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(54) **Electric discharging using a fluid**

Elektrisches Entladen unter Verwendung eines Fluids

Décharge électrique en utilisant un fluide

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Description

BACKGROUND ART

[0001] The present invention relates to discharging an electrically charged element.

[0002] A liquid chromatography/mass spectrometry device (LC/MSD) may provide molecular weight and structural information that complements the data from other liquid chromatography detectors. Such a device is e. g. disclosed in document US 2005/0017164 A1. These sets of data may provide confident compound identification from a single run and in one report. Different implementations include standard positive and negative ionization modes, and a choice of electrospray ionization (ESI) or atmospheric-pressure chemical ionization (APCI). This may allow the analysis of drugs and drug metabolites, proteins and peptides, pesticides and herbicides, and many other compounds. An example for such a device is an apparatus of the 1100 Series LC/MSD of Agilent Technologies.

[0003] In such a kind of apparatus, a tip of a separation device for separating different components of an analyte may emit a spray beam of the analyte which spray beam may be directed towards an inlet of a mass spectrometry device. In such a scenario, it may happen that the performance of the system is deteriorated due to electric charges which may be accumulating at the tip and/or at any tip surrounding parts.

DISCLOSURE

[0004] It is an object of the invention to provide efficient discharging of an electrically charged element. The object is solved by the independent claims. Further embodiments are shown by the dependent claims.

[0005] According to an exemplary embodiment of the present invention, a discharging device for discharging an electrically charged element (for example a tip of a measurement device emitting a spray beam) is provided, the discharging device comprising a fluid supply unit adapted to supply a fluid (for example a gas or a liquid or a combination thereof or a combination of a gas or a liquid with solid particles) to the electrically charged element in such a manner that the electrically charged element is at least partially discharged by the fluid (for example the electric charges may be carried away or removed from the tip using the fluid).

[0006] According to another exemplary embodiment, a measurement apparatus (for example a liquid chromatography/mass spectrometry device) is provided, the measurement apparatus comprising an electrically charged or chargeable element (for instance an element which is prone to be electrically charged during a normal operation of the measurement apparatus) and a discharging device having the above mentioned features for discharging the electrically charged element.

[0007] According to still another exemplary embodiment, a method of discharging an electrically charged element is provided, wherein the method comprises supplying a fluid (for example a fluid atmosphere or a fluid flow) to the electrically charged element in such a manner that the electrically charged element is at least partially discharged using the fluid.

[0008] According to an exemplary embodiment, gas flow grounding may be made possible, which may particularly denote removing electric charges from an electrically charged element by using a fluid, particularly a gas, which may be brought in functional contact with the electrical charges so as to remove these electrical charges from the electrically charged element using electric and/or mechanical forces. By taking this measure, the implementation of a conventional grounding system using an electrical conducting connection between an electrically charged element and a ground potential may become dispensible. Furthermore, it may become possible that even an electrically insulating charged element may be electrically discharged. In many applications, it may be desirable that such an electrically insulating component is prevented from being electrically charged, since this may deteriorate the functionality of the electrically charged element, for instance in the case of a tip of a liquid chromatography mass spectroscopy device emitting a fluid spray of a sample to be separated.

[0009] In such a LC/MSD, it may happen that a fluidic sample stream to be separated is emitted by a tip of a plastics chip. The propagation direction of such a fluidic ion stream may be turned around so as to supply the stream to a channel for feeding in the ion stream into a mass spectroscopy device for further analysis. Such an ion stream may be forced to turn using an electric field generated by applying a high voltage of, for instance, 2 kV to suitably arranged electrodes.

[0010] In such a scenario, it may happen that the tip of the plastics chip and/or other components of the LC/MSD or another measurement device, for instance a chamber wall of the LC/MSD, is or are electrically charged during the operation of such a device. It may be helpful to provide a metallization or any other electrically conducting connection between the charged device and an electrical ground potential. However, this may involve a high expenditure and may be undesired in particular circumstances.

[0011] According to an exemplary embodiment, the grounding of such an electrically charged electrically insulating element may be achieved or supported by a gas flow which removes the electrical charges from the charged element in order to promote its neutralization.

[0012] For this purpose, the electrically charged element may be rinsed using the electrically discharging gas or fluid. For instance, a mixture of essentially 95% Nitrogen (N_2) and of essentially 5% Oxygen (O_2) may be used. The Oxygen containing atmosphere may astonishingly significantly improve the electrically discharging functionality of the rinsed gas.

[0013] It may be particularly advantageous to use such an electrically discharging gas in a chamber in which a high electric voltage is present, for instance for redirecting the ions of a sample to be analyzed from an electrically charged tip to a channel of a mass spectroscopy device. It is believed that, under such conditions, the Oxygen contribution of the discharging gas is capable to at least partially reduce charges or to transport away charges of electrically charged particles.

[0014] According to an exemplary embodiment, the system in which the element to be discharged is arranged is a completely self-contained system which is separated or decoupled from the environment. In other words, the gas atmosphere inside of the self-contained system used for discharging the electrically charged element may be adjusted to be selectively different from an atmosphere outside of the self-contained system. By shielding this interior atmosphere from the exterior environment, it may be prevented that contaminations are undesirably injected into the measurement space.

[0015] By continuously discharging a tip of a measurement device emitting a spray of a sample to be analyzed, it may prevented that the continuous ion transport is interrupted which may deteriorate the functionality, particularly the mass separation functionality, of the device. Such problems which may occur conventionally may be efficiently prevented by grounding the tip using a gas stream.

[0016] Using a pure Nitrogen atmosphere or stream may, under certain circumstances, be not sufficient to efficiently remove all the electrical charge from the tip. Nitrogen is a relatively inert substance, so that a decomposition of the materials of the apparatus may be avoided by using a Nitrogen contribution for an anti-ionizing fluid. On the other hand, pure Oxygen is a strong oxidizing agent which may cause a decomposition of materials of the apparatus in a very high concentration. It has been discovered that a mixture of Oxygen and Nitrogen may provide both simultaneously, a proper discharging of an electrically charged element and a gentle treatment of the device.

[0017] Therefore, two opposing effects may be satisfied with a mixture of Nitrogen and Oxygen. The Nitrogen component is an inert carrier gas, and the Oxygen component is an ion transporting gas which is polarizable easily. Therefore, according to an exemplary embodiment, a two-component rinse gas composition of (preferably a large amount of) Nitrogen and of (preferably a small amount of) Oxygen may be provided as a discharging gaseous composition.

[0018] The discharging fluid may be provided as a laminar or turbulent stream which conveys the electrically charges dynamically. Additionally or alternatively, the discharging fluid can be provided as a resting gas composition (i.e. a static "atmosphere") which may be brought in functional contact with an element to be discharged in a closed space.

[0019] The discharging gas may be provided by a gas generator, for instance a Nitrogen generator generating Nitrogen based on surrounding air and removing other components from the air by filtering. The Nitrogen generator may be adapted in such a manner that particularly the Oxygen component is filtered out of the surrounding air, but preferably only up to a predeterminable extent, so that a selectable mixture of Nitrogen as a main component and a small contribution of Oxygen may be inserted to a space accommodating the electrically charged element to be discharged.

[0020] Alternatively, a Nitrogen-Oxygen mixing generator may be provided, or gas bottles including the various gas contributions may be provided and may be mixed using suitably operated or controlled valves.

[0021] Embodiments of the invention may particularly be provided for use with a HPLC chip/MS interface, that is an interface between a liquid chromatography device and a mass separation device.

[0022] A device according to an exemplary embodiment may provide improved sensitivity by efficiently transporting away electrically charges on the tip of a liquid chromatography chip. The space in which the discharging gas is provided may be (essentially completely) shielded with respect to the environment, for instance by taking corresponding measures like providing sealings, etc. In such a sealed device, the gas components may be selectively inserted, wherein the contributions may be selected so that both an efficient electrical discharging and a gentle handling of the devices may be possible.

[0023] Exemplary embodiments may be particularly related to a closed system in which the gas atmosphere adjacent the electrically charged element is decoupled from the environment. In such a system, even more than in an open system, problems resulting from electrically charged elements may occur, which may be eliminated or reduced using an appropriate rinse gas. Such a rinse gas may be a gas flow or a constant gas atmosphere.

[0024] Thus, exemplary embodiments may allow to ground a charged or chargeable element using a gas or a liquid for eliminating charges or for avoiding a charging of an element from the very beginning.

[0025] By discharging elements of a closed measurement system, a background signal may be reduced, and an improved signal-to-noise ratio may be obtained. Furthermore, such a measurement may be less sensitive with respect to laboratory conditions. Particularly, a certain amount of Oxygen may be added to a Nitrogen carrier for stabilizing such a system.

[0026] Discharging features according to exemplary embodiments may be particular applied to a fluidic plastics chip of, for instance, polyimide. Within such a chip, a column of a liquid chromatography system may be embedded. A pump may pump an analyt through this column. At the end of such a plastics chip, a tip may be formed, and this tip may be adapted for emitting a spray stream of the analyt to be examined. An electrical potential of, for instance, 2 kV may be applied between a cone like channel of an inlet of a mass spectroscopy device and a counter electrode. The spray which is emitted from the tip is redirected under the influence of the electric field so that the ions of the spray stream are fed into the mass spectroscopy device for further analysis. By discharging the tip of such a plastics chip sensor, deterioration of the tip (for example due to arc discharge effects) may be avoided. The mass spectroscopy function of the mass spectroscopy device may then be performed as known by the person skilled in the art.

[0027] According to an exemplary embodiment, gas flow grounding for a mass spectroscopy spray may be provided. In order to improve the spray quality and the spray stability in ESI applications (Electro Spray Ionization), a defined Oxygen contribution or a contribution of a chemically similar material may be added to a Nitrogen carrier gas component in a closed spray environment.

[0028] For instance, a Nitrogen generator may introduce Nitrogen in an abutting portion between a cube and an ion trap of an MS. Inside of such a spray chamber, a tip of a fluidic device may emit a stream including components to be separated. Under the influence of high electric fields being present in this spray chamber, the stream may be directed into a cone-like inlet of a mass spectroscopy device. This cone may have an electrical potential of, for instance, -1800 Volt as compared to a counter electrode. A PEEK ring beneath the cone may emit a defined Nitrogen-Oxygen gas mixture so as to electrically discharge the tip of the microfluidic device. Furthermore, an exhaust air tube may be provided for pumping or transporting air from the inside of the spray chamber to the exterior atmosphere.

[0029] Next, further exemplary embodiments will be described.

[0030] In the following, further exemplary embodiments of the discharging device for discharging an electrically charged element will be explained. However, these embodiments also apply for the measurement apparatus and for the method of discharging an electrically charged element.

[0031] The fluid may be a gas. Alternatively, the fluid may be a liquid or a gas-liquid mixture. It is also possible that the fluid comprises a mixture of a gas and/or a fluid with solid particles (for instance to form some kind of smoke).

[0032] The fluid supply unit may be adapted to supply a fluid flow to the electrically charged element, and the electrically charged element may be at least partially discharged by the fluid flow. By providing a streaming fluid/fluid flow, a mechanical force or pressure may act on the electrically charged element so as to mechanically promote the discharging function.

[0033] The fluid may be a gas flow directed towards the electrically charged element. By such a vectored or directional oriented fluid flow, an efficient and selective discharging with a high spatial resolution may be achieved.

[0034] The fluid may be a gas comprising multiple components. By using a plurality of components for such a gas, different properties of the discharging fluid may be selectively adjusted so as to improve and to refine the discharging capability.

[0035] The fluid supply unit may be adapted to dispatch electrical charge of the electrically charged element to a reference potential, for instance to an electrical ground potential using the fluid. Therefore, a fluid supported grounding may be obtained.

[0036] The discharging device may comprise a dosing unit adapted for controlling the fluid supply unit so as to dose the fluid. Such a dosing unit may include a control unit which receives sensor information concerning the actual gas atmosphere in the measurement chamber, a charging state of the electrically charged element to be discharged, etc. Using such sensor information, the control unit may accurately adjust valves or the like so as to control or regulate the components and their relative contributions to the discharging fluid.

[0037] Furthermore, the fluid may be a gas comprising an inert carrier gas component and an electrical charge dispatching gas component. The inert carrier gas component may be provided as a carrier (for example as a main component) which is essentially inert and thus does not corrode components of or otherwise deteriorates the measurement apparatus. The electrical charge dispatching gas component on the other hand may be the "active" component which efficiently removes the electrical charge.

[0038] The inert carrier gas component may be one of the group consisting of Nitrogen, Helium, Neon, and Carbon dioxide. However, any other chemicals may be used having such essentially inert characteristics within a measurement chamber.

[0039] The electrical charge dispatching gas component may be one of the group consisting of Oxygen, Chlorine, Fluorine, and Carbon monoxide. However, any other chemical may be used as the electrical charge dispatching gas component provided that it has electrical charge dispatching properties.

[0040] An amount of the inert carrier gas component may be larger, particularly significantly larger, than an amount of the electrical charge dispatching gas component. Thus, the ratio of the contributions of the inert carrier gas component to the electrical charge dispatching gas component may be larger than one, particularly larger than three, more particularly larger than ten.

[0041] The inert carrier gas component may be less polarizable than the electrical charge dispatching gas component. Therefore, the inert carrier gas component may serve for treating the apparatus with care and without chemically aggressive effects, and the high polarizability of the electrical charge dispatching gas component may promote the electrical discharging of the electrically charged element.

[0042] Moreover, the inert carrier gas component may be less polarizable than the electrical charge dispatching gas component.

[0043] Particularly, the inert carrier gas component may be Nitrogen and the electrical charge dispatching gas component may be Oxygen. The combination of Nitrogen and Oxygen, more particularly with a properly selected contribution ratio, has turned out to be particularly efficient in practical experiments.

[0044] The weight percentage of Nitrogen may be in the range between 90% and 99.5%, particularly in the range between 92% and 97%, and more particularly in the range between 93% and 95%. The weight percentage of Oxygen may be in the range between 0.5% and 10%, particularly in the range between 3% and 8%, and more particularly in the range between 5% and 7%.

[0045] Preferably, the weight percentage of Nitrogen may be in the range between 92% and 97%, and the weight percentage of Oxygen may be in the range between 3% and 8%. More preferably, the weight percentage of Nitrogen may be in the range between 93% and 95%, and the weight percentage of Oxygen may be in the range between 5% and 7%. These ratios have turned out to be especially efficient with respect to the removal of electrical charges from an electrically charged element in practical experiments.

[0046] In the following, further exemplary embodiments of the measurement apparatus will be described. However, these embodiments also apply for the discharging device and for the method of discharging an electrically charged element.

[0047] The electrically charged element may comprise or may consist of an electrically insulating material. Thus according to an exemplary embodiment, it is made possible to electrically discharge an electrically insulating material which is a challenge and which is quite sophisticated due to the non-conducting property of the electrically charged element.

[0048] For instance, the electrically charged element may comprise a material of the group consisting of a ceramics, polyimide, polypropylene, polyethylene, polytetrafluorethylene, polyesterimide, polyetherimide, and polyamideimide.

[0049] The electrically charged element may be a microfluidic chip. The term "microfluidic device" or "microfluidic chip" may particularly denote a fluidic device as described herein which allows to convey fluid through micropores or microchannels, that is pores or channels having a dimension in the order of magnitude of micrometers.

[0050] The electrically charged element may comprise an electrically conductive material so as to electrically transport electrical charges of the electrically charged element to an electric ground potential. Such an electrically conductive grounding feature may promote, in addition to the fluid-supported grounding, the discharging of the electrically charged element.

[0051] The measurement apparatus may be adapted to analyze at least one of the group consisting of a physical, a chemical and a biological parameter of at least one compound of a fluidic sample to be analyzed by the measurement apparatus. The term "physical parameter" may particularly denote a mass, or a size or a temperature of the fluid or of a contribution therefrom. The term "chemical parameter" may particularly denote a charge of a fraction of the analyt, a concentration of a fraction of the analyt, an affinity parameter, or the like. The term "biological parameter" may particularly denote a concentration of a protein, a gene or the like in a biochemical solution, a biological activity of a component, etc.

[0052] The electrically charged element may comprise a tip adapted to emit a fluidic sample to be analyzed using the measurement apparatus. Such a fluidic sample may be, for instance, a chemical or biological sample to be analyzed with regard to the components thereof.

[0053] Particularly, the measurement apparatus may comprise a separation device coupled to the tip. Such a separation device may be capable of separating different components of the stream emitted by the tip, for instance based on differing physical parameters like weight, electrical charge, ratio thereof, or the like.

[0054] The separation device may comprise at least one of the group of a sensor device, a device for chemical, biological and/or pharmaceutical analysis, an electrophoresis device, a capillary electrophoresis device, and a liquid chromatography device. Particularly, the fluidic device may be a high performance liquid chromatography device (HPLC) in which different fractions of an analyt may be separated and investigated.

[0055] The measurement apparatus may comprise an analysis unit having a channel adapted in such a manner that the fluidic sample emitted by the tip is supplied to the channel for analysis. For this purpose, the fluidic sample may be, if desired or necessary, redirected, for instance by generating an electrical force resulting from a (high) voltage applied between different components of the apparatus, for instance between a counter electrode and a channel of the analysis unit.

[0056] The channel of the measurement apparatus may be adapted in such a manner that the fluidic sample emitted by the tip is supplied to the channel for analysis, and the measurement apparatus comprises a mass spectrometer coupled to the analysis unit. This mass spectrometer may be adapted to separate the different components of a sprayed sample which is emitted from the tip and which is conducted inside the channel of the mass spectrometer. Such a mass spectrometer may be denoted as an analytical device which may determine the mass to charge ratio of ions of the sample. Thus, the mass spectroscopy device of the measurement apparatus may be used to find the composition of the sample by generating a mass spectrum representing the masses of the components. In this context, mass spectrometry may be denoted as an analytical technique which may allow to determine the mass-to-charge ratio of ions. It may be used to analyse the composition of a physical, chemical or biological sample by generating a mass spectrum representing the masses of at least a part of the components of a sample.

[0057] Furthermore, the measurement apparatus may comprise a sealed housing accommodating the electrically charged element and the discharging device so as to define a self-contained system in an interior of the housing. In other words, the atmosphere surrounding the electrically charged element inside the housing may be decoupled from an atmosphere in the outer environment of the housing.

[0058] The sealed housing may be adapted to define a gas atmosphere in the interior of the housing. Furthermore, the sealed housing may be adapted to define the gas atmosphere in the interior of the housing in a manner to differ from the gas atmosphere in the exterior of the housing.

[0059] Next, an exemplary embodiment of the method of discharging an electrically charged element will be explained. However, this embodiment also applies for the discharging device for discharging an electrically charged element, and for the measurement apparatus.

[0060] The method may comprise controlling the fluid supply unit for dosing the fluid. In other words, the composition or other parameters defining the supplied fluid may be selectively predetermined by a user or by a machine-controlled entity so as to be in accordance with requirements of a particular application for discharging the electrically charged element.

BRIEF DESCRIPTION OF DRAWINGS

[0061] Other objects and many of the attendant advantages of embodiments of the present invention will be readily appreciated and become better understood by reference to the following more detailed description of embodiments in connection with the accompanied drawings. Features that are substantially or functionally equal or similar will be referred to by the same reference signs.

Fig. 1 shows a discharging device according to an exemplary embodiment.

Fig. 2 shows a measurement apparatus according to an exemplary embodiment.

Fig. 3 shows a fluid supply unit for a discharging device according to an exemplary embodiment.

Fig. 4 shows a measurement apparatus according to an exemplary embodiment.

[0062] The illustration in the drawing is schematically.

[0063] In the following, referring to Fig.1, a discharging device 100 according to an exemplary embodiment will be described.

[0064] The discharging element 100 is adapted for discharging an electrically charged element 101. The discharging device 100 comprises a fluid supply unit 102 which is adapted to supply a fluid 103 to the electrically charged element 101 in such a manner that the electrically charged element is at least partially discharged by the fluid 103.

[0065] In other words, a gas flow 103 is generated by the fluid supply unit 102 in such a manner that the gas flow is brought into functional contact with electrical charges 104 accumulated at a tip of the electrically charged element 101. The electrically charged element 101 may be the end portion of a microfluidic device in which a fluidic sample 105 has been separated in a manner which is not shown in Fig. 1.

[0066] The microfluidic sample 105 is emitted, at the tip of the electrically charged element 101, as a spray stream (see arrow) which is further separated by a mass spectrometer which is not shown in Fig. 1. The emission of the spray 105 may have the (undesired) consequence that the tip of the electrically insulating element 101 is charged (see accumulation of ions 104). The electrically charged element 101 may be made of polyimide. The gas flow 103 may, as a result of mechanical and/or electrical forces, remove a part of the electrically charged ions 104 from the tip 101 so as to electrically neutralize the tip 101 or, in other words, to effectively ground the electrically insulating tip 101.

[0067] For this purpose, the fluid stream 103 may comprise a mixture of 95% Nitrogen and 5% Oxygen.

[0068] The contributions of the fluid 103 may be selectively dosed so as to be in accordance with predetermined requirements of a special application. For instance, the components of the gas stream 103, their relative contributions, a gas stream velocity, etc. may be adjusted in accordance with the requirements of a particular application.

[0069] In the following, referring to Fig. 2, a measurement apparatus 200 according to an exemplary embodiment will be explained.

[0070] The measurement apparatus 200 comprises an electrically charged element 101 and a discharging device 220 for discharging the electrically charged element 101.

[0071] A liquid chromatography device 206 may comprise a polyimide microfluidic chip 101. At a tip-like end portion 204 of the electrically insulating member 101, an ion stream 205 of separated components of a biological sample is emitted. The different components of the sample have already been pre-separated in the liquid chromatography device 206 and in the microfluidic chip 101.

[0072] A voltage of, for instance, 2 kV may be applied between a cone-shaped inlet 210 of a mass spectroscopy device 207 and a counter electrode 213 using a high voltage source 214. Under the influence of the electric field generated by this high voltage, the ion stream 205 is redirected from an essentially vertical to an essentially horizontal direction so as to be transported from the tip 204 into a channel 208 of the cone-like inlet 210.

[0073] During the operation of the measurement apparatus 200, it may happen that the tip 204 is electrically charged due to the emission of the ion stream 205. In order to suppress or eliminate disturbing phenomena resulting from this effect, the discharging device 220 may help to discharge the tip 204.

[0074] The discharging device 220 comprises a Nitrogen container 215 and an Oxygen container 216, wherein Nitrogen and Oxygen included in these containers 215, 216 can be introduced into a measurement chamber 221 of the measurement apparatus 200 by correspondingly controlling first to third valves 201 to 203. Valves 201 and 202 can be used for adjusting a mixture of Nitrogen and Oxygen. By opening valve 203, this mixture may be introduced in the measurement chamber 221. For instance, a mixture of 95% Nitrogen and 5% Oxygen may be inserted in the measurement chamber 221. This static mixture may be capable of efficiently removing charges from the tip 204 so as to electrically discharge the tip 204 of the microfluidic device 101.

[0075] In case that it is desired to remove gas from the measurement chamber 221, a fourth valve 211 may be selectively operated so that a pump 212 may evacuate the measurement chamber 221, for instance for exchanging the gas atmosphere.

[0076] Furthermore, it is shown in Fig. 2 that the measurement chamber 221 is delimited by a sealed housing 209 which accommodates the electrically charged element 101 and a part of the discharging device 220 so as to define a self contained system in which an interior of the housing 209 is decoupled from an exterior gas atmosphere 222.

[0077] Next, referring to Fig. 3, a fluid supply unit 300 for a discharging device according to an exemplary embodiment will be described.

[0078] Fig. 3 shows in more detail portions of the discharging device 220 of Fig. 2. The Nitrogen bottle 215 and the Oxygen bottle 216 store Nitrogen and Oxygen, respectively, which may be, by opening the valves 201 or 202, inserted in a mixing chamber 303. In this mixing chamber 303, a desired mixture ratio between these two components and, if desired, of at least one further component, may be prepared. In the described embodiment, this mixture may contain 95% Nitrogen 301 and 5% Oxygen 302. The molecules in the mixing chamber 303 are only shown for illustrative purposes and do not necessary fulfil the stochiometric ratio of 95:5. Opening the valve 203 may insert the desired electrically discharging gas 301, 302 into a measurement space, like the chamber 221 shown in Fig. 2.

[0079] The valves 201 to 203 may be operated manually, or may be controlled automatically in response to sensor signals detected from the measurement chamber and/or from the tip 204. When it is determined, based in such sensor parameters, that the atmosphere in the interior 221 of the apparatus 200 should be modified, then the valves 201 to 203 may be selectively regulated. The same holds for a human user which operates the valves 201 to 203.

[0080] In the following, referring to Fig. 4, a measurement apparatus 400 according to an exemplary embodiment will be explained.

[0081] The measurement apparatus 400 distinguishes from the measurement apparatus 200 in the detailed configuration of the discharging device.

[0082] In Fig. 4, the electrical discharging fluid 103 is emitted at a position between the cone-like inlet 210 and the mass spectrometer 207. Therefore, the gas stream 103 can be directed towards the tip of the electrically charged element 101 for an efficient removal of electrical charge therefrom.

[0083] It should be noted that the term "comprising" does not exclude other elements or features and the "a" or "an" does not exclude a plurality. Also elements described in association with different embodiments may be combined. It should also be noted that reference signs in the claims shall not be construed as limiting the scope of the claims.

Claims

1. A measurement apparatus (200) comprising
an element (101) having a tip (204) adapted to emit a fluidic sample (205) to be analyzed using the measurement apparatus (200), **characterised in that** the element (101) comprises or consists of an electrically insulating material being electrically charged resulting from the emission of the fluidic sample (205), and
a discharging device (100) for discharging the element (101) and comprising a fluid supply unit (102) adapted to supply a fluid (103) to the element (101) in such a manner that the element (101), if electrically charged, is at least partially discharged by the fluid (103).

2. The measurement apparatus (200)of claim 1, comprising at least one of the following features
the fluid (103) is a gas preferably with a gas flow directed towards the electrically charged element (101);
the fluid supply unit (102) is adapted to dispatch electrical charge (104) of the electrically charged element (101) to an electric ground potential using the fluid (103);
the discharging device (100) comprises a dosing unit (201 to 203) adapted for controlling the fluid supply unit (102) for dosing the fluid (103).

3. The measurement apparatus (200) of claim 1 or any one of the above claims, wherein the fluid (103) is a gas comprising an inert carrier gas component (301) and an electrical charge dispatching gas component (302).

4. The measurement apparatus (200) of claim 3, comprising at least one of the following features
the inert carrier gas component (301) is one of the group consisting of Nitrogen, Helium, Neon, and Carbon dioxide;
the electrical charge dispatching gas component (302) is one of the group consisting of Oxygen, Chlo-

rine, Fluorine, and Carbon monoxide;
an amount of the inert carrier gas component (301) is larger, particularly significantly larger, than an amount of the electrical charge dispatching gas component (302);
the inert carrier gas component (301) is less polarizable than the electrical charge dispatching gas component (302).

5. The measurement apparatus (200) of claim 3 or any one of the above claims,
wherein the inert carrier gas component (301) is Nitrogen and the electrical charge dispatching gas component (302) is Oxygen.

6. The measurement apparatus (200) of claim 5, wherein
the weight percentage of Nitrogen is in the range between 90% and 99.5%, and the weight percentage of Oxygen is in the range between 0.5% and 10%.

7. The measurement apparatus (200) of claim 1 or any one of the above claims, comprising at least one of the following features
the element (101) comprises or consists of at least one material of the group consisting of a ceramic, polyimide, polypropylene, polyethylene, polytetrafluorethylene, polyester, polyether, and polyamide;
the electrically charged or chargeable element (101) comprises an electrically conductive material so as to be capable of electrically transporting electrical charges of the electrically charged or chargeable element to an electric ground potential.

8. The measurement apparatus (200) of claim 1 or any one of the above claims, comprising at least one of the following features
the electrically charged or chargeable element (101) is a microfluidic chip;
the measurement apparatus (200) is adapted to analyze at least one of the group consisting of a physical, a chemical and a biological parameter of at least one compound of a fluidic sample to be analyzed using the measurement apparatus (200).

9. The measurement apparatus (200) of claim 1 or any one of the above claims, wherein
the measurement apparatus (200) comprises a separation device (206) coupled to the tip (204), wherein preferably the separation device (206) comprises at least one of a sensor device, a device for chemical, biological and/or pharmaceutical analysis, an electrophoresis device, a capillary electrophoresis device, and a liquid chromatography device.

10. The measurement apparatus (200) of claim 1 or any one of the above claims, wherein
the measurement apparatus (200) comprises an analysis unit (207) having a channel (208) adapted in such a manner that the fluidic sample (205) emitted by the tip (204) is supplied to the channel (208) for analysis, and preferably comprises a mass spectrometer coupled to the analysis unit (207).

11. The measurement apparatus (200) of claim 1 or any one of the above claims, wherein
the measurement apparatus (200) comprises a sealed housing (209) accommodating the electrically charged or chargeable element (101) and the discharging device so as to define a self-contained system in an interior of the housing (209), wherein preferably the sealed housing (209) is adapted to define the gas atmosphere in the interior of the housing (209) preferably differing from a gas atmosphere in an exterior of the housing (209).

12. A method of discharging an element (101) having a tip (204) adapted to emit a fluidic sample (205) to be analyzed using the measurement apparatus (200), **characterized in that** the element (101) comprises or consists of an electrically insulating material being electrically charged resulting from the emission of the fluidic sample (205), the method comprises
supplying a fluid (103) to the electrically charged element (101) in such a manner that the electrically charged element (101) is at least partially discharged using the fluid (103).

13. The method of claim 12,
comprising controlling the fluid supply unit (102) for dosing the fluid (103).

Patentansprüche

1. Eine Messvorrichtung (200) aufweisend

ein Element (101), welches eine Spitze (204) hat, welche eingerichtet ist, eine fluidische Probe (205) abzugeben, welche zu analysieren ist unter Verwenden der Messvorrichtung (200),
dadurch gekennzeichnet, dass

das Element (101) aufweist oder besteht aus

einem elektrisch isolierenden Material, welches elektrisch geladen ist als Folge der Abgabe der fluidischen Probe (205), und
einer Entladevorrichtung (100) zum Entladen des Elements (101) und aufweisend
eine Fluid Zuführeinheit (102), welche eingerichtet ist, dem Element (101) ein Fluid (103) derartig zuzuführen, dass das Element (101), falls es elektrisch geladen ist, zumindest teilweise mittels des Fluids (103) entladen wird.

2. Die Messvorrichtung (200) gemäß Anspruch 1, aufweisend zumindest eines der folgenden Merkmale

das Fluid (103) ist ein Gas, bevorzugt mit einem Gasstrom, welcher in die Richtung des elektrisch geladenen Elements (101) gerichtet ist;
die Fluid Zuführeinheit (102) ist eingerichtet, die elektrische Ladung (104) des elektrisch geladenen Elements (101) zu einem elektrischen Massepotenzial zu transportieren unter Verwenden des Fluids (103);
die Entladevorrichtung (100) weist eine Dosiereinheit (201 bis 203) auf, welche eingerichtet ist zum Steuern der Fluid Zuführeinheit (102) zum Dosieren des Fluids (103).

3. Die Messvorrichtung (200) gemäß Anspruch 1 oder irgendeinem der vorangehenden Ansprüche, wobei das Fluid (103) ein Gas ist, welches eine inerte Trägergaskomponente (301) und eine elektrische Ladung Transportgaskomponente (302) aufweist.

4. Die Messvorrichtung (200) gemäß Anspruch 3, aufweisend zumindest eines der folgenden Merkmale

die inerte Trägergaskomponente (301) ist eines aus der Gruppe bestehend aus Stickstoff, Helium, Neon und Kohlendioxid;
die elektrische Ladung Transportgaskomponente (302) ist eines aus der Gruppe bestehend aus Sauerstoff, Chlor, Fluor und Kohlenmonoxid;
eine Menge der inerten Trägergaskomponente (301) ist größer, insbesondere signifikant größer, als eine Menge der elektrische Ladung Transportgaskomponente (302);
die inerte Trägergaskomponente (301) ist geringer polarisierbar als die elektrische Ladung Transportgaskomponente (302).

5. Die Messvorrichtung (200) gemäß Anspruch 3 oder irgendeinem der vorangehenden Ansprüche,

wobei die inerte Trägergaskomponente (301) Stickstoff ist und die elektrische Ladung Transportgaskomponente (302) Sauerstoff ist.

6. Die Messvorrichtung (200) gemäß Anspruch 5, wobei

der Gewichtsprozentsatz des Stickstoffs in einem Bereich zwischen 90 % und 99,5 % ist und der Gewichtsprozentsatz des Sauerstoffs in einem Bereich zwischen 0,5 % und 10 % ist.

7. Die Messvorrichtung (200) gemäß Anspruch 1 oder irgendeinem der vorangehenden Ansprüche, aufweisend zumindest eines der folgenden Merkmale

das Element (101) weist auf oder besteht aus zumindest einem Material aus der Gruppe bestehend aus einer Keramik, Polyimid, Polypropylen, Polyethylen, Polytetrafluorethylen, Polyester, Polyether und Polyamid;
das elektrisch geladene oder ladbare Element (101) weist ein elektrisch leitfähiges Material auf, um geeignet zu sein zum elektrischen Transportieren von elektrischen Ladungen des elektrisch geladenen oder ladbaren Elements zu einem elektrischen Massepotenzial.

8. Die Messvorrichtung (200) gemäß Anspruch 1 oder irgendeinem der vorangehenden Ansprüche, aufweisend zumindest eines der folgenden Merkmale

das elektrisch geladene oder ladbare Element (101) ist ein mikrofluidischer Chip;
die Messvorrichtung (200) ist eingerichtet zum Analysieren von zumindest einem aus der Gruppe bestehend aus einem physikalischen, einem chemischen und einem biologischen Parameter von zumindest einer Verbindung einer fluidischen Probe, welche zu analysieren ist unter Verwenden der Messvorrichtung (200).

9. Die Messvorrichtung (200) gemäß Anspruch 1 oder irgendeinem der vorangehenden Ansprüche, wobei

die Messvorrichtung (200) eine Trennvorrichtung (206) aufweist, welche mit der Spitze (204) gekoppelt ist, wobei die Trennvorrichtung (206) bevorzugt zumindest eines aufweist von einer Sensorvorrichtung, einer Vorrichtung für eine chemische, biologische und/oder pharmazeutische Analyse, eine Elektrophorese Vorrichtung, eine Kapillarelektrophorese Vorrichtung .und eine Flüssigchromatographie Vorrichtung.

10. Die Messvorrichtung (200) gemäß Anspruch 1 oder irgendeinem der vorangehenden Ansprüche, wobei

die Messvorrichtung (200) eine Analyseeinheit (207) aufweist, welche einen Kanal (208) hat, welcher derartig eingerichtet ist, dass die fluidische Probe (205), welche mittels der Spitze (204) abgegeben wird, dem Kanal (208) zur Analyse zugeführt wird, und bevorzugt ein Massenspektrometer aufweist, welches mit der Analyseeinheit (207) gekoppelt ist.

11. Die Messvorrichtung (200) gemäß Anspruch 1 oder irgendeinem der vorangehenden Ansprüche, wobei

die Messvorrichtung (200) ein abgedichtetes Gehäuse (209) aufweist, in welchem das elektrisch geladene oder ladbare Element (101) und die Entladevorrichtung aufgenommen sind, um ein abgeschlossenes System in einem Inneren des Gehäuses (209) zu definieren, wobei bevorzugt das abgedichtete Gehäuse (209) eingerichtet ist, die Gasatmosphäre in dem Inneren des Gehäuses (209) zu definieren, bevorzugt unterschiedlich von einer Gasatmosphäre in einem Äußeren des Gehäuses (209).

12. Ein Verfahren zum Entladen eines Elements (101), welches eine Spitze (204) hat, welche eingerichtet ist, eine fluidische Probe (205) abzugeben, welche zu analysieren ist unter Verwenden der Messvorrichtung (200),

dadurch gekennzeichnet, dass
das Element (101) aufweist oder besteht aus einem elektrisch isolierenden Material, welches elektrisch geladen ist als Folge der Abgabe der fluidischen Probe (205),

wobei das Verfahren aufweist

Zuführen eines Fluids (103) zu dem elektrisch geladenen Element (101) derartig, dass das elektrisch geladene Element (101) zumindest teilweise entladen wird unter Verwenden des Fluids (103).

13. Das Verfahren gemäß Anspruch 12, aufweisend

Steuern der Fluid Zuführeinheit (102) zum Dosieren des Fluids (103).

Revendications

1. Appareil de mesure (200) comprenant
un élément (101) ayant une pointe (204) adaptée pour émettre un échantillon fluidique (205) devant être analysé au moyen de l'appareil de mesure (200), **caractérisé en ce que** l'élément (101) comprend ou est constitué d'un matériau électriquement isolant qui est chargé électriquement suite à l'émission de l'échantillon fluidique (205), et
un dispositif de décharge (100) pour décharger l'élément (101) et comprenant une unité d'alimentation en fluide (102) adaptée pour fournir un fluide (103) à l'élément (101) de telle manière que l'élément (101), s'il est chargé électriquement, est au moins partiellement déchargé par le fluide (103).

2. Appareil de mesure (200) selon la revendication 1, comprenant au moins une des caractéristiques suivantes
le fluide (103) est un gaz ayant de préférence un flux de gaz dirigé vers l'élément chargé électriquement (101) ;
l'unité d'alimentation en fluide (102) est adaptée pour distribuer la charge électrique (104) de l'élément chargé électriquement (101) à un potentiel de masse électrique au moyen du fluide (103) ;
le dispositif de décharge (100) comprend une unité de dosage (201 à 203) adaptée pour contrôler l'unité d'alimentation en fluide (102) pour doser le fluide (103).

3. Appareil de mesure (200) selon la revendication 1 ou l'une quelconque des revendications ci-dessus, dans lequel le fluide (103) est un gaz comprenant une composante de gaz vecteur inerte (301) et une composante de gaz de distribution de charge électrique (302).

4. Appareil de mesure (200) selon la revendication 3, comprenant au moins une des caractéristiques suivantes
la composante de gaz vecteur inerte (301) est l'une du groupe constitué d'azote, hélium, néon et dioxyde de carbone ;
la composante de gaz de distribution de charge électrique (302) est l'une du groupe constitué d'oxygène, chlore, fluor et monoxyde de carbone ;
une quantité de la composante de gaz vecteur inerte (301) est plus importante, en particulier beaucoup plus importante, qu'une quantité de la composante de gaz de distribution de charge électrique (302) ;
la composante de gaz vecteur inerte (301) est moins polarisable que la composante de gaz de distribution de charge électrique (302).

5. Appareil de mesure (200) selon la revendication 3 ou l'une quelconque des revendications ci-dessus, dans lequel la composante de gaz vecteur inerte (301) est l'azote et la composante de gaz de distribution de charge électrique (302) est l'oxygène.

6. Appareil de mesure (200) selon la revendication 5, dans lequel
le pourcentage en poids d'azote est dans la plage comprise entre 90 % et 99,5 %, et
le pourcentage en poids d'oxygène est dans la plage comprise entre 0,5 % et 10 %.

7. Appareil de mesure (200) selon la revendication 1 ou l'une quelconque des revendications ci-dessus, comprenant au moins une des caractéristiques suivantes
l'élément (101) comprend ou est constitué d'au moins un matériau du groupe constitué d'une céramique, d'un polyimide, d'un polypropylène, d'un polyéthylène, d'un polytétrafluoroéthylène, d'un polyester, d'un polyéther et d'un polyamide ;
l'élément chargé ou chargeable électriquement (101) comprend un matériau électriquement conducteur de sorte à être capable de transporter électriquement des charges électriques de l'élément

chargé ou chargeable électriquement vers un potentiel de masse électrique.

8. Appareil de mesure (200) selon la revendication 1 ou selon l'une quelconque des revendications ci-dessus, comprenant au moins une des caractéristiques suivantes
l'élément chargé ou chargeable électriquement (101) est une puce microfluidique ;
l'appareil de mesure (200) est adapté pour analyser au moins l'un du groupe constitué d'un paramètre physique, d'un paramètre chimique et d'un paramètre biologique d'au moins un composé d'un échantillon fluidique devant être analysé au moyen de l'appareil de mesure (200).

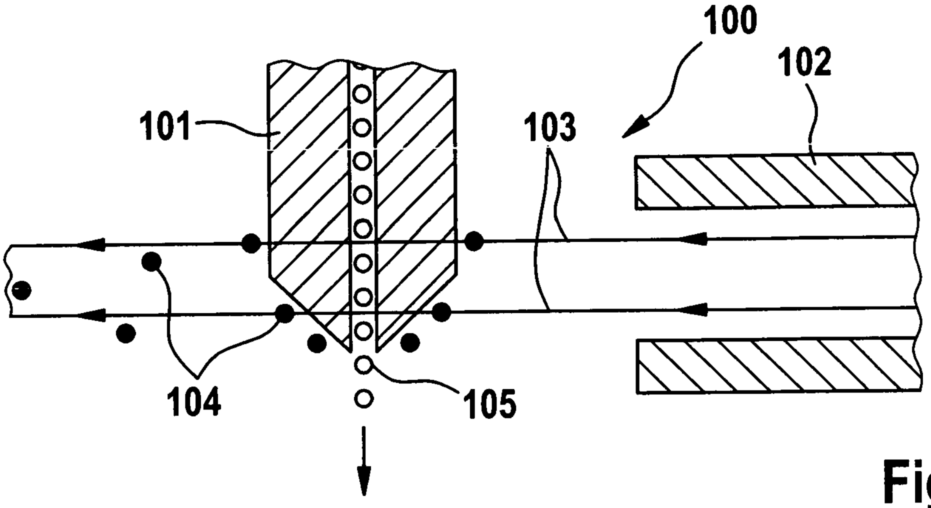
9. Appareil de mesure (200) selon la revendication 1 ou l'une quelconque des revendications ci-dessus, dans lequel
l'appareil de mesure (200) comprend un dispositif de séparation (206) couplé à la pointe (204), dans lequel de préférence le dispositif de séparation (206) comprend au moins l'un d'un dispositif capteur, d'un dispositif pour analyse chimique, biologique et/ou pharmaceutique, d'un dispositif d'électrophorèse, d'un dispositif d'électrophorèse capillaire et d'un dispositif de chromatographie liquide.

10. Appareil de mesure (200) selon la revendication 1 ou selon l'une quelconque des revendications ci-dessus, dans lequel
l'appareil de mesure (200) comprend une unité d'analyse (207) ayant un canal (208) adapté de telle manière que l'échantillon fluidique (205) émis par la pointe (204) est fourni au canal (208) pour analyse, et comprend de préférence un spectromètre de masse couplé à l'unité d'analyse (207).

11. Appareil de mesure (200) selon la revendication 1 ou l'une quelconque des revendications ci-dessus, dans lequel
l'appareil de mesure (200) comprend un logement scellé (209) logeant l'élément chargé ou chargeable électriquement (101) et le dispositif de décharge de sorte à définir un système autonome dans un intérieur du logement (209), dans lequel de préférence le logement scellé (209) est adapté pour définir l'atmosphère gazeuse à l'intérieur du logement (209) différant de préférence d'une atmosphère gazeuse dans un extérieur du logement (209).

12. Procédé de décharge d'un élément (101) ayant une pointe (204) adaptée pour émettre un échantillon fluidique (205) devant être analysé au moyen de l'appareil de mesure (200), **caractérisé en ce que** l'élément (101) comprend ou est constitué d'un matériau électriquement isolant qui est chargé électriquement suite à l'émission de l'échantillon fluidique (205), le procédé comprend
la fourniture d'un fluide (103) à l'élément chargé électriquement (101) de telle manière que l'élément chargé électriquement (101) soit au moins partiellement déchargé au moyen du fluide (103).

13. Procédé selon la revendication 12,
comprenant le contrôle de l'unité d'alimentation en fluide (102) pour doser le fluide (103).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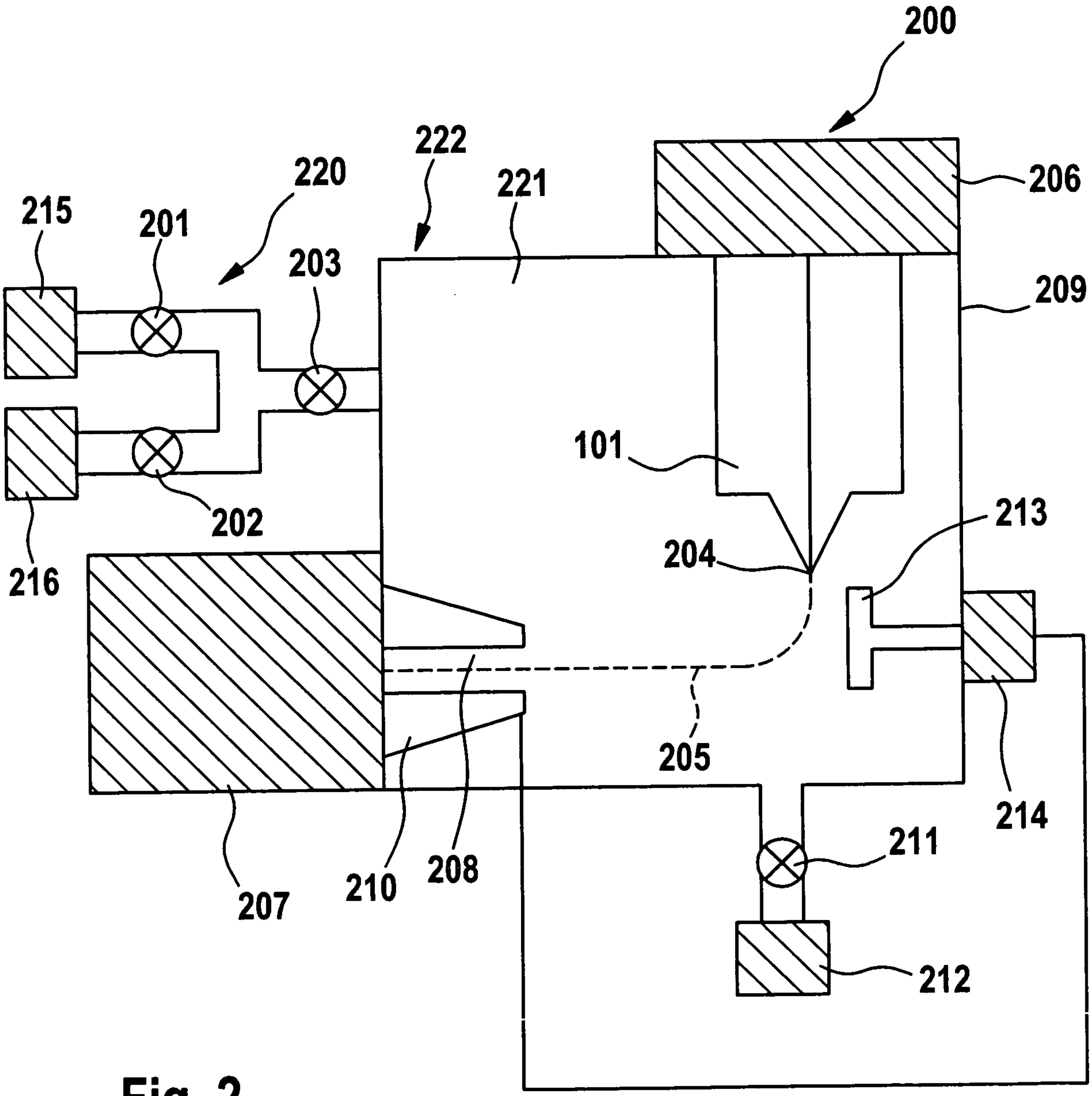
102
101
103
104
105

Fig. 1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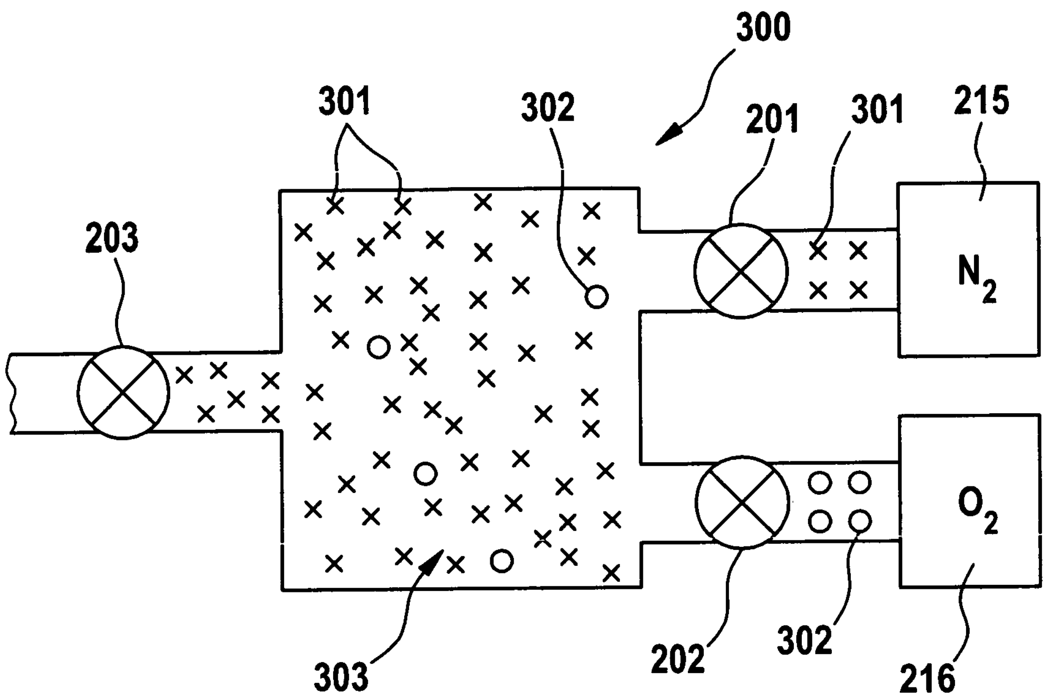
212

Fig. 2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302
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203
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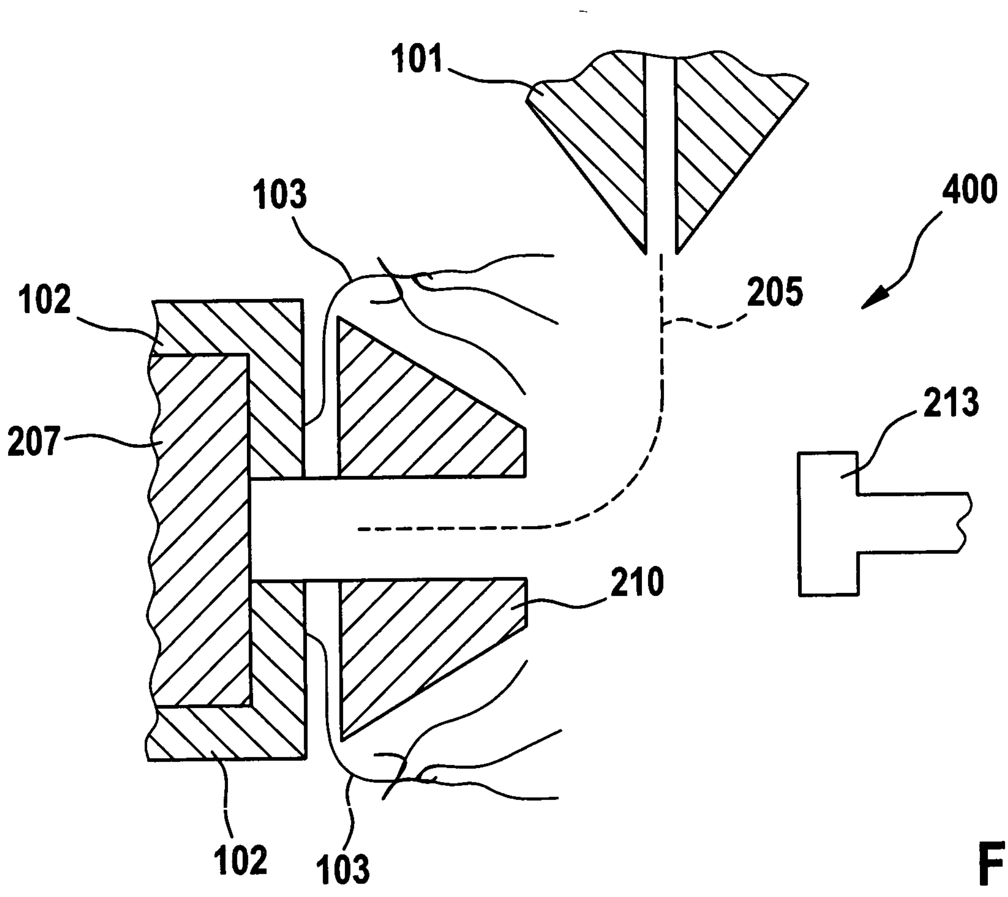
O2
303
202
302
216

Fig. 3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400
102
205
207
213
210
102
103

Fig. 4

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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