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(71) Applicant: **Virus Free Air B.V.**
3115 HB Schiedam (NL)

(72) Inventor: **Khoury, Eliane**
3115 HB Schiedam (NL)

(74) Representative: **de Hoog, Johannes Hendrik**
Octrooibureau de Hoog
Gouverneurslaan 18 A
3905 HE Veenendaal (NL)

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(54) GAS FLOW CLEANING DEVICE

(57) The invention relates to a gas flow cleaning device (100) comprising a corona electrode (102) provided with corona tips (102A), a non-corona electrode (104) with a cylinder axis (104B). The corona electrode is centrally positioned in the cylindrical non-corona electrode. The cylindrical non-corona electrode (104) comprises a circumferential wall section (402B) with a multitude of openings. The corona electrode comprises a cylindrical array of corona tips. The gas flow cleaning device further comprises a gas flow generator (106) configured to generate a gas flow through the cylindrical non-corona electrode along the corona electrode.

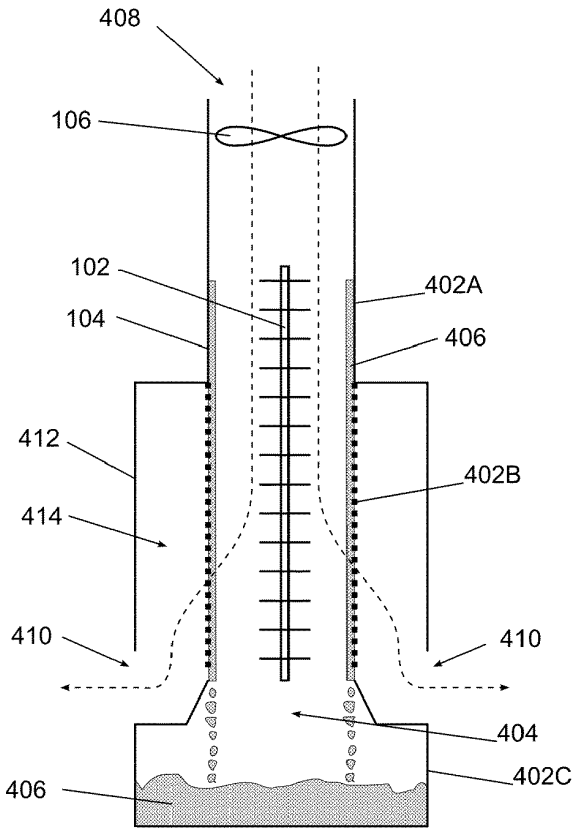


FIG. 4

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Description

TECHNICAL FIELD

[0001] The invention relates to a gas flow cleaning device comprising a corona electrode provided with corona tips and a non-corona electrode. The invention further relates to a method for manufacturing a corona electrode.

BACKGROUND

[0002] Gas flow cleaning devices of the above mentioned kind are commonly known. An electrostatic precipitator (ESP) contains a row of thin vertical wires, and followed by a stack of large flat metal plates oriented vertically, with the plates typically spaced about 1 cm to 18 cm apart, depending on the application. The air or gas stream flows horizontally through the spaces between the wires, and then passes through the stack of plates. A negative voltage of several thousand volts is applied between wire and plate. If the applied voltage is high enough, an electric corona discharge ionizes the gas around the wires, the corona electrodes. Negative ions flow to the plates and charge the gas-flow particles. This form of ionization generates a lot of ozone.

[0003] US3,526,081 discloses a gas purification apparatus having a treatment chamber and concentric first central brush-corona discharge electrode and second cylindrical screen-like peripheral electrode axially disposed within said treatment chamber.

[0004] US4,010,011 discloses an air cleaner with a corona electrode in the form of a wire which is located on the axis of a tube which forms the non-corona electrode.

[0005] US4,670,026 discloses a centre electrode which includes an array of radial, closely spaced conductive sharp pointed needles or the like.

[0006] EP2305976A2 discloses an exhaust gas treatment apparatus. The apparatus comprises a discharge electrode having a disk-like electrode support disposed perpendicularly to the flow direction of the flow passage and needle-like dischargers disposed perpendicularly to the electrode support.

SUMMARY

[0007] It is an object of the invention to provide a gas flow cleaning device with a corona electrode with a multitude of corona tips with an improved structure. The improved structure provides at least one of the following advantages: reducing the manufacturing costs of a corona electrode with a multitude of corona tips, could be manufactured with a simple process, enables to easily replace a worn corona tip or tips and allows adapting the axial length of the corona electrode and the density of corona tips.

[0008] According to the invention, this object is achieved by a gas flow cleaning device having the features of Claim 1. Advantageous embodiments and further ways of carrying out the invention may be attained by the measures mentioned in the dependent claims.

[0009] According to a first aspect of the invention, there is provided a gas flow cleaning device wherein the corona electrode comprises at least one disclike member. Each disclike member comprises a disclike support part and a number of conductive bendable wires attached to the disclike support part. A corona tip is formed by a free end of a conductive bendable wire. A part of the conductive bendable wire is wound around or bent along a protrusion of the disclike support part to fasten the conductive bendable wire to the disclike support part. The disclike member is easily to manufacture with low costs. Furthermore, as the current through a wire to the corona tip is relatively small, the resistance of the electrical coupling between the conductive disclike element and wire has almost no influence on the functioning of a corona tip. Disclike in the context of the present application means: having a flat substantially rotation-symmetrical shape. By bending the wire around and/or along the protrusion, an electrical connection with sufficiently low resistance is obtained by the contact surfaces between the disclike element and the wire. Bendable wire in the context of the present application means any elongate body that could be bent at least once without breaking. Wire includes a needle, a pre-bend needle, pin, little rod-like element, cord or string of a suitable conductive material. The conductive bendable wire could be any suitable conductive wire with a tip that could resist the harsh corona discharge environment such as for instance a type of wire taken from a group comprising tinned annealed solid copper wire, NiChrome wire, tungsten wire, silver wire, steel wire.

[0010] In an embodiment, a conductive bendable wire passes through an opening at a distal end of a protrusion from one side to an opposite site of the disclike support part. The opening functions as a position means of the wire at the distal end of the protrusion. This feature enables to pull the wire straight in radial direction of the disclike support part and to cut the wire such that the tip is at a predefined distance from the centre of the disclike support part.

[0011] In an embodiment, a conductive bendable wire is wound around two protrusions of a disclike support part and each of the two free ends of the conductive bendable wire forms a corona tip. This feature provides a simple and cost effective process to manufacture two corona tips.

[0012] In an embodiment, the disclike support part has a centre and the corona tips have predetermined distance from the centre. This feature makes the disclike member orientation independent when positioning the corona electrode in a cylindrical non-corona electrode.

[0013] In an embodiment, a part of a conductive bendable wire between a disclike support part and free end of the conductive bendable wire substantially extends in radial direction. This feature provides corona tips with the optimal ionization of particles in the space between the tip and the circular surface of non-corona electrode.

[0014] In an embodiment, the protrusions are radial protrusions. It has been found that it is easiest to wind a wire around a radial protrusion.

[0015] In an embodiment, the non-corona electrode is a cylindrical part with a cylinder axis. The corona electrode is positioned in the cylindrical element and the at least one disclike member is positioned perpendicular to the cylinder axis. When the centre of the disclike member coincides the cylinder axis, the corona tips will have substantially the same distance to the non-corona electrode. In this way, the corona tips will generate the same amount of ions.

[0016] In an embodiment, the cylindrical part comprises a circumferential wall section with a multitude of openings. By forcing the gas flow through the openings of the wall section, the charged particles are forced to the non-corona electrode which will capture most of the charged particles. In this way, relatively large particles could easily be filtered from a gas flow.

[0017] In a further embodiment, the cylindrical element is closed at at least one end. This feature enables that the entire gas flow flows through the multitude of openings.

[0018] In an embodiment, the corona electrode further comprises a rod-like support structure which extends through a central opening of the at least one disclike member and the at least one disclike member is fastened to the rod-like support structure by clamping. This feature, allows replacing disclike members with worn corona tips by new one.

[0019] In an embodiment, the rod-like support structure is an assembly of rods which are coupled by means of a coupling structure. A disclike member is clamped between two coupled rods. A simple coupling structure is a thread coupling. By screwing two rods together, the disclike member is automatically positioned perpendicular to the axis of the rods.

[0020] In an alternative embodiment, the rod-like support structure comprises a threaded rod and spacer sleeves which define the distance between the disclike elements. Instead of space sleeves, two nuts could be used to fasten a disclike member to the threaded rod.

[0021] According to a second aspect of the invention, there is provided method for manufacturing a part of a corona electrode. The method comprises

- providing a bendable wire and a disclike element with a midpoint and comprising a number of protrusions;
- bending the bendable wire along a protrusion of the disclike element to attach the bendable wire to the protrusion;
- positioning a part of the bendable wire along a radius of the disclike element;
- cutting the part of the bendable wire at a predefined distance L from the midpoint of the disclike element.

[0022] Other features and advantages will become apparent from the following detailed description, taken in conjunction with the accompanying drawings which illustrate, by way of example, various features of embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] These and other aspects, properties and advantages will be explained hereinafter based on the following description with reference to the drawings, wherein like reference numerals denote like or comparable parts, and in which:

Fig. 1 illustrates a cross section of a first embodiment of a gas flow cleaning device;
Fig. 2 illustrates top view of a first embodiment of a disclike member;
Fig. 3 illustrates top view of a second embodiment of a disclike member;
Fig. 4 illustrates a cross section of a second embodiment of a gas flow cleaning device;
Fig. 5 illustrates a cross section of a third embodiment of a gas flow cleaning device;
Figs 6A - 6C illustrate a method of manufacturing a disclike member; and,
Fig. 7 illustrates a cross section of a fourth embodiment of a gas flow cleaning device.

DETAILED DESCRIPTION

[0024] Fig. 1 illustrates a cross section of a first embodiment of a gas flow cleaning device 100 according to the invention. The gas flow cleaning device could be a standalone device to reduce the amount of particulate matter in a room of a building. In this case, the gas is the air in the room. In another example of a gas flow cleaning device, the gas cleaning device is used in a garage to clean the exhaust gases of combustions engines running in the garage. The gas flow cleaning device 100 comprises a corona electrode 102 provided with corona tips 102A, a non-corona electrode 104, a gas flow generator 106 and an electrostatic precipitator (ESP). The ESP functions as a filter and could be replaced by an electret filter. Both types of particle collector are commonly known in the art. A high voltage source 112 is electrically coupled to the plates 108 of the ESP.

[0025] The non-corona electrode 104 forms the housing of the gas flow cleaning device 100. The gas flow generator 106 could be any suitable means to generate a gas flow through a duct. In the present embodiment the gas flow generator is a fan.

[0026] The non-corona electrode is a cylindrical part which forms a duct with an inlet and an outlet. In the present embodiment, the gas flow generator 106 is positioned at the inlet side of the duct. It might be clear that the gas flow generator 106 could also be positioned at the outlet side of the duct. Arrows 114 indicate the direction of the gas flow. The non-corona electrode has a cylinder axis 104B.

[0027] The corona electrode 102 is positioned in the cylindrical element. The corona electrode 102 comprises four disclike members 102B. Disclike in the context of the present application means: having a flat substantially rotation-symmetrical shape. The disclike members 102B are positioned perpendicular to the cylinder axis 104B. Furthermore, the centre of the disclike members coincides with the cylinder axis 104B. The disclike members comprise a number of bendable wires attached to a disclike element by bending. The bendable wires comprise a free end extending radially from the midpoint of the disclike element. The tip of a free end of a bendable wire has a predefined distance from the midpoint of the disclike element. Bendable wire in the context of the present application means any elongate body that could be bent at least once without breaking. Wire includes a needle, a pre-bend needle, pin, little rod-like element, cord or string of a suitable conductive material. The disclike members will be described in more detail with reference to Fig. 2.

[0028] The corona electrode further comprises a rod-like structure 102C. The disclike members 102B are fastened to the rod-like support structure 102C. The rod-like support structure 102C extends through a central opening 102B1 of each of the four disclike members 102B. The rod-like support structure 102C in Fig. 1 is an assembly of rod parts 102C1. Each end of a rod part comprises a coupling structure. Some examples of a coupling structure are a thread coupling, a bayonet mount, press fit and snap fit. After coupling two rod parts 102C1, the disclike member is clamped between the two rod parts 102C1. The rod-like structure comprises a body axis which coincides with the cylinder axis 104B.

[0029] In Fig. 1 a support element 116 is used to position the corona electrode rigidly at the cylinder axis. The support element 116 is at one side attached to the cylinder part 104A and at the other side to a rod part 102C1. In an alternative embodiment, at both ends of the rod-like support structure are support element is used to position the corona electrode 102 in an aligned way in the cylinder of the non-corona electrode. The latter embodiment with a support at both ends of the rod-like support structure is suitable for corona electrodes having a relative long body axis. The body length of each of the rod parts 102C1 defines the space between two neighbouring disclike members of the corona electrode.

[0030] In an alternative embodiment of rod-like support structure, the structure comprises a centre rod and spacer sleeves. A threaded part at at least one end of the rod is used to fasten the spacer sleeves and the disclike members to the rod. The length of the spacer sleeves defines the distance between the disclike members. In another alternative embodiment, the centre rod is a threaded rod. Two nuts are used to secure a disclike member to the threaded rod. The distance between two neighbouring disclike parts is defined by the position of the corresponding nuts at the threaded rod.

[0031] The gas flow cleaning device further comprises a high voltage source 110 to generate a potential difference between the corona electrodes, i.e. the corona tips 102A and the non-corona electrode 104.

[0032] The gas flow cleaning device as shown in Figure 1 functions in the following way. The gas flow generator 106 generates a gas flow with particulate material through the non-corona electrode 104. The high voltage potential between corona tips and inner surface of the cylindrical body of the non-corona electrodes generates a corona discharge around the corona tips 102A. The corona discharge ionizes or charges air or gas molecules. These charged air molecules, which are called ions, then attach to the airborne particulates, charging them. The non-corona electrode attracts the charged particles to the electrode surfaces. The charged particles that are deposited on the electrode surfaces have been removed from the gas flow. In this way the gas is cleaned. To further increase the gas flow cleaning efficiency (which in the ionizer depends on the exact configuration of the electrodes, the gas velocity and the level of the high voltage used), an electrostatic filter downstream the corona and non-corona electrode pair is applied to collect at least a part of the remaining dust particles in the gas flow.

[0033] To improve the ionization of the gas flow, a gas flow guide 114 could be applied upstream the corona electrode 102. The gas flow guide 114 directs the gas flow through the space between the corona tips 102A and the non-corona electrode 104.

[0034] Fig. 2 illustrates top view of a first embodiment of a disclike member 102B. The disclike member 102B comprises a disclike support part 202 and three conductive bendable wires 204 attached to the disclike support part 202. A corona tip 102A is a free end 204A of a conductive bendable wire 204. The disclike support part 202 comprises six protrusions 202A. The protrusions are equidistantly distributed on the circular periphery of the disclike support part 202. A distal end 202A2 of a protrusion comprises an opening 202A1 or space to receive the bendable wire 204 such that the wire passes from one side to the other side of the disclike support part 202.

[0035] A part 204B of the conductive bendable wire 204 is wound around a protrusion 202A of the disclike support part 202 and secured in the opening 202A1. The part of the wire 204C to the free end 204A forming the corona tip 102A extends radially away from the centre of the disclike support part 202. In the first embodiment one wire is wound around two protrusions 202A and both free ends 204A of the conductive bendable wire 204 forms a corona tip 102A. The corona tips 102A have predetermined distance R from the centre or midpoint 202B of the disclike support part 202.

[0036] In the present embodiment the distal ends 202A1 of the disclike support part form hooks such that the bendable wire could be pulled in radial direction of the disclike support. In this way, a curved bendable wire could be made straight.

[0037] The disclike support part 202 could be made

from any suitable conductive material. Two examples of a suitable material are brass and stainless steel. The disclike support part 202 could be made from a sheet of metal by laser cutting and/or punching.

[0038] The conductive bendable wire 204 could be any suitable conductive wire with a tip that could resist the harsh corona discharge environment such as for instance a type of wire taken from a group comprising tinned annealed solid copper wire, NiChrome wire, tungsten wire, silver wire, steel wire. Wires made from other materials might prove suitable as well. The diameter of the wire could be in the range of 0.1 - 1 mm and depends on the bending characteristics of the wire and its stiffness. A tinned annealed solid copper wire with a diameter of 0.35 or 0.51 mm has been found suitable to generate a needle-like structure to form the corona tips.

[0039] It should be noted that the number of corona tips per disc-support part is not limited to six and could be any number suitable to manufacture cost effectively a corona electrode.

[0040] Fig. 2 further shows the circular wall of the cylinder part 104A of the non-corona electrode 104. The disclike member 102B is positioned such in the non-corona electrode that the distance between corona tip and inner surface of the non-corona electrode is similar for all corona tips.

[0041] Fig. 3 illustrates top view of a second embodiment of a disclike member. This embodiment differs from the embodiment shown in Fig.2 in that the disclike support part has another outline. Furthermore, the opening 202A2 at the distal end 202A1 is alternating at the left and right side of the protrusion 202A. As a result of this, the part 204C of the bendable wire between free end and distal end of the disclike support part is located at the same side of the disclike support part for all wires.

[0042] Fig. 4 illustrates a cross section of a second embodiment of a gas flow cleaning device. In this embodiment, both the corona electrode 102 and non-corona electrode are positioned vertically. The gas flow is going down. The gas flow cleaning device comprises a cylindrical non-corona electrode 104 and an elongated corona electrode 102 positioned in the non-corona electrode 104. The corona electrode 102 comprises a multitude of disclike members as described above which are attached to a rod-like support structure. A characteristic of this embodiment is that the cylindrical non-corona electrode comprises a circumferential wall section with a multitude of openings. The gas flows through an inlet 408 of a first section 402A of the non-corona electrode through the multitude of openings of a second section 402B of the non-corona electrode 102 to an outlet 410 of the gas flow cleaning device. The circumferential wall of the second section 402B could be in the form of a meshwork of conductive wires or a cylindrical grid. Furthermore, the surface of the multitude of openings is a few times larger than the surface of a cross section of the cylindrical non-corona electrode. As a result of this, the velocity of the gas through the openings is much lower than the velocity of the gas at the inlet 408. This allows charged particulate matter 406 to precipitate on the non-corona electrode and subsequently to fall down in a container 402C below the non-corona electrode. The gas flow cleaning device further comprises a housing 412 around at least the second section 402B of the non-corona electrode 102. The housing forms an air channel 414 around the openings of the second section 402B. The gas in the space between housing and second section is going down along the exterior of the non-corona electrode. As a result of this the velocity of the gas through the openings is almost similar over the entire area of the second section 402B. It should be noted that the container 402C in which the particulate matter is collected closes the bottom end 404 of the cylindrical non-corona electrode 104. The dashed lines indicate the gas flow through the gas flow cleaning device.

[0043] Fig. 5 illustrates a cross section of a third embodiment of a gas flow cleaning device. In this embodiment the direction of the gas flow is upward. The non-corona electrode 104 is positioned vertically and comprises a first cylindrical section 402A and a second cylindrical section 402B. An inlet 508 of the device has a diameter which is smaller than the diameter of the non-corona electrode 104. This allows dust 406 collected at the non-corona electrode to fall down in a ring-shaped container 502 in which dust is collected. The opening of the ring is the inlet of the gas flow cleaning device. The cylinder-shaped non-corona electrode is at the upper side closed with a lid. The device further comprises a housing 512 which forms an air channel 514 around the second section 402B with a multitude of openings of the non-corona electrode 102. The housing 512 further comprises an outlet 510. Furthermore, the housing 512 accommodates a gas flow generator 106. The surface of the multitude of openings in the second section 402B is a few times larger than the surface of a cross section of the cylindrical non-corona electrode. As a result of this, the velocity of the gas through the openings is much lower than the velocity of the gas at the inlet side of the non-corona electrode. This allows charged particulate matter 406 to precipitate on the non-corona electrode and subsequently to fall down in the container 502 below the non-corona electrode. The dashed lines indicate the direction of the gas flow through the gas flow cleaning device.

[0044] Fig. 7 illustrates a fourth embodiment of a gas flow cleaning device. In this embodiment the direction of the gas flow is downward. The non-corona electrode 104 is positioned vertically and comprises an upper cylindrical section 702A and a lower cylindrical section 702B. The non-corona electrode 104 is arranged in a housing 712. A partition wall 716 between the housing 712 and the non-corona electrode 104 divides the space between the housing 712 and the non-corona electrode 104 in a first air channel 714A and a second air channel 714B. The upper cylindrical section 702A is above the partitioning wall 716 and the lower cylindrical section 702B is below the partitioning wall 716. The opening of the upper end

704A of the non-corona electrode 102 is closed by a closing member and the opening 704B of the lower end of the non-corona electrode is closed by a container or collecting member 702D in which dust and particulate matter is collected. A gas flow flows via the inlet 708 along the gas flow generator 106 through the first air channel 714A. Via openings in the upper cylindrical section 702A the gas flow flows through the space in the non-corona electrode to the lower cylindrical section 702B. Then the gas flow flows through the multitude of openings in the lower cylindrical section 702B to the second air channel 714 arranged around the non-corona electrode 104 and leaves the gas flow cleaning device via outlet 710.

[0045] An advantage of this embodiment is that the entire gas flow has the flow through the space between a virtual cylinder formed by the corona tips and the non-corona electrode 104. This improves the charging op de particulate matter in the flow of air and consequently the precipitation of the particulate matter on the wall of the non-corona electrode 104.

[0046] It might be clear that in the fourth embodiment the gas flow could also be upward. In that case, most of the charged particulate material is collected at the upper cylindrical section 702A of the non-corona electrode 104. Optionally, the gas flow could be alternately upward and down ward. In that case, a reversible fan could be used to change the direction of the gas flow.

[0047] The second to fourth embodiment could be used to reduce the emission of dust from a chicken shed. In that case, the non-corona electrode and corona electrode could have a height in the range of 2 - 3 meter or even more. The non-corona electrode could have a diameter in the range of 0.3 - 0.6 meter and the distance between non-corona electrode and housing is in the range of 0.1 - 0.2 meter or more. The distance between two neighbouring disclike members is in the range of 0.05 - 0.2 meter. With this dimension, a corona electrode could comprise 20 or more disclike members. The dust collected on the non-corona electrode could be reduced by shaking or hammering on the non-corona electrode. It should further be noted that a corona electrode comprising a number of disclike members could be replaced by alternative corona electrodes comprising a cylindrical array of corona tips

[0048] Figs 6A - 6C illustrates a method of manufacturing a disclike member suitable for use as a part of a corona electrode in a gas flow cleaning device described in the present application. Fig. 6A shows the components that have to be present to manufacture the disclike member. The figure shows a spool 600 around which a conductive bendable wire 204 is wound and the disclike support element 202 as shown in Fig. 2 and described with corresponding description. The figure further shows a scissor positioned at a predefined distance R from the centre of midpoint of the disclike support element 202. The scissor represents a cutting means suitable to cut the wire 204 at a predefined length which is defined by radial distance R.

[0049] Fig. 6B shows the situation in the manufacturing of the disclike member wherein a free end part of the wire 204 is wound around a first protrusion 202A1 of the disclike support element 202. The position of the wire 204 relative to the distal end of the first protrusion is fixated by positioning the wire in the opening at the distal end of the first protrusion 601. By pulling at the free end of the wire, the part of the wire projecting outside the disclike support element is positioned along a radius of the disclike element. By pulling at the free end of the wire, the curvature of the wire due to the winding around the spool 600 is reduced. Subsequently the wire is cut by a suitable wire cutting means to provide a first corona tip at a predefined distance R from the centre or midpoint of the disclike element, wherein the predefined distance R is larger than the radius of the distal end of the protrusion of the dislike element.

[0050] Subsequently, a part of the wire between the part that is wound around the first protrusion 601 and the spool 600 is wound around a second protrusion 602 of the disclike support element 202, secured in the opening at the distal end of the second protrusion. After pulling at the wire between distal end of the second protrusion and the spool 600, to radially position wire projecting outside the disclike support element, the wire is cut to provide a second corona tip at said predefined distance R from the centre of the disclike member 202.

[0051] The steps described with reference to Fig. 6B and 6C have to be repeated twice to obtain the disclike member shown in Fig. 2.

[0052] The method provides a simple manufacturing process to make disclike members provided with needle like corona tips just by bending a wire around a protrusions of a disclike support element. The disclike support element and wires are made from a conductive material. The electrical contact between wire and disclike support element by winding or bending is sufficient to supply the necessary voltage potential and current to the corona tip to generate a corona discharge. There is no need to weld the wire to the support element or to fasten it by clamping which actions would increase the production cost. Another advantage is that the disclike member could be refurbished by replacing a wire comprising a worn corona tip with a new wire.

[0053] Another problem with corona electrodes with an array of needles is that during storage the needles have to be protected from bending. Furthermore, such preassembled corona electrodes require a lot of storage space. An advantage of the disclike members is that they could easily be stored on a spindle. A spindle is a base plate with a vertical rod. The disclike members could be stacked on the spindle alternating with plates or sheets having a size larger than the outline of the disclike members. The sheets will protect the wires from bending. A stack of disclike members will need much less space than a preassembled corona electrode with an equivalent amount of disclike members.

[0054] To obtain a corona electrode, the disclike mem-

bers are clamped between parts of a rod-like support structure as described previously.

[0055] It should be noted that the number of corona tips of the corona electrode is determined by the amount of charge that has to be added to the gas flow to remove enough particulate matter from the gas flow. The amount of charge is linear to the flow rate and the degree of pollution of the gas with particulate matter. Each corona tip could add a predetermined maximum amount of charge to the gas flow. In this way, the number of corona tips could be derived.

[0056] It should further be noted that in the described embodiments the gas flow generator is integrated in the device which forms a gas flow system. This is not essential as the gas flow cleaning device could be in the form of a duct part and the gas flow is generated by an external flow generator unit which is attached to the gas flow cleaning device. Thus, the gas flow cleaning device could be a part that in combination with other components forms an air flow system. The gas flow cleaning device could be used to clean any gas which comprises particulate matter. Examples of a gas are: air in building, exhaust gases of combustion engines, flue gases from heaters or incinerators, and air from animal sheds in particular poultry houses.

[0057] While the invention has been described in terms of several embodiments, it is contemplated that alternatives, modifications, permutations and equivalents thereof will become apparent to those skilled in the art upon reading the specification and upon study of the drawings. The invention is not limited to the illustrated embodiments. Changes can be made without departing from the scope and spirit of the appended claims.

Claims

1. Gas flow cleaning device (100) comprising a corona electrode (102) and a cylindrical non-corona electrode (104) with a cylinder axis (104B), the corona electrode being centrally positioned in the cylindrical non-corona electrode
   characterized in that
   the cylindrical non-corona electrode (104) comprises a circumferential wall section (402B) with a multitude of openings, the corona electrode comprises a cylindrical array of corona tips and the gas flow cleaning device further comprises a gas flow generator (106) configured to generate a gas flow through the cylindrical non-corona electrode along the corona electrode.

2. The gas flow cleaning device according to claim 1, wherein the axial length of the circumferential wall section (402B) is more than three times the shortest distance between the corona electrode and the non-corona electrode.

3. The gas flow cleaning device according to any of the claims 1 - 2, wherein the axial length of the circumferential wall section (402B) is at least two times the radius of the circumferential wall section.

4. The gas flow cleaning device according to any of the claims 1 - 3, wherein the cylindrical non-corona electrode comprises at least one closed end (402C) and the gas flow generator is configured to generate a gas flow along the corona electrode in direction of a closed end of the at least one closed end.

5. The gas flow cleaning device according to any of the claims 1 - 4, wherein the cylindrical non-corona electrode comprises a first circumferential wall section (402A) upstream the circumferential wall section (402B) with a multitude of openings, wherein the surface of the first circumferential wall section (402A) is a closed surface and a part of the corona electrode is positioned in the first circumferential wall section (402A).

6. The gas flow cleaning device according to any of the claims 1 - 5, wherein the device further comprises a container (402C) below the non-corona electrode to collect particulate material precipitated on the non-corona electrode and falling down from the non-corona-electrode.

7. The gas flow cleaning device according to any of the claims 1 - 6, wherein the non-corona electrode and corona electrode have a height of at least 2 meter.

8. The gas flow cleaning device according to any of the claims 1 - 7, wherein the non-corona electrode has a diameter in the range of 0.3 - 0.6 meter.

9. The gas flow cleaning device according to any of the claims 1 - 8, wherein the surface of the circumferential wall section (402C) with the multitude of openings is more than two times larger than the surface of a cross section of the cylindrical non-corona electrode.

10. The gas flow cleaning device according to any of the claims 1 - 9, wherein the distance between the corona tips and the non-corona electrode is in the range of 0.06 and 0.2 meter.

11. The gas flow cleaning device according to any of the claims 1 - 10, wherein the circumferential wall section (402B) with the multitude of openings is in the form of a meshwork of conductive wires or a cylindrical grid.

12. The gas flow cleaning device according to any of the claims 1 - 11, wherein the non-corona electrode comprises an inlet side adapted such that the velocity of the gas through the multitude of openings is lower

than the velocity of the gas at the inlet side of the non-corona electrode.

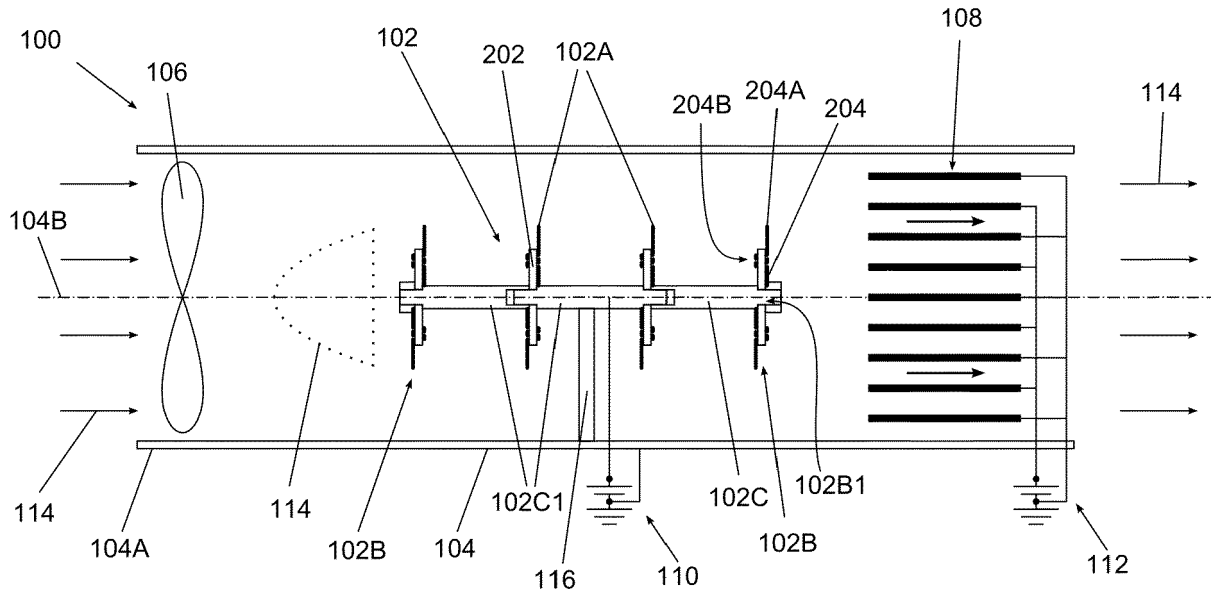

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106
102
202
102A
204B
204A
204
108
114
104B
114
104A
114
102B
104
102C1
116
110
102C
102B
102B1
112

FIG. 1

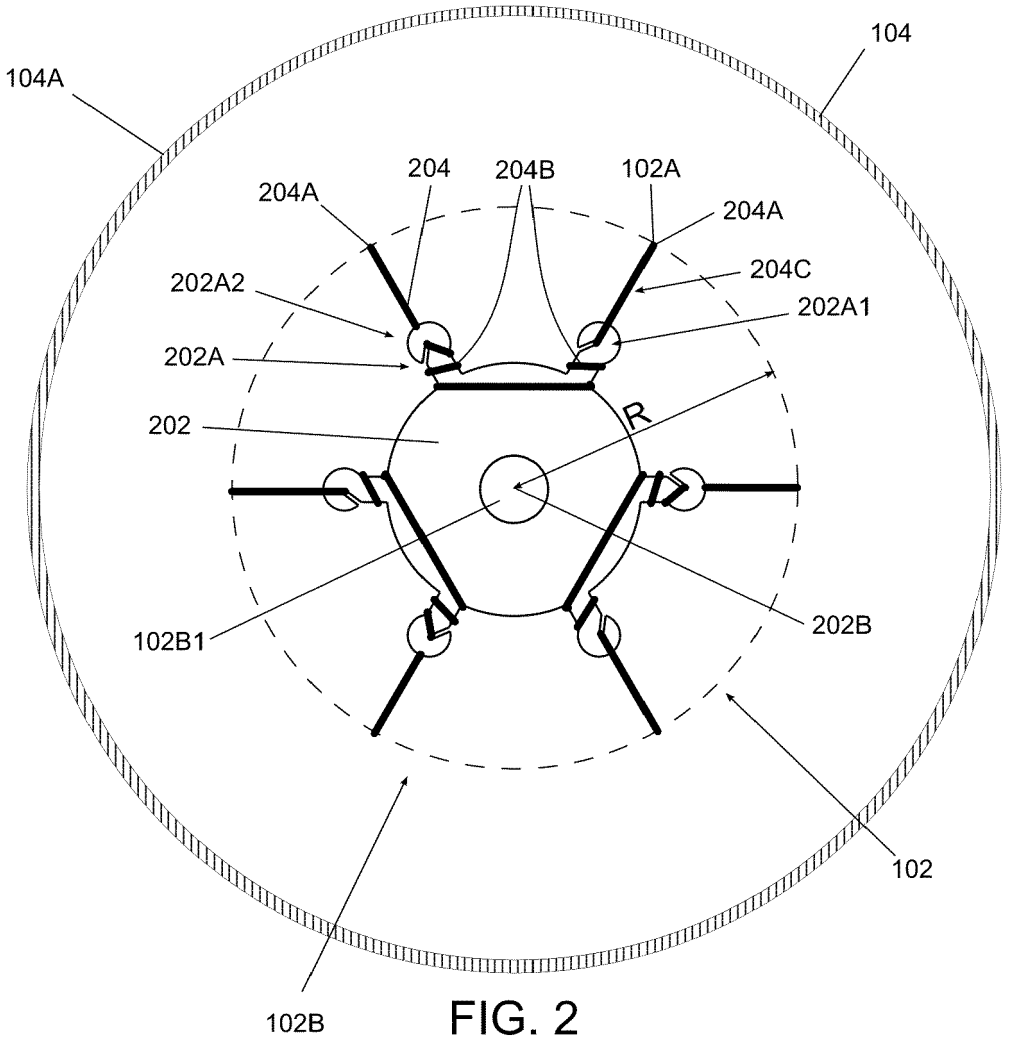

104
104A
204
204B
102A
204A
204A
204C
202A2
202A1
202A
202
R
102B1
202B
102
102B

FIG. 2

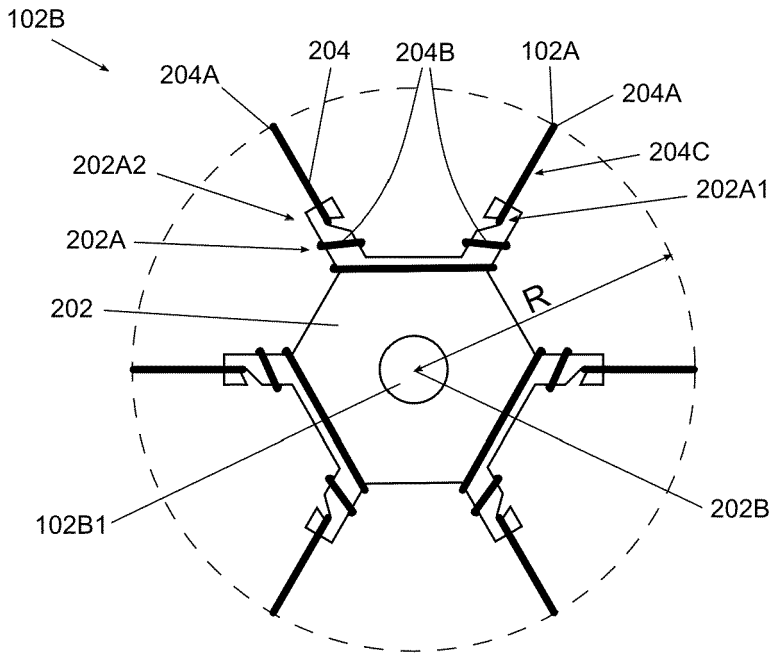

102B
204
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102A
204A
204A
204C
202A2
202A1
202A
R
202
102B1
202B

FIG. 3

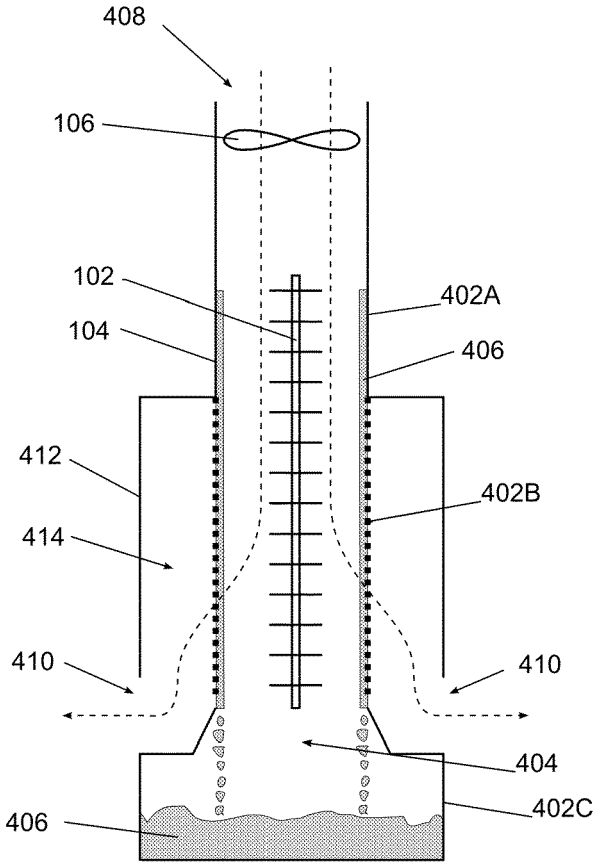

408
106
102
402A
104
406
412
402B
414
410
410
404
406
402C

FIG. 4

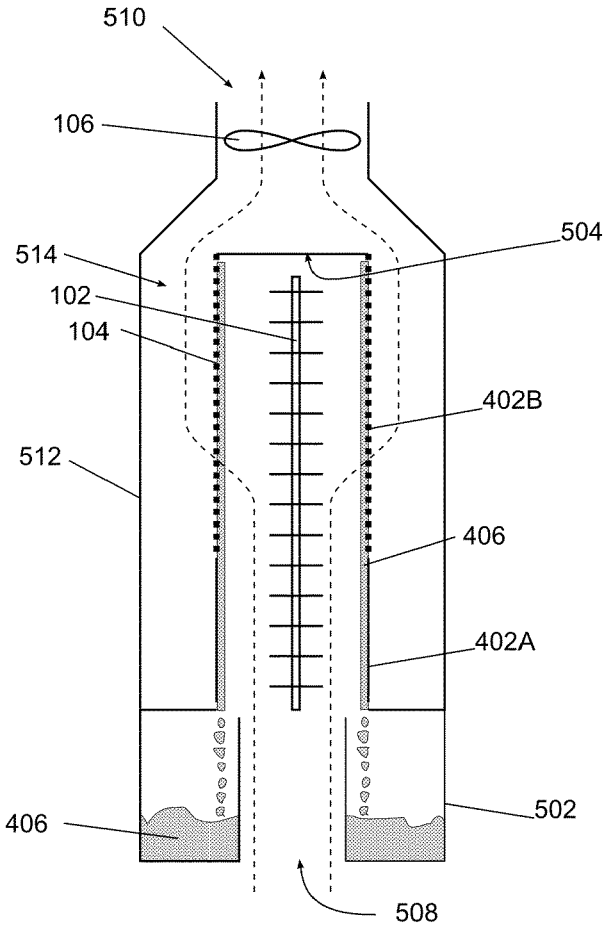


FIG. 5

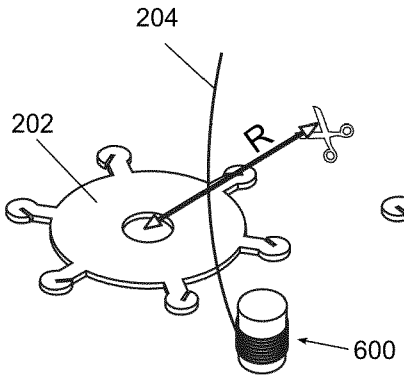


FIG. 6A

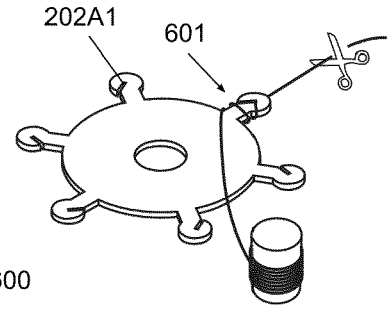


FIG. 6B

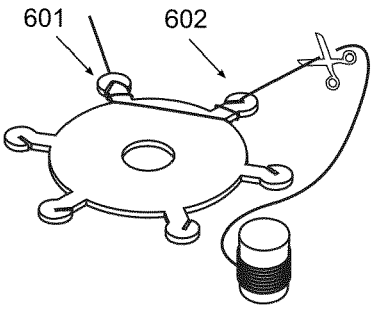


FIG. 6C

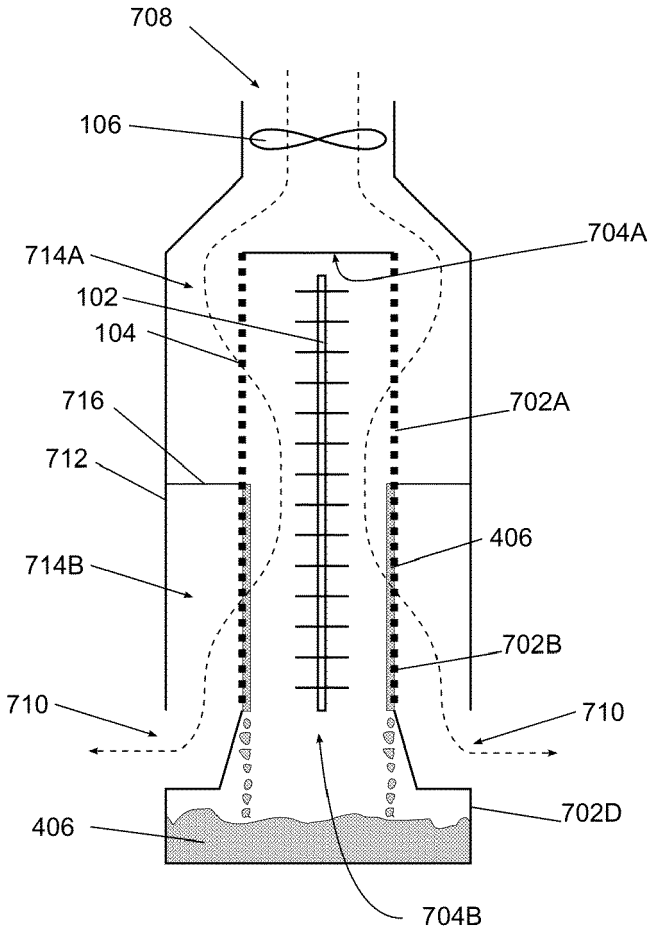

708
106
704A
714A
102
104
716
702A
712
406
714B
702B
710
710
406
702D
704B

FIG. 7

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EUROPEAN SEARCH REPORT

Application Number
EP 17 17 8670

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Place of search	Date of completion of the search	Examiner
The Hague	15 November 2017	Menck, Anja

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