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(54) ODORIZATION DEVICE FOR COMBUSTABLE GAS AND METHOD FOR DISPENSING ODOUR GAS IN A GAS FLOW

(57) The invention relates to an odorization device for a combustable gas, such as natural gas, wherein the odorization device comprises an electrohydrodynamic atomisation (EHDA) apparatus that is configured to atomizing odorant into charged droplets of odorant for dispensing into a gas transportation means.

The invention further relates to a method for dispensing odorant into a gas stream and the use of an electrohydrodynamic atomisation (EHDA) apparatus in a method according to the invention.

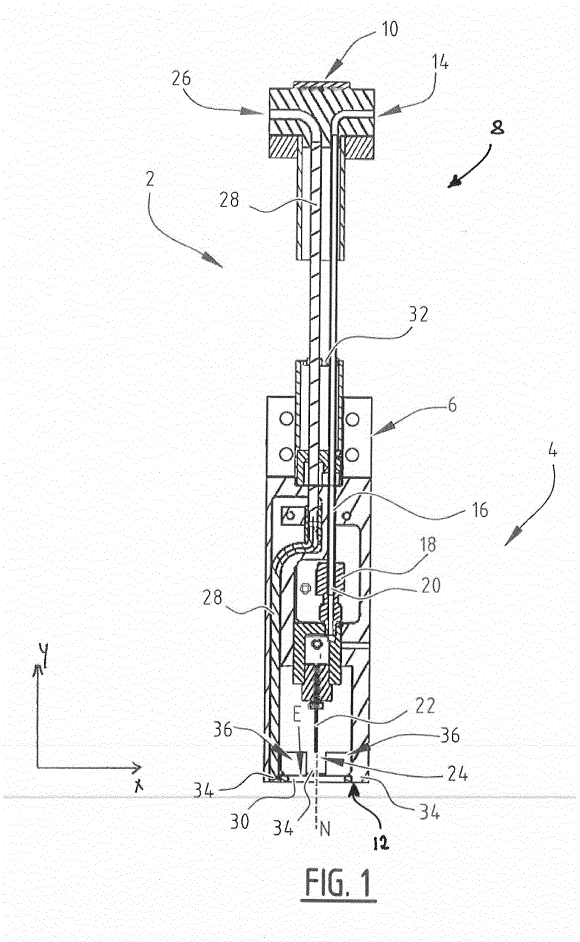

FIG. 1

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Description

[0001] The present invention relates to an odorization device for a combustable gas, an assembly comprising such odorization device and further relates to a method for dispensing odour / odorant into a gas stream and the use of an electrohydrodynamic atomisation (EHDA) apparatus in a method according to the invention.

[0002] The use of combustable gas, in particular natural gas and biogas, as energy source for domestic heating and industrial applications is well known. It is also known that, due to the odourless nature of such gas, leakage of gas during transportation, storage and/or use is difficult to detect and thus forms a safety risk. In order to mitigate this risk, odorization devices are used to add odorant to the gas. The odorant is a liquid that, when dispersed inside the gas will diffuse providing an artificial odour to the (otherwise odourless) gas that allows detection of gas leaks based on smell. Such devices, which are for example widely used in pipeline systems, are based on drip injection of liquid odorant into a gas stream. The device comprise a nozzle that injects small droplets (with a size of several millimetres) into a gas flow, in which the droplets diffuse and mix.

[0003] A disadvantage of the known devices is that the droplet size achieved in drip injection is relatively large and that only limited control of the droplet size can be exercised. As a result, the diffusion of the odorant in the gas stream is limited, especially at low flow velocities and the nondiffused part of the odorant accumulates at the bottom of the pipeline.

[0004] The present invention is aimed at obviating or at least reducing the aforementioned problems by providing an improved odorization device.

[0005] This objective is achieved with an odorization device for a combustable gas, such as natural gas, wherein the odorization device comprises an electrohydrodynamic atomisation (EHDA) apparatus that is configured to atomize an odorant into charged droplets of odorant for dispensing into a gas transportation means.

[0006] An advantage of the odorization device according to the invention is that, due to the use of an electrohydrodynamic atomisation (EHDA) apparatus, the average droplet size of the odorant that is dispensed into the gas transportation means is significantly reduced. As a result, the diffusion of the odorant in the combustable gas is increased and the accumulation of odorant in the gas transportation means, for example near a lower end thereof, is reduced.

[0007] In general, the odorization device according to the invention provides droplets in the range of few micrometers to 70 micrometers, which is significantly lower than the average size of several millimetres achieved using the known odorization devices based on drip injection.

[0008] A further advantage is that the odorization device, due to the electrohydrodynamic atomisation (EHDA) apparatus, also provides a charge (i.e. an electric charge) to the atomized droplets of odorant. This is achieved by the fact that the electrohydrodynamic atomisation (EHDA) apparatus, during operation, atomizes the odorant by means of an electric field, which also imparts the charge to the droplets.

[0009] It is noted that the odorization device according to the invention is connectable to a gas transportation means to, in use, provide atomized odorant droplets to a gas flow present in the gas transportation means. The gas transportation means can in this respect be a pipeline, yet may also be a gas storage, gas production facility, waste water treatment plant or other facilities in which a gas flow of combustable gas is provided and/or maintained. In other words, the odorization device may be used in any facility or system in which combustable, odourless gas is used and in which the risk of leakage may occur.

[0010] In an embodiment according to the invention, the atomized droplets of odorant are atomized charged droplets of odorant.

[0011] In an embodiment according to the invention, the odorization device may be configured to dispense the atomized droplets into a gas flow channel of the gas transportation means in one of:

- a flow direction in the gas flow channel; or
- a counterflow direction in the gas flow channel; or
- a crossflow direction in the gas flow channel.

[0012] It has been found that the efficiency of the dispersion of the atomised odorant in the gas flow is increased significantly when the dispensing of the atomized droplets is in a flow direction, or a counterflow direction of a gas flow in the gas flow channel of the gas transportation means in which the odorant is to be diffused. Alternatively, the atomized droplets may be dispensed in a cross-flow direction, that is, directed towards a wall of for example a pipeline, to increase dispensing and diffusion.

[0013] It is preferred that the odorization device comprises a nozzle that is positioned such that, when the odorization device is connected to, or even at least partially inserted into, the gas transportation means, such as a pipeline, the nozzle is positioned in the direction of a flow in the gas transportation means, or alternatively in a counterflow direction thereof.

[0014] In an embodiment according to the invention, the odorization device comprises connecting means that are configured to connect to the odorization device to a gas transportation means.

[0015] It is noted that, in order to provide the atomized odorant droplets to the gas channel, the odorization device may be connected to the gas transportation means, for example by connecting means including one or more of a flange, a sealing, a screw connection and/or a connection by adhesive. The connecting means may advantageously comprise any one of more of the abovementioned means to establish a good, especially gas-tight or

sealed connection between the odorization device and the gas transportation means. This reduces the risk of leakage of combustable gas from the gas transportation means.

[0016] In an embodiment according to the invention, the EHDA apparatus may comprise a first electrode and a second electrode that are configured to, during operation, establish an electric field to atomize the odorant.

[0017] An advantage of providing an electric field between the first and the second electrode is that the odorant can be atomized in an efficient and effective manner. It allows a spray of odorant to be driven by the electric field through the second electrode and, during passing, be broken up (or disseminated) into atomized droplets.

[0018] In an embodiment according to the invention, the EHDA apparatus further may comprise a housing extending in a longitudinal direction from a first end to a second end, a feed tube for odorant that extends within the housing from an odorant inlet towards a feed tube end and a nozzle that is connected to the feed tube end and having a nozzle opening that is configured to eject odorant towards the second electrode. The EHDA apparatus may further comprise a conductor extending within the housing from an inlet towards a conductor end that is connected to the second electrode, wherein the first electrode is positioned adjacent or at the nozzle opening and wherein the second electrode is positioned at a predetermined distance from the first electrode.

[0019] An advantage of this embodiment is that, due the use of a housing and a separated conductor and feed tube, a robust, compact and efficient device is achieved.

[0020] In an embodiment according to the invention, the nozzle forms the first electrode.

[0021] An advantage of this embodiment is that there is no need to provide a separate electrode to establish the electrical field. Another advantage is that the odorant ejected from the nozzle is automatically provided into the electrical field which increases efficiency and effectivity of the atomization.

[0022] In an embodiment according to the invention, the nozzle comprises a first portion that extends from the feed tube end in the longitudinal direction and an end portion that is positioned under an angle of 45 - 135 degrees with the first portion, and wherein the second electrode is a metallic ring that extends in a plane substantially perpendicular to the end portion of the nozzle or at least substantially perpendicular to a direction in which the end portion extends.

[0023] An advantage of this embodiment is that, due to the ring-form of the electrode, substantially all odorant ejected from the nozzle is passed through the electric field, which increases efficiency of atomization.

[0024] In an embodiment according to the invention, the angle is substantially 90 degrees, and the end portion extends along an end portion axis in a second direction that is perpendicular to the longitudinal direction, and a centre point of the metallic ring is positioned on the end portion axis.

[0025] By positioning the centre of the metallic ring on the nozzle axis at the predetermined distance from the nozzle, a relatively compact design of the odorization device is achieved. Another advantage is that, due to lining up of the nozzle opening and the ring, the odorant that is ejected from the nozzle opening is substantially automatically passed through the electrical field in which it is atomized.

[0026] In an embodiment according to the invention, the housing may be configured to be at least partially insertable in the gas flow channel of the gas transportation means.

[0027] An advantage of this embodiment is that the atomized odorant can directly be injected into the gas channel of the gas transportation means, which increases dispersion and diffusion of the droplets into the gas channel even further.

[0028] In an embodiment according to the invention, the housing comprises lateral flow openings that are positioned at or adjacent the second end of the housing, wherein the lateral flow openings are preferably configured to facilitate a flow of gas through the end portion of the housing in the second direction.

[0029] An advantage of this embodiment is that the atomized odorant can, by means of a laterally directed gas flow in the gas flow channel, (even more) efficiently be dispersed and diffused into the gas channel.

[0030] In an embodiment according to the invention, the nozzle may be integrally formed with the feed tube end, or the device may comprise at least one coupling that connects the nozzle to the feed tube end, and preferably wherein the at least one coupling is manufactured from a metal or metallic material and more preferably wherein the at least one coupling is manufactured from copper or stainless steel.

[0031] The nozzle can be connected to the feed tube in various different ways. An advantage of an integrally formed nozzle is that leakage of odorant in the odorization device is prevented. In addition, an sturdy and reliable electrical connection is made between the nozzle and the feed tube.

[0032] An advantage of providing a coupling between the nozzle and the feed tube is that it allows the nozzle to be replaced if worn out without having to replace the feed tube and/or the entire odorization device. In addition, the coupling allows for a more flexible device by providing the option to swap out the nozzle for a different type and/or a nozzle with a different nozzle opening size and/or form.

[0033] In an embodiment according to the invention, the electrical field has an electrical field strength in the range of 0.3 kV/cm to 20 kV/cm, more preferably in the range of 0.8 kV/cm to 15 kV/cm, and more preferably in the range of 1 kV/cm to 10 kV/cm.

[0034] By providing an electrical field in the abovementioned range, an effective and efficient atomization is achieved. It has been found that in the abovementioned field strength range diffusion and dispersion of the atom-

ized droplets is also present at low gas flow rates in the gas channel. This field strength is generally achieved by applying an electric potential difference in the range of 0.3 kV to 20 kV, more preferably in the range of 0.8 kV to 15 kV, and more preferably in the range of 1 kV to 10 kV, and providing a predetermined distance in the range of 1 centimeter to several centimeters.

[0035] In an embodiment according to the invention, the device may comprise at least one support that is positioned in the housing and that is configured to spatially separate the conductor and the feed tube from each other, and preferably wherein the spacers are manufactured from an electrically non-conductive material, and more preferably are manufactured from plastic.

[0036] An advantage of providing supports is that the feed tube and the conductor can be used to provide the electrical potential difference between the first electrode and the second electrode. Another advantage is that the at least one support provides additional rigidity and structural strength to the housing of the odorization device.

[0037] A further advantage of the odorization device according to the invention is that it avoids short circuits between the different potential lines.

[0038] In an embodiment according to the invention, the device may comprise an odorant inlet that is connectable to an odorant supply and/or may comprise an electrical connector that is connectable to a power source to provide an electrical potential difference between the first and the second electrode, wherein the odorant inlet is preferably connected to the feed tube and wherein the electrical connector is preferably connected to the conductor to provide a high voltage connection to one of the first and the second electrode.

[0039] The invention also relates to an assembly, the assembly comprising:

- at least one odorization device according to the invention; and
- at least one gas transportation means, such as a gas pipeline, comprising a gas flow channel configured for accommodating a flow of combustable gas, such as natural gas or biogas;
  wherein the at least one odorization device is connected to the gas transportation means.

[0040] The assembly according to the invention provides similar advantages and effects as the odorization device according to the invention. It is noted that the assembly according to the invention may freely be combined with any one or more of the embodiments of the odorization device as mentioned above.

[0041] An advantage of the assembly is that the atomized droplets of odorant are injectable into a gas stream in the gas transportation channel in the flow direction of the gas flow or in a counterflow direction of the gas flow, which in both cases increases diffusion and dispersion of the atomized droplets into the gas stream or flow.

[0042] It is noted that, with respect to this application, the phrases gas stream, gas flow, flow, and stream may be used interchangeably. The assembly according to the invention thus allows that, during operation of the gas transportation means, the odorant is efficiently evaporated and mixed into the gas flow.

[0043] In an embodiment of the assembly according to the invention, the assembly may further comprise a connector that is configured for providing a sealed connection between the odorization device and the gas transportation means.

[0044] An advantage of providing a connector is that the connection between the odorization device and the gas transportation means is exchangeable, for example after a preset period of time and/or when wear is detected. Another advantage is that the sealed connection provides a gas-tight or gasimpermeable connection, thus (further) reducing the risk of leakage of gas from the gas flow channel of the gas transportation means.

[0045] In an embodiment of the assembly according to the invention, the assembly comprises a plurality of odorization devices and a plurality of gas transportation means, and wherein each one of the plurality of odorization devices is associated with one of the plurality of gas transportation means.

[0046] It is noted that the assembly may comprise a gas delivery network or system including one or more of gas pipelines, storage facilities, gas regulation systems and/or control systems.

[0047] The invention also relates to a method for dispensing odorant into a gas stream, the method comprising:

- providing a gas flow, preferably natural gas or biogas;
- atomizing the odorant into charged droplets of odorant; and
- dispensing the atomized droplets of odorant in one of:
  - a flow direction of the gas flow; or
  - a counterflow direction of the gas flow; or
  - a crossflow direction of the gas flow.

[0048] The method according to the invention provides similar advantages and effects as the odorization device and/or the assembly according to the invention. It is noted that the method according to the invention may freely be combined with any one or more of the embodiments of the odorization device and/or the assembly as mentioned above.

[0049] It has been found that, by injecting atomized droplets of odorant into a gas stream or flow of combustable gas, such as natural gas or biogas, the dispersion and/or diffusion of the droplets is significantly increased. In addition, it has been found that it also provides an increased evaporation of the atomized droplets into the gas flow. This is especially true when the atomized droplets are introduced into the flow direction or the counter-

flow direction of the gas flow.

[0050] In an embodiment of the method according to the invention, the step of atomizing comprises applying an electric potential difference between a first electrode and a second electrode to create an electric field, and ejecting droplets of odorant through the electric field to provide atomized droplets that have a smaller size that the ejected droplets.

[0051] Providing an electrical field for passing droplets of odorant therethrough has been found to be an effective method of atomizing the droplets, therewith breaking up the droplets into smaller (i.e. atomized) droplets.

[0052] In an embodiment of the method according to the invention, the first electrode is a nozzle extending in a second direction (i.e. the flow or counterflow direction) and having a nozzle axis extending in the second direction. The second electrode is a metallic ring having a central point and extending in a plane perpendicular to the second direction, wherein the central point is positioned on the nozzle axis, and wherein the nozzle and the metallic ring are, when viewed in the second direction, positioned at a predetermined distance from each other.

[0053] The abovementioned construction provides the advantage that the electric field is established between the outlet of the nozzle or nozzle opening and the second electrode, which means that the droplets ejected from the nozzle opening are automatically subjected to the electrical field and are thus automatically atomized.

[0054] In an embodiment of the method according to the invention, the size of the atomized droplets is in the range of several micrometers to about 60 micrometers.

[0055] In an embodiment of the method according to the invention, the method may further comprise the step of adjusting a strength of the electrical field between the first and second electrode to adjust a droplet size of the atomized droplets.

[0056] It has been found that, by adjusting the field strength of the electric field, the droplet size of the atomized droplets can be controlled. This increases the efficiency of the atomization and allows the droplet size to be adapted to for example a gas flow velocity in the gas flow channel.

[0057] In an embodiment of the method according to the invention, the method may further comprise the step of measuring a current to one of the first and the second electrode to monitor the atomization of the droplets, and preferably may comprise measuring the ground connection electric current or the current on the voltage line connected to one of the electrodes.

[0058] It has been found that monitoring the ground connection electric current allowed the performance of the nozzle operation and/or the atomization to be measured. It has also been found that if the current in the voltage line (that is the non-ground connection to the electrodes) was measured, an even more accurate reading is obtained of the atomization and spray operations.

[0059] The invention also relates to the use of an electrohydrodynamic atomisation (EHDA) apparatus in a method according to the invention.

[0060] The use according to the invention provides similar advantages and effects as the odorization device and/or the assembly and/or the method according to the invention. It is noted that the use according to the invention may freely be combined with any one or more of the embodiments of the odorization device and/or the assembly and/or the method as mentioned above.

[0061] Further advantages, features and details of the invention are elucidated on the basis of preferred embodiments thereof, wherein reference is made to the accompanying drawings, in which:

- Figure 1 shows a cross sectional view of an example of an odorization device according to the invention;
- Figure 2 shows a cross sectional view of an example of an assembly according to the invention;
- Figure 3 shows an example of a method according to the invention; and
- Figure 4 shows a cross sectional view of a second example of an odorization device according to the invention.

[0062] In an example of odorization device 2 according to the invention (see figure 1), odorization device 2 comprises electrohydrodynamic atomisation (EHDA) apparatus 4 and connector 6. Odorization device 2 further comprises housing 8 that extends from first end 10 to second end 12.

[0063] First end 10 of housing 8 is provided with odorant inlet 14 that is connectable to a source of odorant (not shown). Odorant inlet 14 is an end portion of feed tube 16 that in this example extends from inlet 14 to coupling 18. Coupling 18 couples feed tube end 20 to nozzle 22. Nozzle 22 in this example is provided with nozzle opening 24 that is positioned on nozzle axis N.

[0064] First end 10 of housing 8 is in this example further provided with electric connection 26 to which a source of electric energy (not shown) is connectable. Electric connection 26 in this example is connected to (or is an outer end of) conductor 28 that extends within housing 8 from connection 26 towards (second) electrode 30 that is positioned at second end 12. Conductor 28 and feed tube 16 are kept at a predetermined distance from each other in housing 8 by support 32, which in this example is a plastic support having openings through which conductor 28 and feed tube 16 extend.

[0065] Second electrode 30 in this example is mounted in supports 34 at second end 12 of housing 8. In this example supports 34 are projections 34 extending from second end 12 of housing 8 between which lateral flow openings 36 are formed. Lateral flow openings 36 allow, when odorization device 2 is mounted with second end 12 extending in a gas channel of a gas transportation means, as gas flow of combustable gas through device 2. This increases the dispersion and/or diffusion of the atomized droplets into the gas flow. It is noted that, when device 2 is in use, an electrical field E (schematically

indicated in figure 1) is induced between nozzle opening 24 that forms the end of electrode 22 and electrode 30 (formed by the ring 30). It is noted that electrical field E may be in the longitudinal direction y of housing 8 of may extend under an angle therewith between the electrodes 22, 30. Connector 6 in this example is designed to allow odorization device 2 to be positioned at a 90 degree angle with gas transportation means (not shown), such as a gas pipeline.

[0066] In an example of assembly 100 (see figure 2), assembly 100 comprises odorization device 2 as shown in figure 1, and gas transportation means 150, which in this case is gas pipeline 150 having flow channel 152 that extends within pipeline 150 in second direction x to accommodate gas flow F.

[0067] In this example, odorization device 2 is positioned perpendicular with, that is at a 90 degree angle with, and partially in gas flow channel 152. Connector 6 is provided to connect odorization device 2 with pipeline 150. It is noted that connector 6 is a mere example and various other alternatives are possible for providing connector 6 and the connection made therewith.

[0068] In an example of method 1000 according to the invention, method 1000 comprises the step of providing 1002 a gas flow or stream, preferably natural gas or biogas in a gas transportation means, such as a gas pipeline 150. Method 1000 may further comprise the step of atomizing 1004 odorant to atomized droplets of odorant, and dispensing 1006 the atomized (charged) droplets of odorant into the gas stream under an angle of 45 to 135 degrees, preferably an angle of 90 degrees.

[0069] The step of atomizing 1004 may comprise the steps of applying 1008 an electric potential difference between a first electrode 22 and a second electrode 30 to create an electric field E, and ejecting 1010 droplets of odorant through the electric field to provide atomized droplets that have a smaller size that the ejected droplets.

[0070] Method 1000 may further additionally comprise the step of adjusting 1012 a strength of the electrical field between the first and second electrode to adjust a droplet size of the atomized droplets.

[0071] Method 1000 may further additionally or alternatively comprise the step of measuring 1014 a current to one of the first and the second electrode to monitor the atomization of the droplets.

[0072] In an example of odorization device 102 according to the invention (see figure 4), odorization device 102 comprises electrohydrodynamic atomisation (EHDA) apparatus 104 and housing 108 that extends from a first end (not shown) to second end 112.

[0073] Feed tube 116 in this example extends to coupling 118. Coupling 118 couples feed tube end 120 to nozzle 122. Nozzle 122 in this example is provided with first portion 121 that extends from the coupling 118 in a longitudinal direction y towards end portion 123 of nozzle 122. End portion 123 extends under an angle of 90 degrees with first portion 121 in second direction x, which in this case is a flow direction F2 of a gas flow in a gas channel. As a result, nozzle opening 124, that is positioned on nozzle axis N extending in direction x, is positioned in the flow direction F2.

[0074] Device 102 is further provided with conductor 128 that extends within housing 108 towards (second) electrode 130 that is positioned at second end 112. Conductor 128 and feed tube 116 are kept at a predetermined distance from each other in housing 108 by support 132, which in this example is a plastic support having openings through which conductor 128 and feed tube 116 extend.

[0075] Second electrode 130 in this example is ring 130 that is mounted in a plane that is perpendicular to nozzle axis N, which nozzle axis N extends through central point 130a of ring 130. In other words, ring 130 is positioned in the longitudinal direction and (in this example) substantially in line with conductor 128. Second electrode 130 in this example is mounted in second end 112 of housing 108. In this example second end 112 is provided with lateral flow openings 136. Lateral flow openings 136 allow, when odorization device 102 is mounted with second end 112 extending in a gas channel of a gas transportation means, a gas flow of combustable gas through device 102 (in flow direction F2). This increases the dispersion and/or diffusion of the atomized droplets into the gas flow. It is noted that, when device 102 is in use, an electrical field E (schematically indicated in figure 4) is induced between nozzle opening 124 that forms the end of electrode/nozzle 122 and electrode 130 (formed by the ring 130). It is noted that electrical field E is in general in the second direction x or under an angle therewith between the electrodes 122, 130.

[0076] The present invention is by no means limited to the above described preferred embodiments and/or experiments thereof. The rights sought are defined by the following claims within the scope of which many modifications can be envisaged.

Claims

1. Odorization device for a combustable gas, such as natural gas, wherein the odorization device comprises an electrohydrodynamic atomisation (EHDA) apparatus that is configured to atomize an odorant into droplets of odorant for dispensing into a gas transportation means.

2. Odorization device according to claim 1, wherein the atomized droplets of odorant are atomized charged droplets of odorant.

3. Odorization device according to claim 1 or 2, wherein the odorization device is configured to dispense the atomized droplets into a gas flow channel of the gas transportation means in one of:

    - a flow direction in the gas flow channel; or
    - a counterflow direction in the gas flow channel;

or
- a crossflow direction in the gas flow channel.

4. Odorization device according to claim 1, 2 or 3, wherein the EHDA apparatus comprises a first electrode and a second electrode that are configured to, during operation, establish an electric field to atomize the odorant.

5. Odorization device according to claim 4, wherein the EHDA apparatus further comprises:

- a housing extending in a longitudinal direction from a first end to a second end;
- a feed tube for odorant that extends within the housing from an odorant inlet towards a feed tube end;
- a nozzle that is connected to the feed tube end and having a nozzle opening that is configured to eject odorant towards the second electrode;
- a conductor extending within the housing from an inlet towards a conductor end that is connected to the second electrode; and

wherein the first electrode is positioned adjacent or at the nozzle opening, wherein the second electrode is positioned at a predetermined distance from the first electrode.

6. Odorization device according to claim 5, wherein:

- the nozzle forms the first electrode; and/or
- the nozzle comprises a first portion that extends from the feed tube end in the longitudinal direction and an end portion that is positioned under an angle of 45 - 135 degrees with the first portion, and wherein the second electrode is a metallic ring that extends in a plane substantially perpendicular to the end portion of the nozzle, and optionally wherein the angle is substantially 90 degrees, and wherein the end portion extends along an end portion axis in a second direction that is perpendicular to the longitudinal direction, and wherein a centre point of the metallic ring is positioned on the end portion axis.

7. Odorization device according to any one of the claims 5 - 6, wherein the housing is configured to be at least partially insertable in the gas flow channel of the gas transportation means, and/or

wherein the nozzle is integrally formed with the feed tube end, or wherein the device comprises at least one coupling that connects the nozzle to the feed tube end, and preferably wherein the at least one coupling is manufactured from a metal or metallic material and more preferably wherein the at least one coupling is manufactured from copper or stainless steel, and/or
wherein the electrical field has an electrical field strength in the range of 0.3 kV/cm to 20 kV/cm, more preferably in the range of 0.8 kV/cm to 15 kV/cm, and more preferably in the range of 1 kV/cm to 10 kV/cm.

8. Odorization device according to any one of the preceding claims, when dependent on claim 6, wherein the device comprises at least one support that is positioned in the housing and that is configured to spatially separate the conductor and the feed tube from each other, and preferably wherein the spacers are manufactured from an electrically non-conductive material, and more preferably are manufactured from plastic.

9. Assembly comprising:

- at least one odorization device according to any one of the preceding claims; and
- at least one gas transportation means, such as a gas pipeline, comprising a gas flow channel configured for accommodating a flow of combustable gas, such as natural gas or biogas;

wherein the at least one odorization device is connected to the gas transportation means.

10. Assembly according to claim 9, wherein the assembly further comprises a connector that is configured for providing a sealed connection between the odorization device and the gas transportation means.

11. Method for dispensing odorant into a gas stream, the method comprising:

- providing a gas flow having a gas flow direction, the gas preferably being natural gas or biogas;
- atomizing odorant into charged droplets of odorant; and
- dispensing the atomized droplets of odorant in one of:
- the flow direction of the gas flow; or
- a counterflow direction of the gas flow; or
- a crossflow direction of the gas flow.

12. Method according to claim 11, wherein the step of atomizing comprises:

- applying an electric potential difference between a first electrode and a second electrode to create an electric field; and
- ejecting droplets of odorant through the electric field to provide atomized droplets that have a smaller size that the ejected droplets.

13. Method according to claim 12, further comprising the

step of adjusting a strength of the electrical field between the first and second electrode to adjust a droplet size of the atomized droplets.

14. Method according to any one of the claims 11-13, further comprising the step of measuring a current to one of the first and the second electrode to monitor the atomization of the droplets.

15. Use of an electrohydrodynamic atomisation (EHDA) apparatus in a method according to any one of the claims 11 - 14.

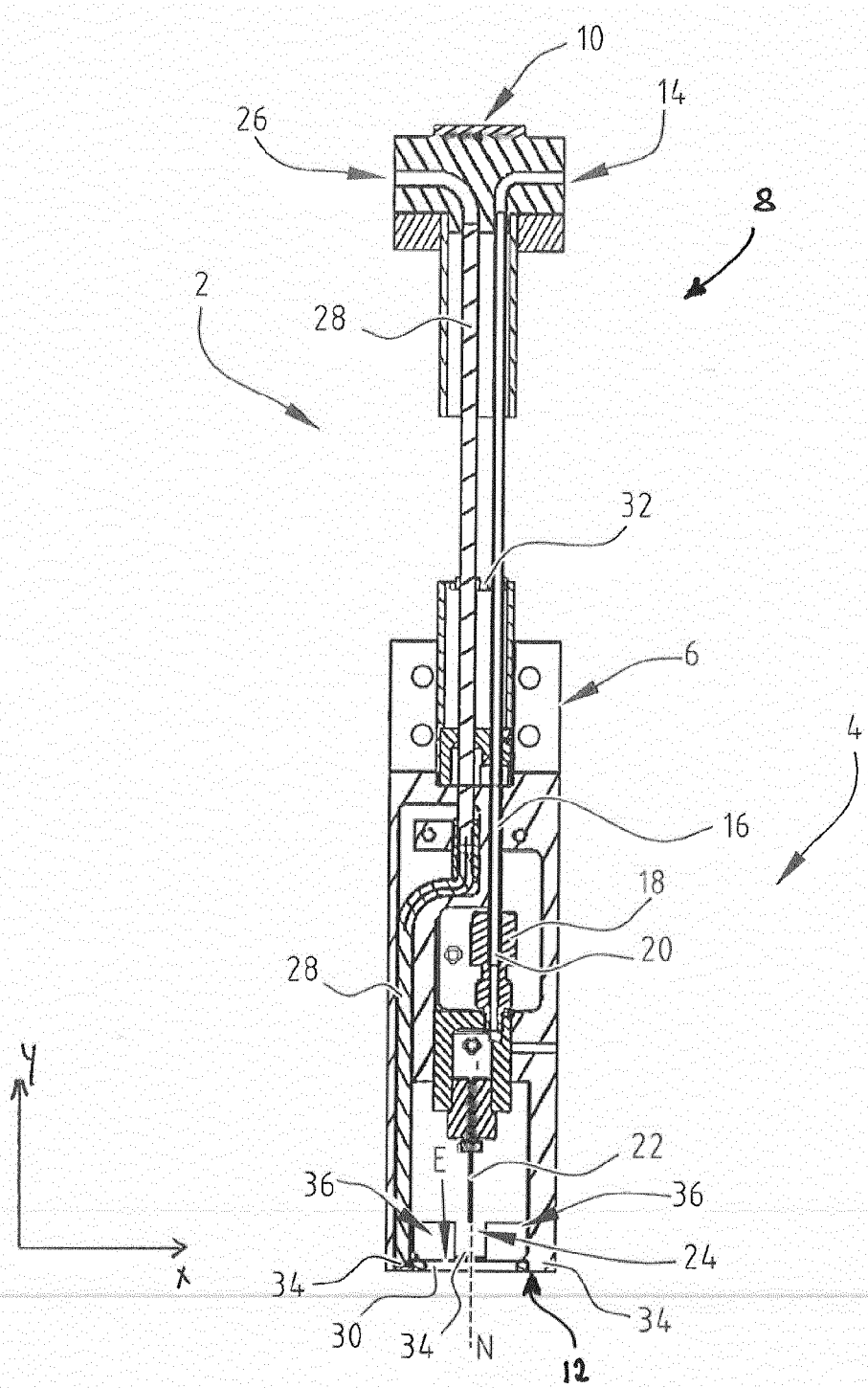

FIG. 1

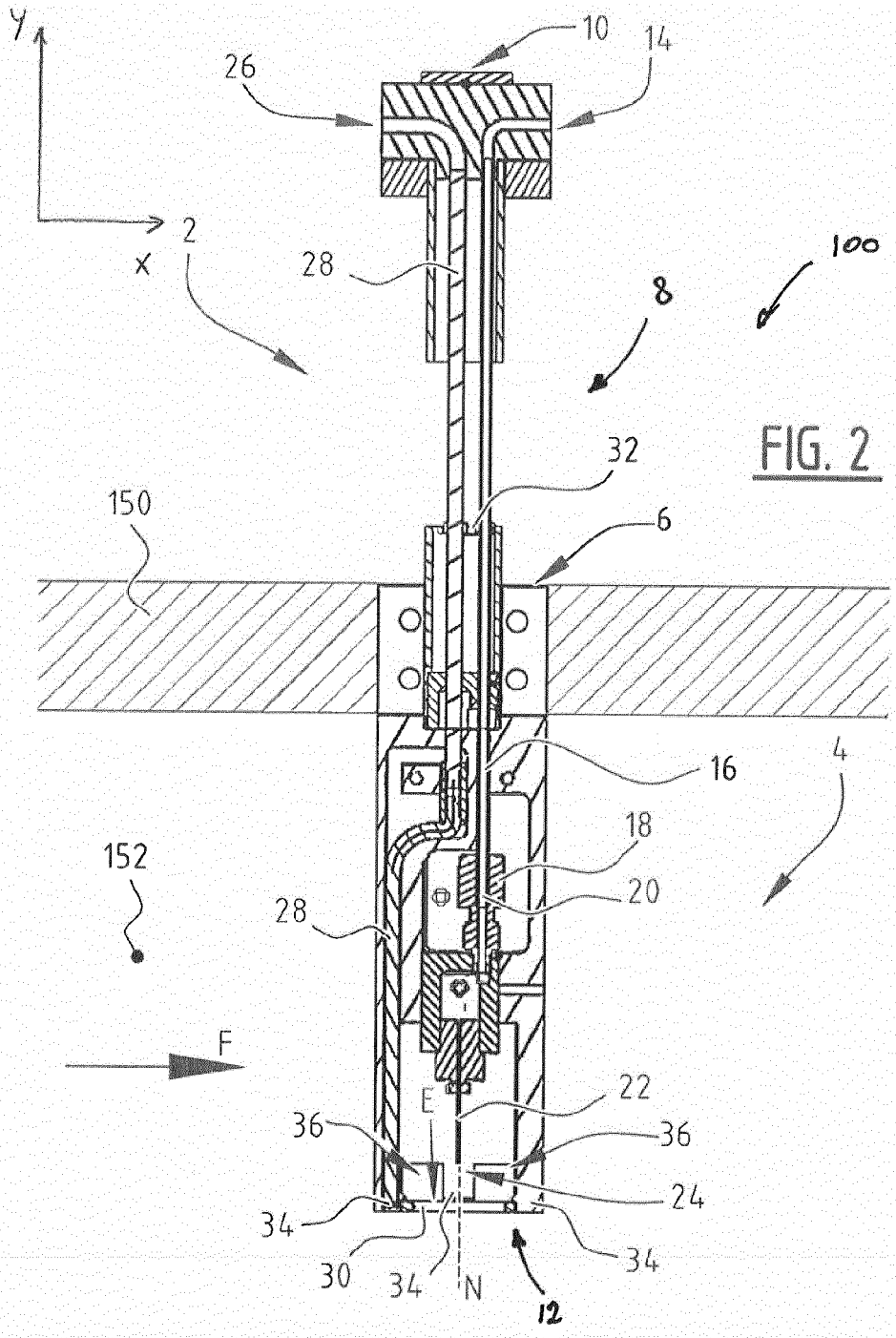
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FIG. 2

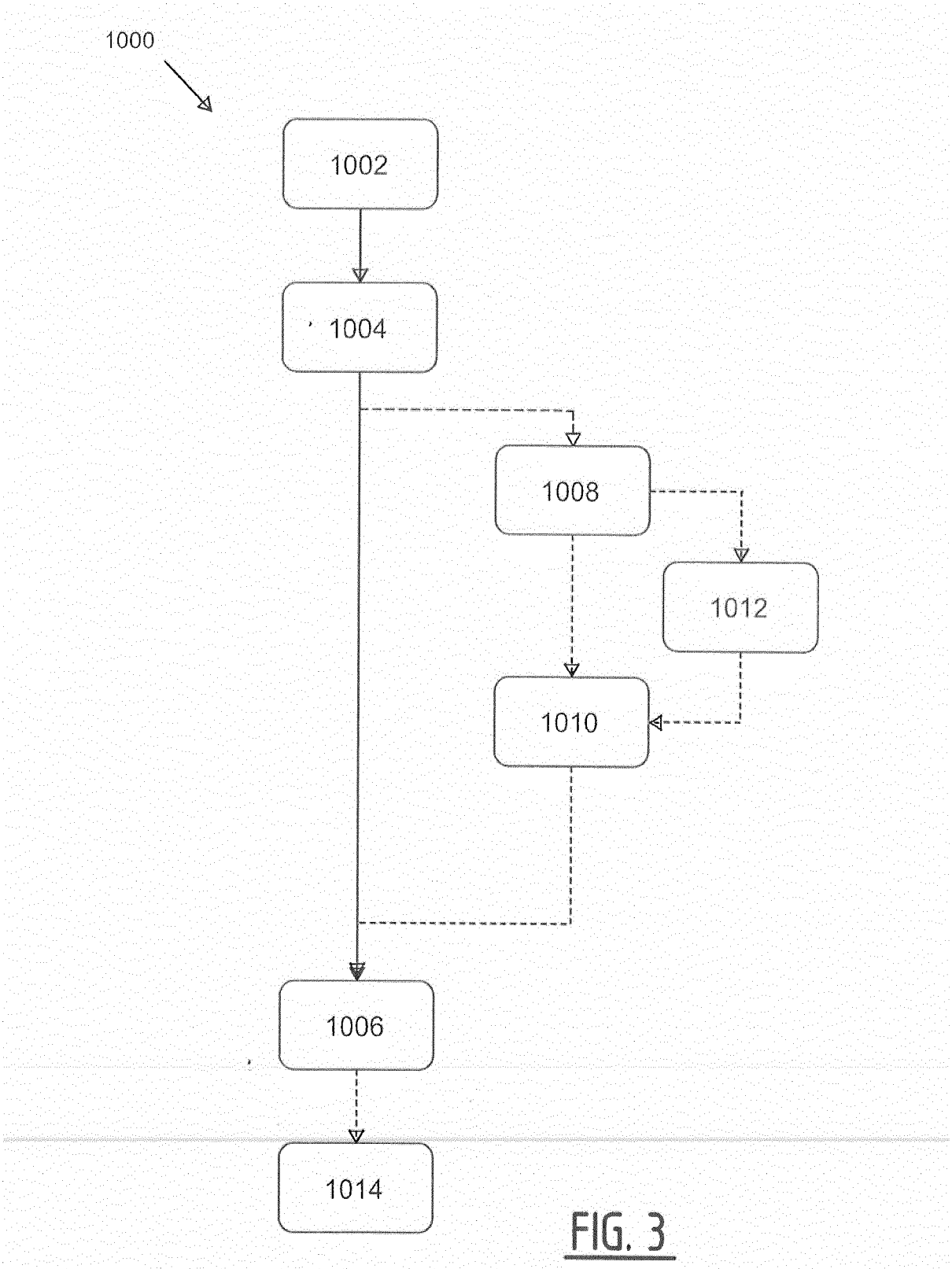

FIG. 3

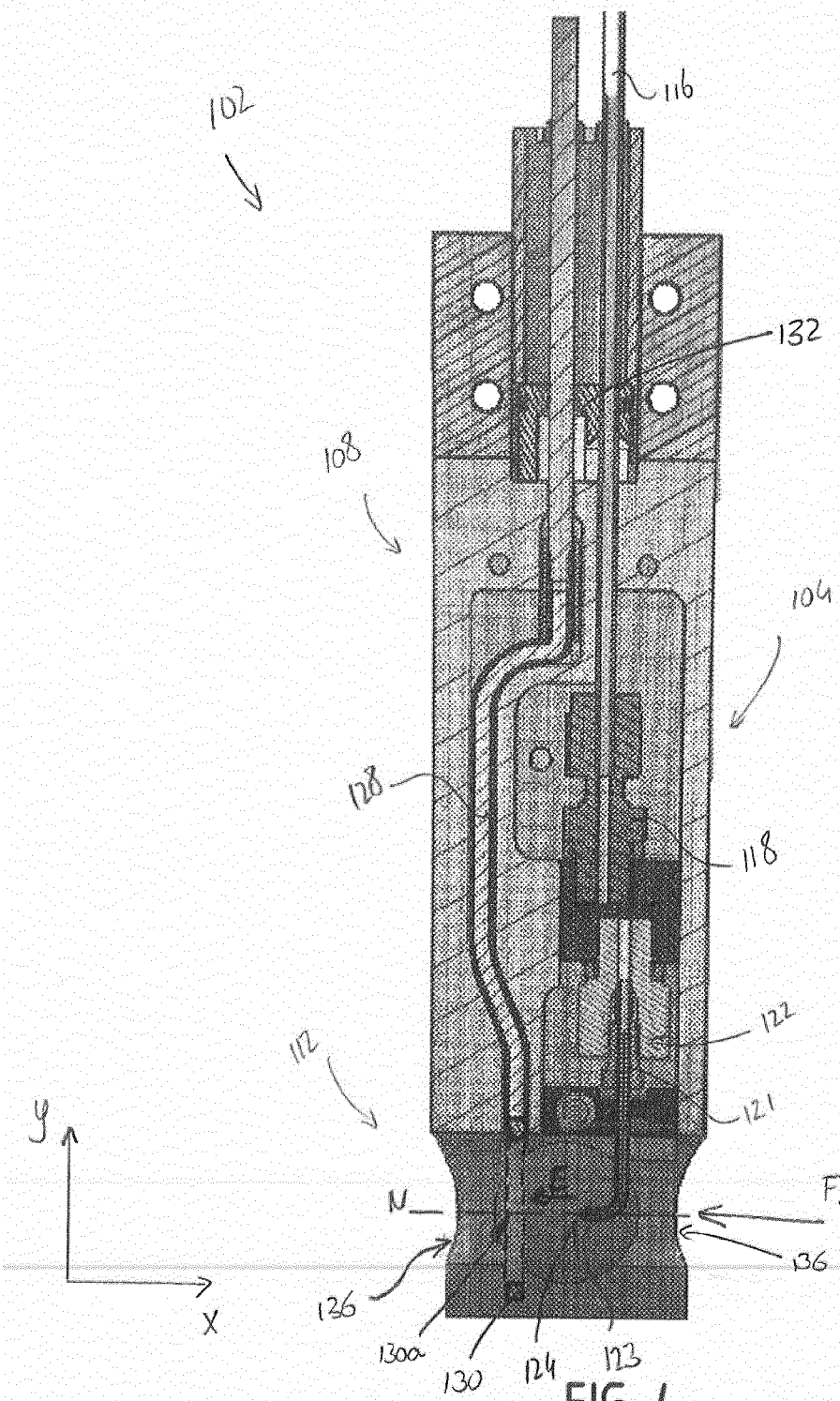
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FIG. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 22 19 7244

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Place of search	Date of completion of the search	Examiner
The Hague	2 February 2023	Bertin, Séverine

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