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(54) IMPROVEMENTS IN OR RELATING TO INONISED GAS STREAMS

(57) Described herein is an ionisation system (100) which is used to generate a balanced ionisation field in an ionisation chamber (160) from a DC input voltage (105), the ionisation field being used to ionise a gas flow introduced into the ionisation chamber. The ionisation system (100) further comprises a programmable DC-to-DC converter (110) controlled by pulse-width modulation signal (192) from a controller (190) to generate an adjustable DC voltage for a high voltage generator (120). The high voltage generator comprises circuitry to convert the adjustable DC voltage into a high frequency, high voltage AC output which is applied to ionising electrodes (150a, 150b) in the ionisation chamber to generate the ionisation field. Ionised gas stream (180) output from the ionisation chamber is balanced with respect to the number of negative and positive ions generated by the ionisation field.

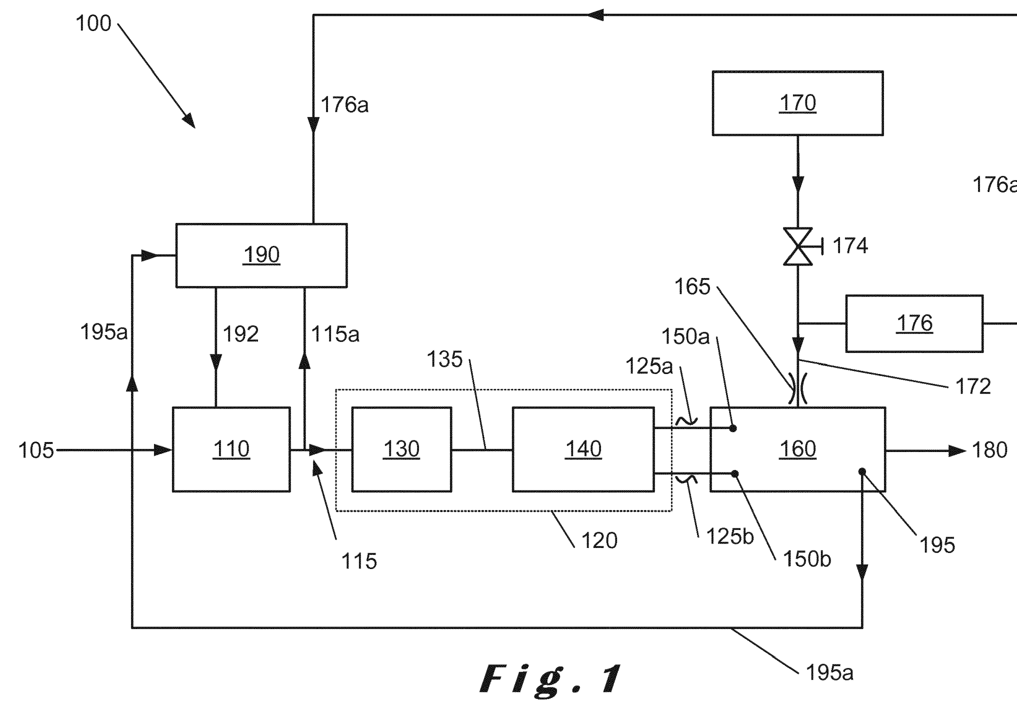

Fig. 1

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Description

Field of the invention

[0001] The present invention relates to improvements in or relating to ionised gas streams, and is more particularly concerned with the production of balanced ionisation in such gas streams.

Background of the invention

[0002] Systems for producing ionising circuits for static eliminators are known. US-A-5153811 describes a high voltage AC ionised air blower in which automatic balancing of positive and negative ions is achieved. A high voltage AC power supply forms a primary of a transformer and a secondary thereof is isolated from ground. Ionisation electrodes providing the ionisation field are also isolated from ground. The ionisation electrodes are connected to one side of the secondary and a reference electrode spaced from the ionisation electrodes is connected to the other side of the secondary. In one embodiment, the reference electrode forms a ring in a duct wall through in which both positive and negative ions are generated, and, in another embodiment, the reference electrode forms a plate where apertures are provided in the vicinity of the ionising electrodes.

[0003] US-B-8693161 describes a static charge neutralising apparatus with uses corona discharge for gas ion generation. The apparatus generates electrically self-balanced bipolar ionised gas flows for charge neutralisation. An ionisation electrode with a tapered tip is mounted in an ionisation chamber through which gas flows to produce the ionised gas flow. A reference electrode is mounted on the wall of the ionisation chamber. Both the ionisation electrode and the reference electrode are connected to a high voltage power supply.

[0004] However, both the systems described above require a high voltage AC voltage power supply which is then transformed to a higher voltage in order to generate the ionisation at the ionisation electrodes. Such systems tend to be industrial systems which cannot normally be operated in other environments due to the large form factor from AC, low frequency high voltage transformers required for the ionisation of gas flow passing over the ionisation electrodes and the required high AC supply voltage.

Summary of the invention

[0005] It is therefore an object of the present invention to provide an ionisation system providing a balanced ionised gas flow which can be handheld without having to insulate for high voltage AC power supplies.

[0006] It is another object of the present invention to provide an ionisation system which utilises a low voltage input DC power supply whilst still producing a balanced ionised gas flow.

[0007] In accordance with one aspect of the present invention, there is provided an ionisation system comprising:-

a DC-to-DC voltage converter configured for receiving an input DC voltage and for providing an output adjustable DC voltage;

a controller configured for controlling the operation of the DC-to-DC voltage converter to provide the output adjustable DC voltage;

a high voltage generator configured for receiving the output adjustable DC voltage as an input and for generating a high frequency, high voltage AC voltage output;

an ionisation chamber;

at least one ionising electrode within the ionisation chamber and connected to the high frequency, high voltage AC voltage output and configured for generating an ionisation field within the ionisation chamber;

a gas supply configured to be introduced into the ionisation chamber through the generated ionisation field to provide an ionised gas flow;

a valve located in a gas supply, the valve having a first position and a second position, the first and second positions being configured for initiating and terminating the gas supply to the ionisation chamber; and

a pressure sensor located in the gas supply and configured for providing a signal to the controller in accordance with a sensed pressure of the gas supply.

[0008] Such an ionisation system has the advantage of having an ionisation chamber in which the ionisation field produced thereby is auto self-balancing. This is because the electrodes are floating and there is no ground connection.

[0009] Furthermore, the pressure sensor controls the generation of the ionisation within the ionisation chamber and therefore pin wear is reduced as no ionisation is present when there is no gas flow therethrough.

[0010] Moreover, by having a low DC voltage, the ionisation system can be used in most environments without having to use large form factor AC transformers.

[0011] In one embodiment, the high voltage generator comprises an oscillator circuit and a high frequency, high voltage transformer circuit.

[0012] The implementation of the high voltage generator in this way has the advantage that a small form factor is needed due to the use of high frequency, high voltage transformer circuits.

[0013] The oscillator circuit preferably comprises a Royer oscillator circuit.

[0014] By using a Royer oscillator circuit, components thereof can readily be integrated with the high frequency, high voltage transformer circuit to provide simplicity, low component count and easy transformer isolation when implementing a high voltage generator for supplying each ionising electrode in the ionisation chamber.

[0015] In one embodiment, the high frequency, high voltage transformer circuit may comprise a single transformer having a centre-tapped primary winding and a secondary winding, the secondary winding comprising a secondary high voltage winding configured for being connected to the at lease one ionising electrode. Where two pin electrodes are provided as ionising electrodes, sides of the secondary high voltage winding is configured to be connected to respective ones of the pin electrodes.

[0016] In another embodiment, the high frequency, high voltage transformer circuit may comprise two transformers in series, each transformer having a primary winding and a secondary winding, each secondary winding comprising a high voltage winding having a high side and a low side, and the transformer circuit is configured to connect the low side of each transformer together with at least one of the high side of one of the transformers being configured to be connected to the at least one ionising electrode. Where two pin electrodes are provided as ionising electrodes, the high side of each transformer is configured to be connect to one of the two pin electrodes.

[0017] In a further embodiment, a single ionising electrode is provided in the centre of a ring-shaped reference electrode. If a single transformer is implemented, the high side of a secondary high voltage winding of the transformer is connected to the pin electrode with the low side thereof connected to the reference electrode. If two transformers are implemented, the high side of each transformer is configured to be connected to one of the pin electrode and the reference electrode.

[0018] In an embodiment, the DC-to-DC converter comprises a programmable DC-to-DC power converter configured to step down the input DC voltage and to step up output current. A feedback signal corresponding to the adjustable DC voltage may be provided to the controller.

[0019] The ionisation chamber comprises an orifice through which the gas supply is introduced therein, and, the ionisation system may further comprise a measurement electrode located in the ionisation chamber, the measurement electrode being configured for taking a measurement within the ionisation chamber and for providing a feedback signal indicative of that measurement to the controller.

[0020] The valve may comprise one of: a manually-operated valve, a pneumatically-operated vale and a hydraulically-operated valve.

[0021] In accordance with another aspect of the present invention, there is provided a charge neutralisation system including:-

- an ionisation system as described above;
- a housing comprising:-
  - at least a first portion having an opening at an end thereof through which ionised gas flow exits the housing, the ionisation chamber of the ionisation system being configured to be located in the first portion adjacent the opening therein;
  - a gas inlet configured for connecting to the gas supply of the ionisation system and for supplying gas flow to the ionisation chamber; and
  - an electrical inlet configured for providing power to the at least one ionising electrode mounted within the ionisation chamber.

[0022] The charge neutralisation system may further comprise a nozzle located at the opening at the end of the first portion of the housing and configured to direct the ionised gas flow as it exits the housing.

[0023] In one embodiment, the charge neutralisation system may comprise an ionising gun. In this embodiment, a trigger or operating button is used to initiate gas flow into the ionisation chamber with the sensed pressure providing a signal for the controller to enable the DC-to-DC converter and to generate the high frequency, high voltage required for each ionising electrode.

Brief description of the drawings

[0024] For a better understanding of the present invention, reference will now be made, by way of example, to the accompanying drawings in which:-

Figure 1 illustrates a schematic block diagram of a gas ionisation system in accordance with the present invention;

Figure 2 illustrates a partial sectioned perspective view of an ionisation device incorporating the gas ionisation system of Figure 1;

Figure 3 illustrates a schematic diagram of a first embodiment of a high voltage module for the generation of balanced ionisation;

Figure 4 illustrates a schematic diagram of a second embodiment of a high voltage module for the generation of balanced ionisation; and

Figures 5a to 5e are schematic views of alternative embodiments of the ionisation device in accordance with the present invention.

Description of the invention

[0025] The present invention will be described with respect to particular embodiments and with reference to certain drawings but the invention is not limited thereto. The drawings described are only schematic and are non-limiting. In the drawings, the size of some of the elements may be exaggerated and not drawn on scale for illustrative purposes.

[0026] The present invention relates to an ionisation system which has an auto self-balancing output. A balanced output is important to avoid the risk of electrostatic discharge (ESD). An input DC voltage is used to generate a high frequency, high voltage output for electrodes in an ionisation chamber.

[0027] Figure 1 illustrates a block diagram of an ionisation system 100 in accordance with the present invention. The system 100 comprises a programmable DC-to-DC power converter 110, a high voltage generator 120, an ionisation chamber 160 and a gas supply 170.

[0028] An input DC voltage 105 is received at the programmable DC-to-DC power converter (or buck converter) 110 which steps down the input DC voltage whilst stepping up output current to provide an adjustable output DC voltage 115. The output 115 forms an input for the high voltage generator 120. T

[0029] The high voltage (HV) generator 120 comprises a Royer oscillator circuit 130 and a high frequency, high voltage (HF-HV) transformer 140. Outputs 125a, 125b from the HV generator 120 are connected to respective pin electrodes 150a, 150b in the ionisation chamber 160.

[0030] The Royer oscillator circuit 130 comprises a saturable-core transformer with a (centre-tapped) primary winding and a feedback winding. The secondary winding provides the high voltage. The two halves of the primary winding are driven by transistors in a push-pull configuration, The feedback winding couples the transformer flux back into the transistors thereby providing positive feedback to generate oscillation. The use of a high voltage generator 120 containing a Royer oscillator circuit 130 and high frequency high voltage transformer 140, has the advantage of simplicity, low component count and easy transformer isolation.

[0031] A gas supply 170 supplies an input gas flow 172 to the ionisation chamber 160 by means of a manually-operated valve 174 and an orifice 165 at the ionisation chamber 160. A pressure sensor 176 is connected to the input gas flow 172 for monitoring the pressure thereof. The ionisation chamber 160 produces an output ionised gas stream 180 from the input gas flow 172.

[0032] The system 100 also includes a controller 190 which is connected to provide pulse-width modulation (PWM) signals 192 for controlling the buck converter 110. Respective feedback signals 115a and 176a are provided to the controller 190 from the adjustable output DC voltage 115 and the pressure sensor 176.

[0033] An optional measurement electrode 195 may be provided in the ionisation chamber 160 which provides a feedback signal 195a for the controller 190.

[0034] Operation of the valve 174 opens the gas flow 172 to the ionisation chamber 160 which is sensed by the pressure sensor 176 and the feedback signal 176a is sent to the controller 190 to enable the PWM signals 192 for the buck converter 110. The buck converter 110 converts the input DC voltage 105 into the adjustable DC voltage 115 in accordance with the PWM signals 192. The feedback signal 115a to the controller 190 indicates that the conversion of the input DC voltage 105 to the adjustable DC voltage 115 is within predetermined limits. The PWM signals 192 can be adjusted by the controller 190 to ensure that the adjustable DC voltage 115 is within the predetermined limits.

[0035] The HV generator 120 receives the adjustable DC voltage 115 as an input to the Royer oscillator circuit 130 which generates a square wave output 135 for the HF-HV transformer 140. The HF-HV transformer 140 receives the square wave output 135 as an input at its primary side and converts that input into HF-HV AC outputs 125a, 125b for the pin electrodes 150a, 150b in the ionisation chamber 160. The HF-HV AC output applied at the electrodes 150a, 150b ionises the gas flow 172 in the ionisation chamber 160 to provide the output ionised gas stream 180.

[0036] The HF-HV transformer 140 is configured to have a sharp resonating frequency so that its output is sine wave, that is, an AC output. In effect, the adjustable DC voltage is converted to a HF-HV AC output for application to the electrode pins 150a, 150b.

[0037] The optional measurement electrode 195 measures the ionisation in the ionisation chamber 190 and provides the feedback signal 195a in accordance with that measurement to the controller 190. The controller 190 uses this measurement for maintaining the required ionisation level within the ionisation chamber 190 by controlling the buck converter 110.

[0038] The input DC voltage 105 may be in a range of between 6V and 50V, preferably at 24V, and, the AC voltage applied to the pin electrodes 150a, 150b is in the range of between 6kV to 20kV, preferably at 10kV. In one embodiment, the voltages applied to the pin electrodes are 180° out of phase and are self-resonating.

[0039] As described above, the input DC voltage is relatively low and is effectively switched by the PWM signals provided to the buck converter to provide an adjustable DC output voltage to the high voltage generator 120.

[0040] Although the electrodes 150a, 150b are described as being pin electrodes, that is, electrodes having a sharp point, these electrodes can take any other suitable form that generates the ionisation of the gas flow in the ionisation chamber 160.

[0041] In one alternative embodiment, an annular electrode may be arranged around a central pin electrode. The annular electrode may be shaped to have a cross-section which graduates from a flat surface to a sharp point. The graduation may be gradual over depth of the annulus or it may be more pronounced at one end thereof. In this embodiment, the pin electrode generates the ions in an electrostatic field, and, whilst the annular electrode is used as a reference electrode.

[0042] The gas supply 170 may comprise any suitable gas, and is preferably a compressed or pressurised gas whose gas flow 172 is controlled by the manually-operated valve 174. In one embodiment, the gas may be compressed air where the gas supply 170 comprises a compressor.

[0043] Figure 2 illustrates a partial cross-sectioned perspective view of an ionisation device 200 in accordance with the present invention. Components previously described with reference to Figure 1 have the same reference numerals.

[0044] The ionisation device 200 includes a hollow housing 210 having a nozzle portion 220, a handle portion 230, an operating button 240 mounted in the handle portion 230 and a gas supply inlet 250.

[0045] The ionisation chamber 160 is positioned in the nozzle portion 220 with the two electrodes 150a, 150b spaced from one another as shown. Gas flow is provided to the ionisation chamber 160 by means a conduit 255 connected to the gas supply inlet 250. As shown, the conduit 255 passes through the handle portion 230 and between the operating button 240 and circuit board 270.

[0046] The manually-operated valve (not shown) is connected to the operating button 240 which is biased to a first position by a spring 260. In this first position, the manually-operated valve is closed. When the operating button 240 is depressed, that is, pressed towards the handle portion 230 of the device 200 and maintained in this second position, the manually-operated valve is opened to allow gas flow through the conduit 255 towards the ionisation chamber 160, the gas flow being sensed by the pressure sensor 265 connected to the conduit 255, the pressure sensor forming part of a distribution block 252 located in the path between the gas supply inlet 250 and the conduit 255. This sensed gas flow produces the feedback signal 176a for the controller 190 which enables the PWM signal 192 for the buck converter 110 etc. to generate the output ionised gas stream 180 as described with reference to Figure 1.

[0047] Although the embodiment described with reference to Figure 2 comprises a manually-operated valve, it will readily be appreciated that any suitable valve may be used, for example, a pneumatically- or a hydraulically-operated valve may be used.

[0048] Once the operating button 240 is released and returned to the first position by the spring 260, the manually-operated valve is closed and gas flow from the gas supply through the conduit 255 is terminated. The operation of the valve controls the gas supply to the ionisation chamber, and, when the gas supply is terminated or off, there is no ionisation generated in the ionisation chamber. This has the advantage of reducing power consumption and pin wear of the ionising electrode(s).

[0049] A circuit board 270 is mounted within the handle portion 230 and comprises electronic components shown in Figure 1 such as the buck converter 110, the pressure sensor (176 in Figure 1 and 265 in Figure 2) and the controller 190. The DC voltage input may be by means of an electrical inlet 280 and is connected to the circuit board 270.

[0050] A HV module 300 is associated with the pin electrodes 150a, 150b and comprises the Royer oscillator circuit 130 and the HF-HV transformer 140, these two components forming HV generator 120. Suitable electrical connections are provided between the circuit board 270 and the HV module 300 to transfer the adjustable DC voltage produced by buck convertor 110 to the high voltage generator 120.

[0051] Figure 3 illustrates a first embodiment of a HV module 300 in accordance with the present invention. The HV module 300 includes first and second power transformers 310, 320 arranged in series. Each power transformer 310, 320 has a primary winding 314, 324 and a secondary winding 316 & 326 as shown. Secondary windings 316, 326 are HV-windings and each has a high side 316a, 326a and a low side 316b, 326b, the low sides of each transformer 310, 320 being connected together. As the low sides 316b, 326b of the secondary HV-windings 316, 326 are connected to one another, the transformers are floating and not connected to ground.

[0052] The high sides of the secondary HV-windings may be capacitively-coupled to the pin electrodes to improve self-balancing.

[0053] The high sides 316a, 326a of each of the secondary HV-windings 316, 326 are connected to one of the two pin electrodes 150a, 150b. Output signal 115 from the buck convertor 110 (Figure 1) is connected to input 330 which, in turn, is connected to the dual primary windings 314, 324 of the power transformers 310, 320.

[0054] The other electronic components shown in Figure 3 between the input 330 and the primary windings 314, 324 of the power transformers 310, 320 form the Royer oscillator circuit 130, and these will not be described in detail here as these components and their functionality will readily be understood by a person skilled in the art. For example, low voltage windings 312, 322 powered by the two transformer cores are used to maintain oscillation in the Royer oscillator circuit.

[0055] Figure 4 illustrates a HV module 400 having a single power transformer 410. The transformer 410 comprises a primary winding 414 with a secondary winding 412, 416. In this embodiment, secondary winding 416 comprises a HV-winding with sides 416a, 416b thereof being connected to respective ones of the pin electrodes 150a, 150b. Output signals 115 from the buck convertor 110 (Figure 1) is connected to input 430 which, in turn, is connected to the primary winding, 414 of the power transformer 410.

[0056] The other electronic components shown in Figure 4 between the input 430 and the primary winding 414 of the power transformer 410 form the Royer oscillator circuit, 130 and these will not be described in detail here as these components and their functionality will readily be understood by a person skilled in the art. For example, low voltage winding 412 powered by the transformer core is used to maintain oscillation in the Royer oscillator circuit.

[0057] Figures 5a to 5e respectively illustrate alternatives to the ionisation device 200 shown in Figure 2. In Figures 5a to 5e, each ionisation device 500a to 500e comprises a housing 510 in which only a HV module (either HV modules 300 or 400 shown in Figures 3 and 4) is mounted and connected to the pin electrodes in the ionisation chamber. The housing 510 includes an electrical inlet 520 and a gas supply inlet 530. Electrical inlet 520 is either connected to a remote circuit board (not shown) which is similar to circuit board 270 shown in

Figure 2 or connected directly to a DC supply voltage. The gas supply inlet 530 is connected to a gas supply (not shown) with optionally a manually-, electrically- or pneumatically-operated valve being provided for initiating and terminating gas flow to the ionisation chamber as described above. An aperture or opening 540 is provided in the housing to which nozzles can be attached as described in more detail below with reference to Figures 5a to 5e.

[0058] Other housing configurations, such as different shapes, orientations, and inlets, are also possible and are not limited to that shown in Figures 5a to 5e.

[0059] In Figure 5a, a flat nozzle 550 is shown which is connected to the housing 510 and to the ionisation chamber to receive an ionised gas stream therefrom. The nozzle 550 comprises a flat end portion 552 and a cylindrical portion 554 which is inserted into the aperture or opening 540 in the housing 510. The flat end portion 552 lies in a plane which is shown passing through a plane in which the two pin electrodes are located. In this particular embodiment, the plane of the nozzle 550 is perpendicular to the plane in which pin electrodes are located. However, the nozzle 550 may be oriented to be at any other angle relative to the plane in which the pin electrodes are located according to the particular implementation.

[0060] In Figure 5b, a conical nozzle 560 is shown which is connected to the housing 510 and to the ionisation chamber to receive an ionised gas stream therefrom. The nozzle 560 comprises a cylindrical portion 562 attached to the housing 510 by means of the opening or aperture 540, and a conical portion 564 having a centrally formed aperture 566 therein through which the ionised gas stream is directed. An axis (not shown) passes through the aperture 566 and is aligned to pass between the two pin electrodes.

[0061] Figure 5c is similar to Figure 5b and illustrates another conical nozzle 570 which comprises a cylindrical portion 572 attached to the housing 510 by means of the opening or aperture 540, and a conical portion 574 having a centrally formed aperture 576 therein through which the ionised gas stream is directed. An axis (not shown) passes through the aperture 576 and is aligned to pass between the two pin electrodes. In addition, the nozzle 570 includes additional apertures 578 provided in cylindrical portion 572 thereof. These additional apertures 578 provides air amplification for the gas flow and also pressure release when aperture 576 is blocked.

[0062] Figure 5d illustrates an elongate nozzle 580 connected to the housing 510 and to the ionisation chamber to receive an ionised gas stream therefrom. The elongate nozzle 580 has a flat nozzle end portion 582 through which the ionised gas stream is directed after passing along a varying cross-section portion 584. The varying cross-section portion 584 is used to direct the gas flow in the direction needed in the end application. The elongate nozzle 580 is mounted in the opening 540 of the housing 510.

[0063] Figure 5e illustrates an elongate cylindrical nozzle 590 which is connected to the housing 510 and the ionisation chamber to receive an ionised gas stream therefrom. In this embodiment, the elongate nozzle 590 is fixed to housing by means of a pipe fixture 592. Although the elongate nozzle 590 has a circular cross-section, it will be appreciated that any other cross-section may be implemented.

[0064] It will be appreciated that the other nozzle implementations are possible in accordance with the use of the charge neutralisation system incorporating the ionisation system described above.

[0065] Although specific embodiments of the present invention have been described, it will be appreciated that these are not limiting provided other embodiments fall within the scope of the claims.

Claims

1. An ionisation system (100) comprising:-

   a DC-to-DC voltage converter (110) configured for receiving an input DC voltage (105) and for providing an output adjustable DC voltage (115);
   a controller (190) configured for controlling the operation of the DC-to-DC voltage converter (110) to provide the output adjustable DC voltage (115);
   a high voltage generator (120, 130, 140) configured for receiving the output adjustable DC voltage (115) as an input and for generating a high frequency, high voltage AC voltage output (125a, 125b);
   an ionisation chamber (160);
   at least one ionising electrode (150a, 150b) within the ionisation chamber (160) and connected to the high frequency, high voltage AC voltage output (125a, 125b) and configured for generating an ionisation field within the ionisation chamber;
   a gas supply (170, 172) configured to be introduced into the ionisation chamber (160) through the generated ionisation field to provide an ionised gas flow (180);
   a valve (174) located in a gas supply (170, 172), the valve having a first position and a second position, the first and second positions being configured for initiating and terminating the gas supply (172) to the ionisation chamber (160); and
   a pressure sensor (176) located in the gas supply (172) and configured for providing a signal to the controller (190) in accordance with a sensed pressure of the gas supply.

2. An ionisation system according to claim 1, wherein the high voltage generator (120) comprises an os-

cillator circuit (130) and a high frequency, high voltage transformer circuit (140).

3. An ionisation system according to claim 2, wherein the oscillator circuit (130) comprises a Royer oscillator circuit.

4. An ionisation system according to claim 2 or 3, wherein the high frequency, high voltage transformer circuit (140) comprises a single transformer (410) having a centre-tapped primary winding (414) and a secondary winding (416), the secondary winding comprising a secondary high voltage winding configured for being connected to the at least one ionising electrode.

5. An ionisation system according to claim 4, wherein two pin electrodes are provided as ionising electrodes and sides (416a, 416b) of the single secondary high voltage winding (416) is configured to be connected to respective ones of the pin electrodes.

6. An ionisation system according to claim 2 or 3, wherein the high frequency, high voltage transformer circuit comprises two transformers (310, 320) in series, each having a primary winding and a secondary winding, each secondary winding comprising a high voltage winding having a high side (316a, 326a) and a low side (316b, 326b), and the transformer circuit is configured to connect the low side of each transformer together with at least one of the high side of one of the transformers being configured to be connected to the at least one ionising electrode.

7. An ionisation system according to claim 6, wherein two pin electrodes are provided with the high side (316a, 326a) of each transformer being connected to respective one of the two pin electrodes.

8. An ionisation system according to any one of the preceding claims, wherein the DC-to-DC converter (110) comprises a programmable DC-to-DC power converter configured to step down the input DC voltage and to step up output current.

9. An ionisation system according to any one of the preceding claims, wherein a feedback signal (115a) corresponding to the adjustable DC voltage is provided to the controller (190).

10. An ionisation system according to any one of the preceding claims, wherein the ionisation chamber (160) comprises an orifice (165) through which the gas supply (172) is introduced therein.

11. An ionisation system according to any one of the preceding claims, further comprising a measurement electrode (195) located in the ionisation chamber (160), the measurement electrode being configured for taking a measurement within the ionisation chamber and for providing a feedback signal (195a) indicative of that measurement to the controller (190).

12. An ionisation system according to any one of the preceding claims, wherein the valve (174) comprises one of: a manually-operated valve, a pneumatically-operated vale and a hydraulically-operated valve.

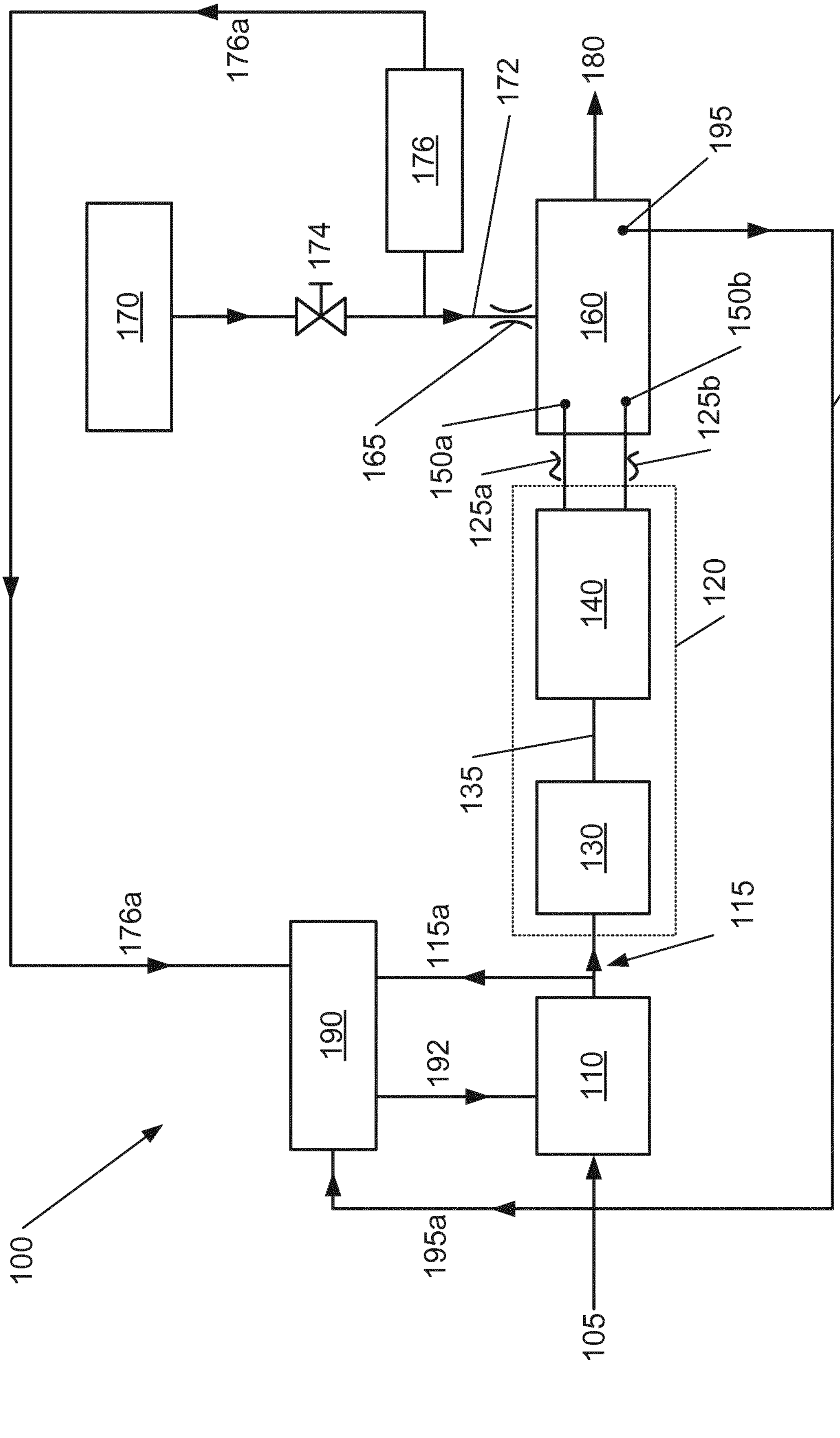
13. A charge neutralisation system (200; 500a, 500b, 500c; 500d; 500e) including:-

   an ionisation system (100) according to any one of the preceding claims;
   a housing (210; 510) comprising:-

      at least a first portion (220) having an opening (540) at an end thereof through which ionised gas flow exits the housing (210; 510), the ionisation chamber (160) of the ionisation system (100) being configured to be located in the first portion adjacent the opening therein;
      a gas inlet (250) configured for connecting to the gas supply of the ionisation system (100) and for supplying gas flow to the ionisation chamber (160); and
      an electrical inlet (280) configured for providing power to at least the at least one ionising electrode (150a, 150b) mounted within the ionisation chamber (160).

14. A charge neutralisation system according to claim 13, further comprising a nozzle (550; 560; 570; 580; 590) located at the opening (540) at the end of the first portion (220) of the housing (200; 510) and configured to direct the ionised gas flow as it exits the housing.

15. A charge neutralisation system according to claim 13 or 14, wherein the charge neutralisation system (200) comprises an ionising gun.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115a
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125a
125b
130
135
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150a
150b
160
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170
172
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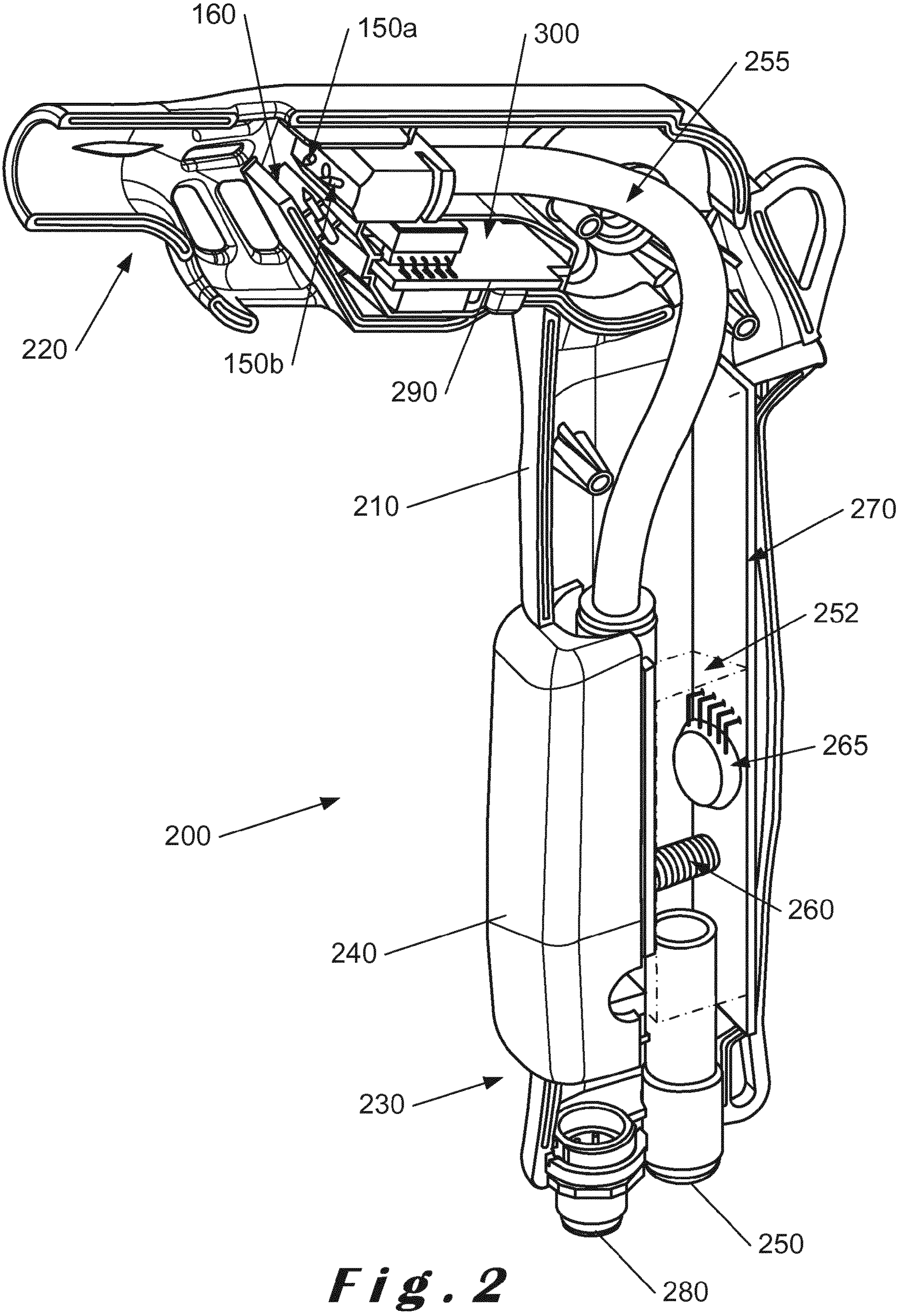
176
176a
180
190
192
195
195a

Fig. 1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150a
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150b
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200
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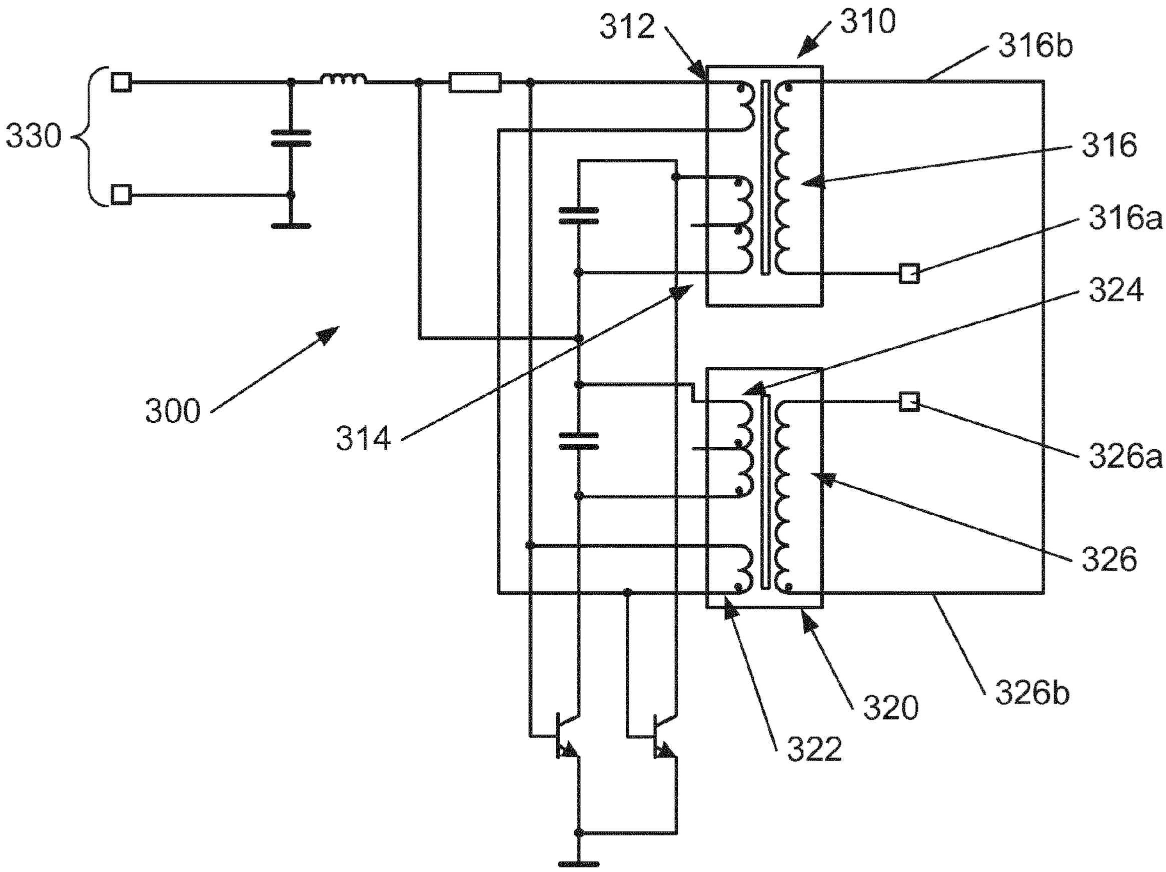
240
230
250
280

Fig. 2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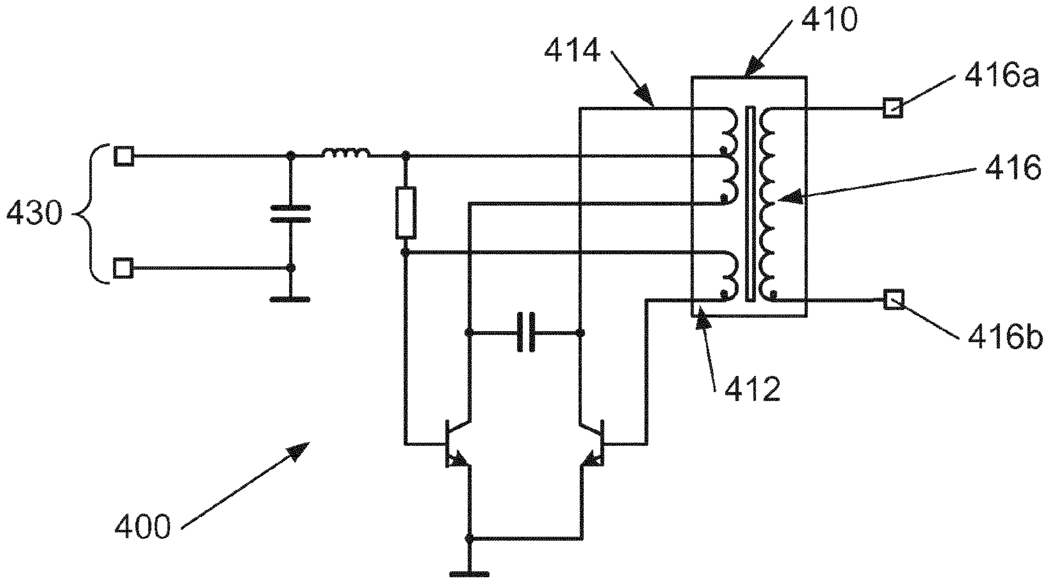
316
316a
324
300
314
326a
326
320
326b
322

Fig. 3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414
416a
416
430
416b
412
400

Fig. 4

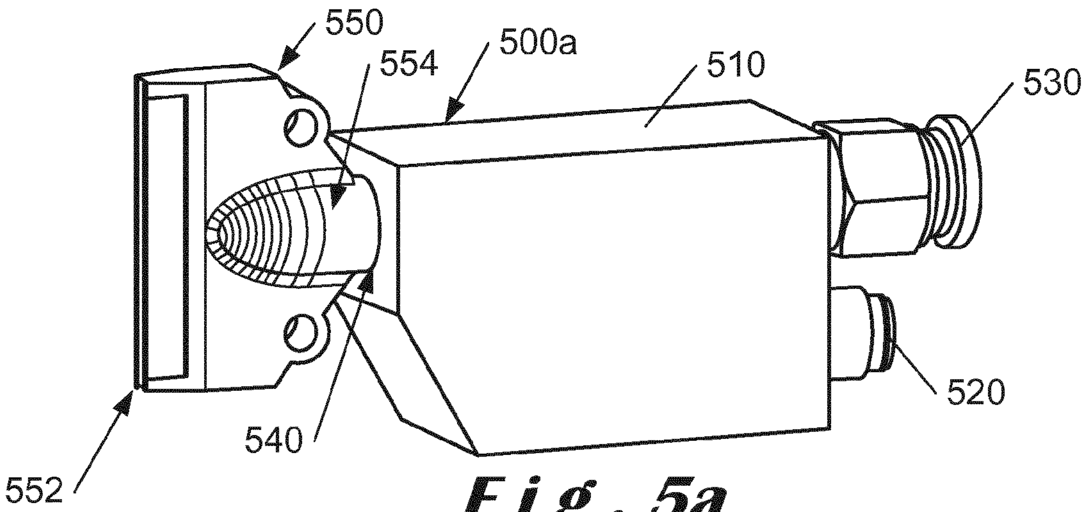

Fig. 5a

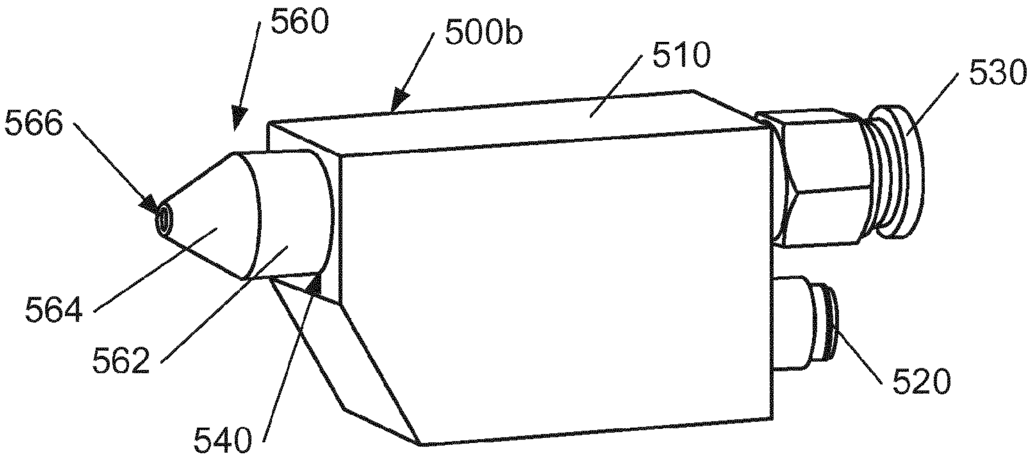

Fig. 5b

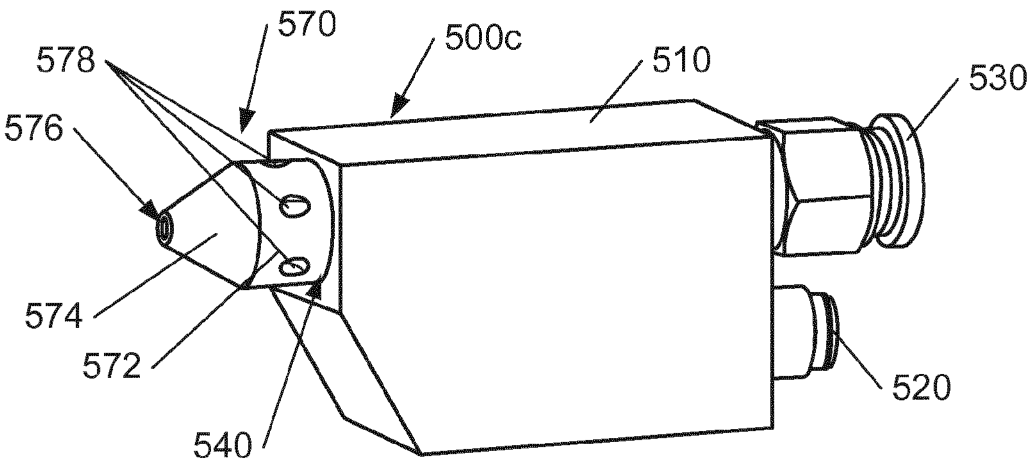

Fig. 5c

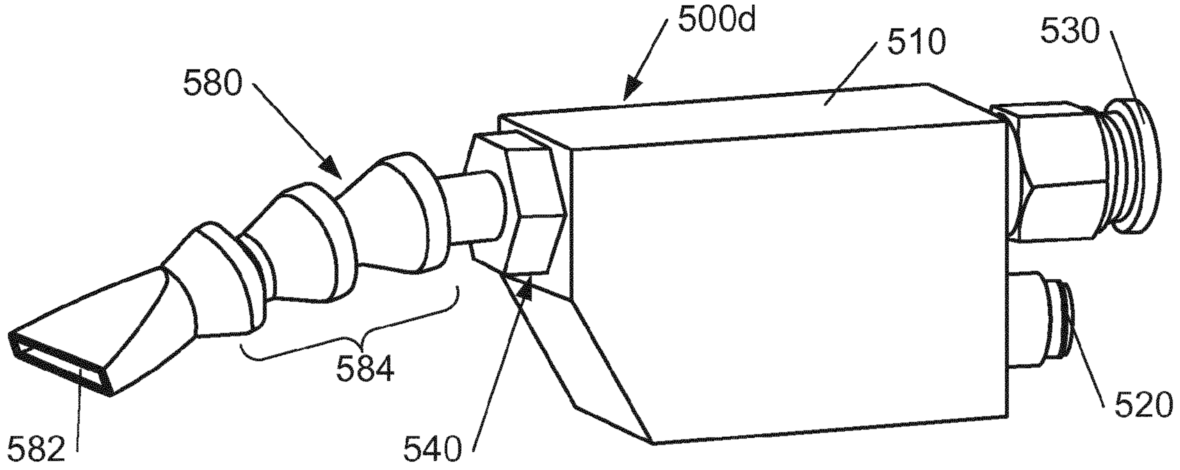

Fig. 5d

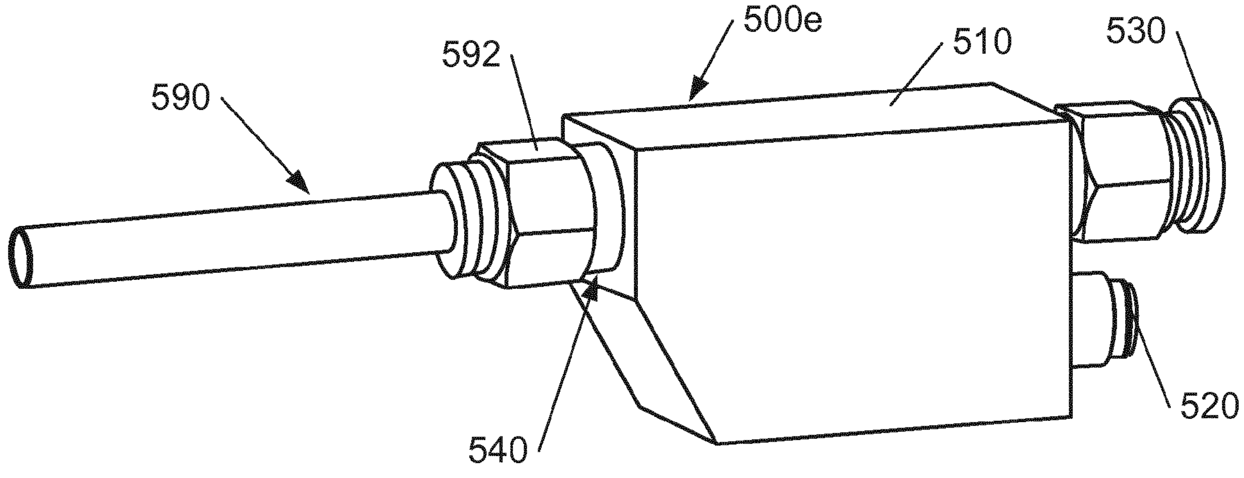

Fig. 5e

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EUROPEAN SEARCH REPORT

Application Number
EP 17 19 4979

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Place of search	Date of completion of the search	Examiner
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