automatically switching the operation mode thereof from the voltage stabilization of the lead connected to the current-conductive plates of the precipitator and to the current-conductive filtering units, to current stabilization once a set value of the consumption current is reached. Hence, the power supply is voltage stabilized, can maintain the consumption current within the set range, and can automatically switch itself from voltage stabilization to current stabilization once a set value of the consumed current is reached.

[0023] It is expedient to make current-conductive plates in the precipitator of a foamed metal and arrange them so that the distance between them decreases along the air flow, and to make the insulating filtering plates of the precipitator of foamed polyurethane and install them in an order such that the cell size of the material of the plates decreases along the air flow. Further, the current-conductive plates of the precipitator may be made of a foamed metal coated with an insulating coating.

[0024] The invention will be further illustrated by means of description of particular embodiments and drawings.

Brief Description of Drawings

[0025]

FIG. 1 schematically shows a section of the apparatus for the inactivation and fine filtration of viruses and microorganisms in an air flow according to the present invention;

FIG. 2 is the same as FIG. 1. with the inactivation chamber wherein the needle electrodes of the first compartment and the second compartment are directed in opposite directions;

FIG. 3 is the same as FIG. 1, with the inactivation chamber wherein the needle electrodes of the first compartment and the second compartment are directed counterflow;

FIG. 4 is the same FIG. 2, but with an insulating plate positioned between the pretreatment means and the inactivation chamber;

FIG. 5 shows an embodiment of the inactivation apparatus having two identical two-compartment inactivation chambers arranged in series to each other and having needle electrodes directed in opposite directions;

FIG. 6 is the same as FIG. 5, but with an insulating plate positioned between the inactivation chambers;

FIG. 7 shows an embodiment of the inactivation apparatus wherein the precipitator is further equipped with a corona unit;

FIG. 8 is the same as FIG. 7, but with another embodiment of the precipitator;

FIG. 9 shows an embodiment of the apparatus wherein the needle electrodes are connected to the power supply via resistors;

FIG. 10 shows an embodiment of a needle corona electrode in section.

Embodiments of the Invention

[0026] The apparatus for the inactivation and fine filtration of viruses and microorganisms in an air flow as shown in FIG. 1 comprises an air flow pretreatment means 1, a two-compartment inactivation chamber 2, and a precipitator 3, all the three being arranged in series along the air flow A and connected to a high-voltage direct-current power supply 4. The air flow pretreatment means 1 contains a first current-conductive filtering unit and a second current-conductive filtering unit 7 and 7', respectively, charged oppositely to each other, and a plate 5 made of a permeable high-porosity insulating material, for example, of open-cell foamed polyurethane, positioned between the filtering units. At least the first current-conductive filtering unit (along the flow A) in this embodiment is embodied as a cylinder electrode 6 having a planar porous base 7 which is adjacent to the plate 5, and a needle corona electrode 8 is arranged coaxially to the cylinder electrode 6 on the side of the front end thereof, the needle corona electrode 8 having its point directed toward the insulating plate 5. In front of the electrode 8, there is a plate 9 made of a high-porosity current-conductive material, for example, foamed nickel, positioned at a small distance from the electrode 8 and electrically connected thereto.

[0027] The two-compartment inactivation chamber 2 in this embodiment is embodied as a single cylinder non-corona electrode 10, wherein a flow-shutting partition 11 made of a permeable high-porosity current-conductive material, for example, of foamed nickel, is installed in the middle of the cylinder electrode across the flow. The needle corona electrodes 12 of the first compartment and the second compartment have their points directed towards each other and are electrically connected to each other and to plates 13 which are made of a permeable high-porosity current-conductive material and are installed so that there is one plate at each end of the cylinder electrode 10. Herein, the potential of the plates 13 is opposite to the potential of the needle electrode 8 of the pretreatment means 1.

[0028] The precipitator 3 contains three plates 14 made of a high-porosity current-conductive material, installed in parallel to each other across the flow A, and connected alternately to the opposite poles of the power supply 4. Between the plates 14, there are plates 15 made of a permeable high-porosity insulating material.

[0029] In the embodiment as shown in FIG. 2, unlike in that shown in FIG. 1, the needle corona electrodes 12 in the first compartment and the second compartment of the inactivation chamber 2 have their points directed in opposite directions and are electrically connected to the current-conductive partition 11. Herein, the corona electrodes 12 are connected to the pole of the power supply 4 opposite to the pole connected to the needle corona electrode 8 of the pretreatment means 1.

[0030] FIG. 3 shows the apparatus according to the invention with one more embodiment of the two-compartment inactivation chamber. In this embodiment, unlike in the two above-described embodiments, the two-compartment inactivation chamber is formed of two in-series arranged cylinder electrodes 10' and 10", wherein a plate 16 made of a permeable high-porosity current-conductive material is adjacent to the first end (along the flow) of each electrode. The cylinder electrodes 10' and 10" are connected to the opposite poles of the power supply 4. The needle corona electrodes 12 of the first compartment and the second compartment have their points directed counterflow and connected so that the electrode 12 of the first compartment is connected to the current-conductive plate 16 which is adjacent to the cylinder electrode of the second compartment and the needle electrode of the second compartment is connected to the current-conductive plate 14 of the precipitator 3 positioned directly following this electrode.

[0031] The embodiment of the apparatus as shown in FIG. 4 is distinct from the embodiment shown in FIG. 2 in that it further comprises a plate 17 made of a permeable high-porosity (filtering) insulating material and installed between the second (along the flow) filtering unit of the pretreatment inactivation means 1 and the first compartment of the inactivation chamber 2.

[0032] The apparatus shown in Fig. 5, as distinct from those described above, contains, apart from the two-compartment inactivation chamber 2, one more two-compartment chamber 18 installed in series to the chamber 2 along the air flow and having an analogous construction but with the opposite electrode connection polarity. In this embodiment, the needle corona electrodes 12 of the next chamber 18 are directed in the same way as the needle electrodes 12 of the previous chamber 2 (i.e., in opposite directions) and are electrically connected to each other and to the corresponding partition 11.

[0033] The embodiment of the apparatus as shown in FIG. 6 is distinct from the embodiment shown in FIG. 5 in that, between the neighboring inactivation chambers 2 and 18, there is further installed a plate 19 made of a permeable high-porosity insulating material, for example, open-cell foamed polyurethane.

[0034] The needle electrodes in the previous and next inactivation chambers may be directed in opposite directions; if so, however, the condition of the obligatory alternation of electrode connection polarity in each next chamber is also to be fulfilled.

[0035] The embodiments of the apparatus according to the invention as shown in FIGS. 7 and 8 are characterized in that the precipitator 3 is equipped with a needle-cylinder corona unit. In the embodiment of the inactivation apparatus as shown in FIG. 7, a needle electrode 20 is electrically connected to the first (along the flow) current-conductive plate 14 of the precipitator 3, this needle electrode having its point directed counterflow, and a cylinder non-corona electrode 21 is installed coaxially thereto, with a plate 22 made of a current-conductive filtering material being adjacent to the front end (along the flow) of the cylinder electrode and electrically connected to the needle electrodes 12 of the inactivation chamber 18.

[0036] In the embodiment of the apparatus as shown in FIG. 8, a cylinder electrode 23 is connected by its end to the first (along the flow) current-conductive plate 14 of the precipitator 3 and a plate 24 is installed across the flow opposite to the other end of the cylinder electrode 23, the plate 24 being followed by a needle corona electrode 25 installed coaxially to the cylinder electrode 23. The needle corona electrode 25 has its point directed along the flow, is electrically connected to the plate 24, and is connected to the pole of the power supply 4 opposite to the pole connected to the needle electrode 12 of the second compartment of the inactivation chamber 2.

[0037] The precipitator 3 is embodied in such a way that the separation between the current-conductive plates 14 decreases along the air flow A, wherein the current-conductive plates 14 are made of, for example, foamed nickel. The insulating plates 15 of the precipitator 3 are made of foamed polyurethane, wherein said plates are arranged so that the cell size of the material of the plates 15 decreases along the air flow A.

[0038] The cylinder electrodes 6, 10 (10' and 10"), 21, and 23 have a honeycomb (cellular) structure, wherein each of the needle electrodes 8, 12, 20, and 25 contains a plurality of needles, each needle being arranged coaxially to the corresponding cell.

[0039] In the embodiment of the apparatus as shown in FIG. 9, each of the needle-cylinder corona units is embodied as a hollow cylinder and a single needle electrode which is positioned concentrically to the cylinder. Herein, each of the needle corona electrodes is connected to the power supply 4 via a high-voltage resistor 26, the resistance whereof being selected from the limit imposed on the peak consumption current value for the set voltage.

[0040] The precipitator 3 is preceded by a turbulizer 27, for example, having the perforated or bladed design, wherein the turbulizer 27 is equipped with a coating that contains a catalyst for catalyzing the decomposition of ozone, nitrogen oxide, and/or other harmful gases (for example, an alumina-based catalyst).

[0041] The high-voltage power supply 4 (FIG. 1) may be embodied as having three autonomous leads "a", "b", and "c". The lead "a" is connected to the needle corona electrodes and to the cylinder non-corona electrodes of the positive "coronas" of the apparatus; the lead "c" is connected to the needle corona electrodes and the cylinder non-corona electrodes of the negative "coronas;" and the lead "b" is connected to the current-conductive plates 14 of the precipitator or the current-conductive filtering units 7 and 7', having a plate made of an insulating filtering material installed between the filtering units. Herein, the power supply 4 is embodied in such a manner that the leads "a" and "c" are current stabilized and differ from each other in the voltage value and the lead "b" is voltage stabilized. Further, the power supply 4 in a preferred embodiment thereof is embodied with a feasibility of automatically switching its operation mode from voltage stabilization at the lead "b" to current stabilization once a set value of the consumed current is reached. Although this embodiment of the power supply is shown only in FIG. 1 which refers to the first embodiment of the invention, the same embodiment of the power supply is useful in other embodiments of the apparatus, too.

[0042] FIGURE 10 shows a section of the preferred embodiment of a needle corona electrode that represents a wire 28 mounted inside a metallic pipe 29 coaxially thereto and protruding therefrom by a value sufficient for an electrical corona to be formed.

[0043] In all embodiments of the apparatus, the non-corona electrodes may be embodied not only as cylinders but also as polyhedra or honeycombs.

[0044] The apparatus operates as follows.

[0045] The air to be treated contains various types of microorganisms, viruses, and particles having various sizes, structures, properties, and electrical charges.

[0046] Once a voltage is applied to electrodes, a corona current appears in the corona units of the apparatus, accompanied by the generation of the corresponding ions from the needle corona electrodes 8 and 12 (FIG. 1). Under the action of the ions generated, inside the pretreatment means 1 bioaerosols are charged and impacted by electrical fields of various strengths and gradients depending on the site where particles reside inside the pretreatment means 1. Cold plasma appears at the point of the needle corona electrode 8 and also has a local impact on bioaerosols. In the first (along the air flow) permeable porous electrode (plate 9), coarse filtration occurs to scavenge coarse particles. While the treated air flow is passing through the corona unit of the pretreatment means 1. microorganisms and viral cells first are charged by ions of one sign (for example, negative ions) and then pass through the porous base 7 of the non-corona electrode 6, which has the opposite potential sign, therein acquiring opposite charges. Then, while passing through the polarized structure of the insulating plate 5, microorganism and viral cells loss part of water from their surfaces in contact with this plate, thereby facilitating subsequent impact of electric fields and ions on the cellular structure, after which the cells change their charges upon passing through the second plate of the current-conductive filtering unit of the pretreatment means 1. Thereby provided are in fact identical electrical charge signs and weakened cellular structures of the microorganisms and viruses entering subsequent treatment. The embodiment of the first current-conductive filtering unit of the pretreatment means 1 as a needle-cylinder corona unit enables:

- improving the conditions for aerosol precipitating on the surface of the plate 5 made of a high-porosity insulating material and enhancing the efficiency of the surface dehydration of a microbial cell, wherein directing the point of the corona electrode 8 toward this plate 5 provides bioaerosol charging and simultaneously creates better conditions for the operation of the point of the needle;
- homogenizing the electrical potential of the bioaerosol contained in the air flow under treatment;
- weakening or partially damaging cellular membranes on account of a change in their surface signs and local structural deformations caused by varying electrical field gradients inside the pretreatment means, thereby considerably easing the subsequent disintegration of the cellular structure.

[0047] Leaving the pretreatment means 1, the bioaerosol-containing air flow enters the two-compartment inactivation chamber 2 which is equipped with two homopolar (FIGS. 1 and 2) or heteropolar (FIG. 3) corona electrodes 12.

[0048] Inside the two-compartment inactivation chamber 2 in a permanent electrical field having locally variable strengths and gradients, the bioaerosol is multiply recharged under the impact of ions, electrical contact with electrodes of opposite signs, and the surface of the polarized insulating filtering material. This impact results in the deformation or local damage of the cellular structure and the alteration of the mechanical, electrical, and other properties of the deformed material (for example, the dielectric constant of the membrane material changes), which induces the disintegration of the cellular structure and the inactivation of microorganisms. Having passed through the inactivation chamber 2, the microorganisms and viruses suspended in the air flow are in an inactivated state.

[0049] The embodiments of the inactivation chamber 2 as shown in FIGS. 1, 2, and 3 differ from one another, in fact, only in the geometry of variation of the electrical field strength and gradients along the flow and across the cross-sectional area thereof and, as a result, in the travel direction and velocity of ions, thereby allowing the selection of the inactivation chamber design proceeding from the parameters of the air flow to be inactivated (the flow velocity, the type of aerosol, the physical parameters of the components thereof, and the like).

[0050] On account of the fact that after passing through the air flow pretreatment means 1, bioaerosol particles enter the inactivation chamber 2 having essentially equal charges and being partially deformed and damaged, the ultimate disintegration of the cellular structure of microorganisms inside the inactivation chamber 2 occurs with a higher efficiency.

[0051] The embodiments of the apparatus as shown in FIGS. 5 and 6 provide a further enhancement of the inactivation effect and an increase in the air flow treatment rate, as well as an improvement of the reliability of the apparatus; these embodiments comprise, apart from the two-compartment inactivation chamber 2, at least one more two-compartment inactivation chamber 18 installed next to the first chamber in series along the flow which is an analogue of the first chamber but has the opposite polarity of electrode connection. Herein, the direction of the needle corona electrodes (12) of each next inactivation chamber is identical or opposite to the direction of the needle electrodes of the previous one. This embodiment provides an additional effect by an increased number of electrode polarity alternations and an increased time of impact of opposite-polarity fields on the bioaerosol.

[0052] The plate 17 (FIG. 4), which is made of a high-porosity insulating material and installed between the second filtering unit of the pretreatment means 1 and the first compartment of the inactivation chamber 2, provides an enhanced efficiency of aerosol dehydration by allowing an additional precipitation of bioaerosol particles on the surface thereof.

[0053] An analogous plate 19 (FIG. 6) made of a high-porosity insulating material and installed between the neighboring current-conductive filtering plates 13 of the previous and next inactivation chambers (2 and 18, respectively) also offers an additional depolarized surface for bioaerosol particles to precipitate.

[0054] After passing the inactivation chambers 2 and 18 and acquiring a charge sufficient for precipitation, the particles enter the precipitator 3 together with the air flow A (FIGS. 7, 8). Herein, the inactivated particles suspended in the air flow precipitate on the plates 14 and 15 of the precipitator 3. Inasmuch as the bioaerosol particle charge is unsteady after the flow A passes the inactivation chambers 2 and 18 and depends on a number of uncontrollable factors (the electrical properties of particles, the condition of corona and non-corona electrodes, air humidity, the air flow rate, and some others), for improving the efficiency of fine filtration and for providing the required degree of air ionization the precipitator 3 (FIG. 7) is equipped with a needle-cylinder corona unit wherein the needle electrode 20 is directed counter the flow A, or with a corona unit wherein the needle-bearing cylinder 25 is directed along the flow A(FIG. 8). After microorganisms and viruses are inactivated in the inactivation chambers 2 and 18, the air flow can contain nonliving particles of microbial cells or their fragments, viruses, aerosols, and other species having sizes of up to 0.08 µm, which may be undesirable. The corona unit installed at the inlet of the precipitator 3 enhances scavenging of the aforementioned particles from the treated flow. The flow turbulizer 27, which is installed in this embodiment upstream of the precipitator 3, enhances the elimination of the nonuniformity of cross-sectional distribution of concentrations of ions, particles, ozone, and other species, this nonuniformity arising from use of more than one corona units in parallel in the apparatus.

[0055] The catalytic coating of the turbulizer, as the presence of a suitable catalyst for catalyzing the decomposition of ozone, nitrogen oxide, and/or other harmful gases in the material of the insulating filtering plates 15 of the precipitator 3, too, provides a decrease in concentrations of ozone, nitrogen oxides, and other admixed harmful gases.

[0056] The power supply 4 embodied as being capable of stabilizing the voltage value and maintaining the consumption current value within the set range, provides the possibility of controlling the course of the inactivation process with limited ozone generation by the corona units.

[0057] The high-voltage resistors 26 (FIG. 9), the resistance whereof is selected from the limit imposed on the peak consumption current value for the set voltage, installed between each needle corona electrode and the power supply 4, provide uniform current distribution over the corona units of the apparatus.

[0058] The permeable porous electrodes have a three-dimensional structure, for example, the structure of an open-cell material (foamed nickel, foamed copper, and others).

[0059] The needle corona electrodes embodied as the wire 28 installed inside the metallic pipe 29 coaxially thereto, as shown in FIG. 10, are characterized by high construction strengths (vibration strength and impact strength).

[0060] The arrangement of the current-conductive plates 14 of the precipitator 3 with the separation between them decreasing along the air flow, promotes the increase in the electric field strength between the neighboring permeable porous electrodes (current-conductive plates) along the flow. Thereby improved is the filtration efficiency at each next filtering unit, as a result providing an enhancement of the overall efficiency of filtration and the life of the precipitator.

[0061] The decreasing cell sizes in the material of the insulating plates 15 of the precipitator 3 along the flow A enhance an increase in the efficiency of fine particle filtration in the treated air flow.

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- RU2026751 **[0002]**
- US2007137486A1 **[0004]**

Patentkrav

1. Indretning til inaktivering og finfiltrering af vira og mikroorganismer i en luftstrøm, omfattende en højspændingsstrømforsyning (4) og, i rækker langs luftstrømmen:
et luftstrømsforbehandlingsmiddel (1), der er dannet af modsat ladede strømledende filterenheder (7, 7') med en plade (5), der fremstilles af et gennemtrængeligt isolationsmateriale med høj porøsitet anbragt mellem filterenhederne;
et torumsinaktiveringskammer (2), hvor hvert rum deraf er udformet som en nål-koronaelektrode (12) og en cylinder-ikke-koronaelektrode (10), der er anbragt indbyrdes koaksialt og hver især elektrisk forbundet til en plade (13), der er fremstillet af strømledende filtermateriale; og
en udskiller (3), der er udformet som modsat ladede plader (14), der er anbragt parallelt med hinanden og fremstillet af et strømledende materiale med høj porøsitet med plader (15) imellem dem, som er fremstillet af et gennemtrængeligt isolationsmateriale med høj porøsitet,
hvor indretningen er **kendetegnet ved, at**
mindst den strømledende filterenhed (7) af forbehandlingsmidlerne (1), som er den første langs luftstrømmen, er udformet som
- en cylinderelektrode (6), der har en basis i form af en plade (7), der er fremstillet af gennemtrængeligt porøst strømledende materiale og grænsende op til plade (5), som er fremstillet af et gennemtrængeligt isolationsmateriale med høj porøsitet,
- en nålelektrode (8), der er anbragt koaksialt med cylinderelektroden (6) på siden af forenden deraf, og har sin spids rettet direkte mod isoleringspladen (5), og
- en plade (9), som er fremstillet af et strømledende materiale med høj porøsitet, er anbragt foran, i en afstand fra og elektrisk forbundet til nålelektroden (8), hvor cylinderelektroden (6) og nålelektroden (8) er forbundet til de modstående poler af strømforsyningen (4).

2. Indretning ifølge krav 1, **kendetegnet ved, at** torumsinaktiveringskammeret (2) er udformet som en enkeltcylinder-ikke-koronaelektrode (10),
hvori en adskillelse (11), der er fremstillet af et gennemtrængeligt strømledende materiale med høj porøsitet, er installeret på tværs af strømmen,

pladen (13), der er fremstillet af et strømledende filtermateriale, er anbragt over for enhver af de frie ender af cylinder-ikke-koronaelektroden, og
og nål-koronaelektroderne (12) af det første rum og det andet rum har deres spidser rettet mod hinanden og er elektrisk forbundet med hinanden og til den tilsvarende plade (13),
hvor nål-koronaelektroderne (12) af det første rum og det andet rum er forbundet til polen af strømforsyningen (4), som er modsat den pol, der er forbundet til nålelektroden (8) af forbehandlingsmidlerne (1).

3. Indretning ifølge krav 1, **kendetegnet ved, at** nål-koronaelektroderne (12) af det første rum og det andet rum af torumsinaktiveringskammeret (2) har deres spidser rettet i modstående retninger og er installeret koaksialt til de tilsvarende cylinderelektroder (10', 10") på de modstående sider af en adskillelse (11), som er fremstillet af et gennemtrængeligt strømledende filtermateriale med høj porøsitet, der er anbragt på tværs af strømmen mellem cylinder-ikke-koronaelektroderne (10', 10") og det første rum og det andet rum, og isoleret fra dem,
hvor pladerne (13), der er fremstillet af et strømledende filtermateriale og grænsende op til enderne af cylinderelektroderne ved indgangen og udgangen af inaktiveringskammeret (2), er elektrisk forbundet til hinanden og til den strømledende filterplade (7') af forbehandlingsmidlet (1), som er sidst langs strømmen, og
hvor nål-koronaelektroderne (12) er elektrisk forbundet til adskillelsen (11), der er fremstillet af et strømledende filtermateriale og anbragt mellem dem.

4. Indretning ifølge krav 1, **kendetegnet ved, at** torumsinaktiveringskammeret (2) er dannet af to cylinder-ikke-koronaelektroder (10', 10"), der er anbragt i rækker, en plade (16), der er fremstillet af et gennemtrængeligt strømledende filtermateriale med høj porøsitet, der grænser op til enden først langs strømmen af hver elektrode,
hvor ikke-koronaelektroderne (10', 10") er forbundet til de modstående poler af strømforsyningen (4), og hvor nål-koronaelektroderne (12) har deres spidser rettet mod strømmen, hvor nålelektroden (12) af den rum af kammeret er elektrisk forbundet til den strømførende plade (16), som grænser op til cylinderelektroden (10") af det andet rum, og nålelektroden (12) af det andet rum af inaktiveringskammeret (2) er elektrisk forbundet til den strømførende plade

af udskilleren (3), der er anbragt umiddelbart følgende efter denne elektrode.

5. Indretning ifølge et hvilket som helst af kravene 2 til 4, **kendetegnet ved, at** en plade (17), der er fremstillet et gennemtrængeligt, isolerende filtermateriale, er installeret mellem filterenheden (7') af forbehandlingsmidlerne (1) som nummer to langs strømmen og det første rum af inaktiveringskammeret (2).

6. Indretning ifølge krav 5, **kendetegnet ved, at** den yderligere indeholder mindst ét mere torumsinaktiveringskammer (18), som svarer til det første kammer (2), men har den modstående polaritet af elektrodeforbindelsen og er installeret i rækker til det første kammer langs strømmen, hvor retningen af nål-koronaelektroderne (12) af hvert næste kammer er identisk med eller modsat til retningen af nålelektroderne (12) af den forrige.

7. Indretning ifølge krav 6, **kendetegnet ved, at** en plade (19), der er fremstillet et isolationsmateriale med høj porøsitet, er installeret mellem de tilgrænsende strømledende filterplader (13) af det forrige og næste inaktiveringskammer (2, 18).

8. Indretning ifølge krav 6 eller 7, **kendetegnet ved, at** en nålelektrode (20) er elektrisk forbundet med den strømførende plade (14) af udskilleren (3) først langs strømmen, hvor elektroden (20) har sin spids rettet mod strømmen, og **ved, at** en cylinder-ikke-korona-elektrode (21) er installeret koaksialt med elektroden (20) og en plade (22), der er fremstillet af et strømledende filtermateriale grænser op til forenden af cylinderelektroden (21) og er elektrisk forbundet med nålelektroderne (12) af inaktiveringskammeret (2) sidst langs strømmen.

9. Indretning ifølge krav 6 eller 7, **kendetegnet ved, at** en cylinderelektrode (23) er forbundet med en ende deraf til den strømledende plade (14) af udskilleren (3) først langs strømmen,
en yderligere plade (24), der er fremstillet af et strømledende filtermateriale, er installeret på tværs af strømmen over den anden ende af cylinderelektroden (23), når en nål-koronaelektrode (25) er anbragt koaksialt med cylinderelektroden (23), har spidsen deraf rettet med strømmen, er elektrisk forbun-

det til den yderligere plade (24), og er forbundet til polen af strømforsyningen (4) over for polen forbundet med nålelektroden (12) af det sidste rum af inaktiveringskammeret (2).

10. Indretning ifølge et hvilket som helst af kravene 1 til 9, **kendetegnet ved, at** den er udstyret med mindst én strømturbulator (27), der er installeret opstrøms for udskilleren (3), der er i stand til at udligne koncentrationerne af partikler, der skal udskilles, ozon, eller ioner i strømmen, hvor mindst én af de strømledende plader (14) af udskilleren (3) og eller turbulatoren (27) er udstyret med en coating, som er i stand til at tilvejebringe nedbrydningen af ozon, nitrogenoxid og/eller andre harmfulde gasser.

11. Indretning ifølge et hvilket som helst af kravene 1 til 10, **kendetegnet ved, at** nål-koronaelektroden (12) er udformet som en tråd (28), der er installeret indvendigt i et metalrør (29) koaksialt dermed og ragende frem derfra.

12. Indretning ifølge et hvilket som helst af de foregående krav, **kendetegnet ved, at** mindst én af koronaelektroderne (8, 12, 20 og 25) er forbundet til strømforsyningen via en modstand (26), hvis modstandsværdi er udvalgt blandt den begrænsning, der pålægges spidsstrømforbruget for den indstillede spænding.

13. Indretning ifølge et hvilket som helst af de foregående krav, **kendetegnet ved, at** højspændingsstrømforsyningen (4) er udformet med tre autonome ledninger (a, b, and c), hvor en ledning (b) er forbundet med de strømledende plader (14) af udskilleren og med de strømledende filterenheder (7, 7') og spændingsstabiliseret og de andre to ledninger (a og c) er forbundet til henholdsvis nål-koronaelektroden (8 eller 12) og cylinder-ikke-koronaelektroden (6 eller 10) af hver respektive rum og er strømstabiliseret.

14. Indretning ifølge krav 13, **kendetegnet ved, at** højspændingsstrømforsyningen (4) er udformet med en mulighed for automatisk omstilling af driftsmodus fra spændingsstabilisering af den ledning, der er forbundet med de strømledende plader (14) af udskilleren og med de strømledende filterenheder (7, 7'), til strømstabilisering, når først en indstillet værdi af forbrugsstrømmen er nået.

15. Indretning ifølge et hvilket som helst af de foregående krav, **kendetegnet ved, at** de strømførende plader (14) af udskilleren er fremstillet af skummet metal, der er coatet med en isolerende coating.

DRAWINGS

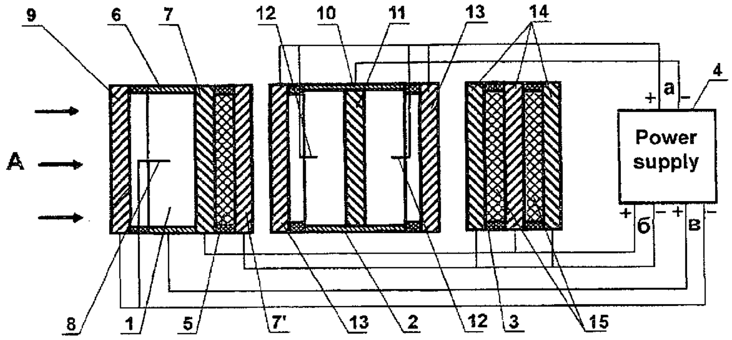

Fig. 1

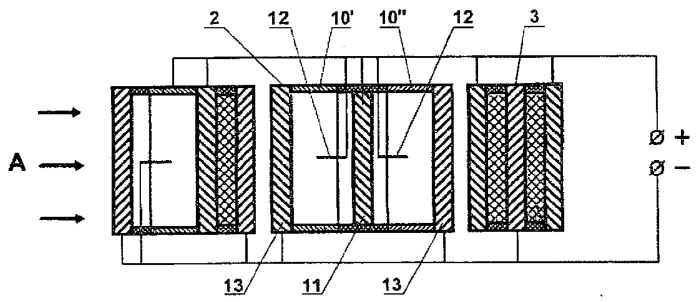

Fig. 2

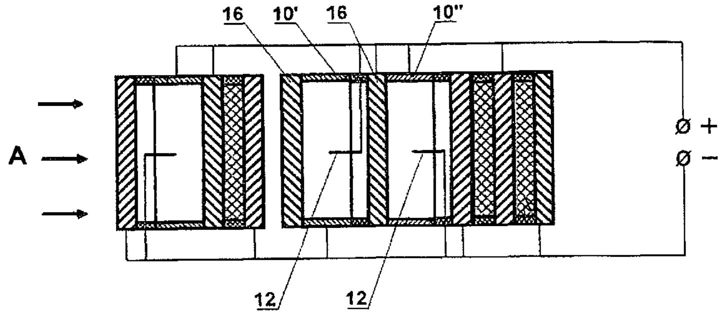

Fig. 3

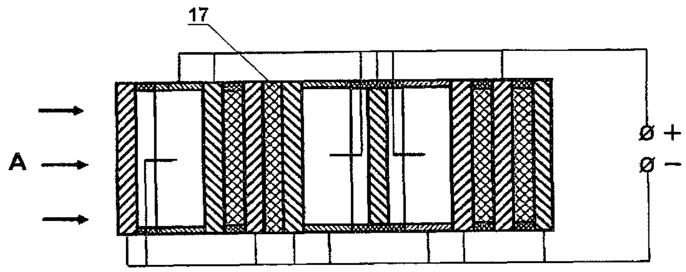

Fig. 4

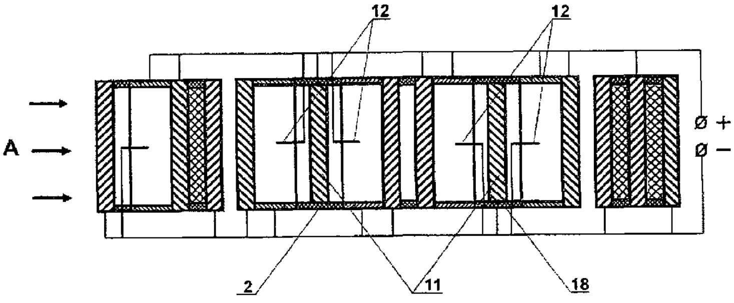

Fig. 5

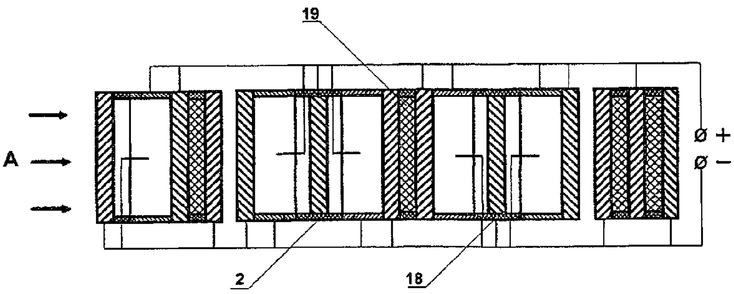

Fig. 6

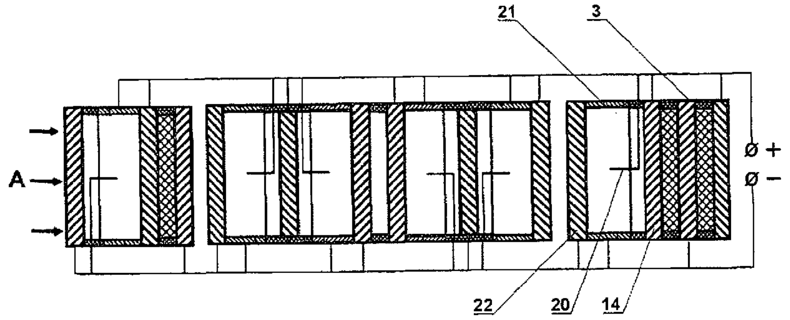

Fig. 7

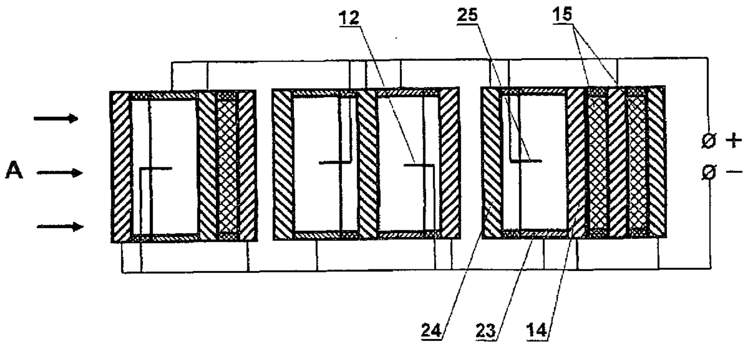

Fig. 8

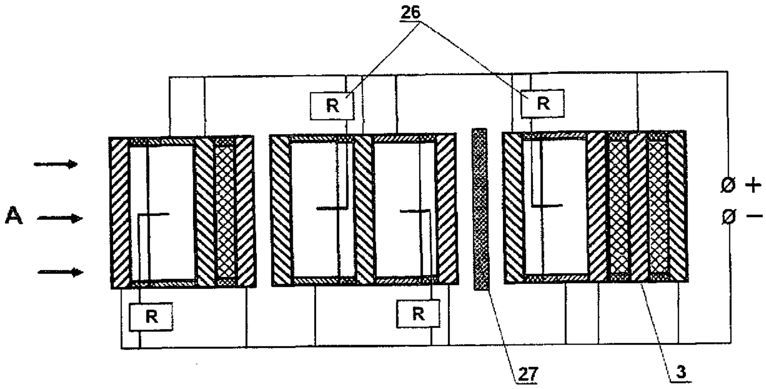

Fig. 9

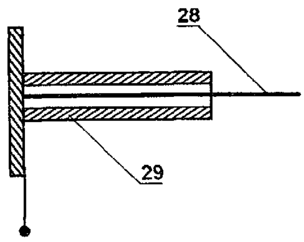

Fig. 10