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(54) Title: AIR CONDITIONER DEVICE WITH INDIVIDUALLY REMOVABLE DRIVER ELECTRODES

(57) Abstract: An air-conditioning device includes a housing, a grill coupled to the housing, an ion generator located in the housing and configured to create ions in a flow of air, and a driver electrode located within the housing and removable from the housing, the driver electrode being located on an interior surface of the grill.



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AIR CONDITIONER DEVICE WITH INDIVIDUALLY REMOVABLE DRIVER ELECTRODES

TECHNICAL FIELD

[0001] The present invention is related generally to a device for conditioning air.

BACKGROUND

[0002] The use of an electric motor to rotate a fan blade to create an airflow has long been known in the art. Although such fans can produce substantial airflow (e.g., 1,000 ft³/minute or more), substantial electrical power is required to operate the motor, and essentially no conditioning of the flowing air occurs.

[0003] It is known to provide such fans with a HEPA-compliant filter element to remove particulate matter larger than perhaps 0.3 μ m. Unfortunately, the resistance to airflow presented by the filter element may require doubling the electric motor size to maintain a desired level of airflow. Further, HEPA-compliant filter elements are expensive, and can represent a substantial portion of the sale price of a HEPA-compliant filter-fan unit. While such filter-fan units can condition the air by removing large particles, particulate matter small enough to pass through the filter element is not removed, including bacteria, for example.

[0004] It is also known in the art to produce an airflow using electro-kinetic techniques, whereby electrical power is converted into a flow of air without utilizing mechanically moving components. One such system is described in U.S. Pat. No. 4,789,801 to Lee (1988), depicted herein in simplified form as Figure 1A, which is hereby incorporated by reference. System 10 includes an array of first ("emitter") electrodes or conductive surfaces 20 that are preferably spaced-apart symmetrically from an array of second ("collector") electrodes or conductive surfaces 30. The positive terminal of a generator such as, for example, pulse generator 40 which outputs a train of high voltage pulses (e.g., 0 to perhaps +5 KV) is coupled to the first array 20, and the negative pulse generator terminal is coupled to the second array 30 in this example.

[0005] In another particular embodiment shown herein as Figure 1B, second electrodes 30 are preferably symmetrical and elongated in cross-section. The elongated

trailing edges on the second electrodes 30 are symmetrically and elongated in cross-section. The elongated trailing edges on the second electrodes 30 provide increased area upon which particulate matter 60 entrained in the airflow can attach. While the electrostatic techniques disclosed by the '801 patent are advantageous over conventional electric fan-filter units, further increased air conditioning efficiency would be advantageous. One method of increasing air conditioning efficiency is to position driver electrodes between the collector electrodes whereby the driver electrodes aid in driving the particulates toward the collector electrodes.

SUMMARY

[0006] Embodiments of the present invention are directed to a method and apparatus for moving air using, for example, an air conditioning system therein, with or without a fan, whereby the system can include at least one emitter electrode, at least one collector electrode, at least one driver electrode disposed adjacent to the collector electrode, and at least one trailing electrode positioned downstream of the collector electrode. The collector electrode and the driver electrode can be removable from the device. In one embodiment, the driver electrodes can be removable from the device and/or the collector electrode. The ability to remove the collector electrode and the driver electrode can allow for easy cleaning of the electrodes. In one embodiment, the present device can include a removable exhaust grill upon which the driver electrode and trailing electrode can be coupled to. The removable grill can allow the user to clean the driver electrode easily without having to remove the collector electrode.

[0007] In one embodiment, an air-conditioning device can include a housing that can have an inlet and an outlet. An ion generator can be located in the housing and can be configured to create ions in a flow of air. Also, a driver electrode can be located proximal to the outlet, wherein the driver electrode can be removable from the housing.

[0008] In one embodiment, an air-conditioning device can include a housing with a removable grill. An ion generator can be located in the housing, and a driver electrode can be located adjacent to a collector electrode of the ion generator, wherein the driver electrode can be coupled to the removable grill.

[0009] In one embodiment, an air-conditioning device can include a housing having an upper portion with a removable grill. An emitter electrode can be located in

the housing, and a collector electrode can be located in the housing, wherein the collector electrode can be removable through the upper portion of the housing. A high voltage source can be operatively connected to at least one of the emitter electrode and the collector electrode. A driver electrode can be coupled to the removable grill, wherein the driver electrode can be removable from the housing.

[0010] In one embodiment, an air-conditioning device can include a housing, an emitter electrode located in the housing, and a collector electrode located in the housing, wherein the collector electrode can be removable from the housing. A high voltage source can be adapted to provide a voltage differential between the emitter electrode and the collector electrode. A driver electrode can be removable from the housing with the collector electrode, wherein the driver electrode can be removable from the collector electrode when the collector electrode is removed from the housing.

[0011] In one embodiment, an air-conditioning device can include a housing having an inlet grill and an outlet grill. At least one emitter electrode can be positioned within the housing proximal to the inlet grill. At least two collector electrodes, each having a leading portion and a trailing portion, can be positioned proximal to the outlet grill. A high voltage source can be adapted to provide a voltage differential between the at least one emitter electrode and the collector electrodes. At least one removable driver electrode can be positioned between the at least two collector electrodes proximal to the trailing portions.

[0012] In one embodiment, a method of providing an air-conditioning device can include providing a housing; positioning an emitter electrode in the housing; and positioning a collector electrode downstream of the emitter electrode. The present method can include coupling a high voltage source that can be adapted to provide a voltage differential between the emitter electrode and the collector electrode, and positioning a removable driver electrode adjacent to the collector electrode in the housing.

[0013] In one embodiment, a method of removing an electrode assembly for cleaning can include lifting the electrode assembly from the housing through an upper portion of the housing, wherein the collector electrodes can be at least partially exposed. The method can further include removing the driver electrode from the lifted electrodes assembly. Alternatively, the method can include removing the grill from the

side of the housing, wherein the driver electrode can be at least partially exposed and can be capable of being removably secured to an interior surface of the grill. The electrode assembly can include an emitter electrode, which can be spaced from the collector electrodes. The electrode assembly can include a driver electrode positioned between the collector electrodes, wherein the emitter electrode and the collector electrodes can be electrically coupled to a high voltage source.

[0014] In one embodiment, a method of removing an electrode assembly, which can include collector and driver electrodes, for cleaning can include lifting the electrode assembly from the housing through an upper portion of the housing, wherein the collector electrodes and the driver electrodes can be accessible.

[0015] In one embodiment, a method of removing an electrode assembly, which can include collector and driver electrodes, for cleaning can include lifting the electrode assembly from the housing through an upper portion of the housing. The method can also include removing the driver electrode from the lifted electrode assembly.

[0016] In one embodiment, a method of cleaning a driver electrode, which can be positioned within an elongated housing of an air-conditioning device, can include removing the grill from a side of the housing, wherein the driver electrode can be at least partially exposed.

[0017] In one embodiment, an air transporting and/or conditioning device can include a housing that can have an inlet and outlet grill, an emitter electrode that can be configured within the housing, a collector electrode that can be configured within the housing and positioned downstream from the emitter electrode, and a driver electrode that can be removable from the housing independent of the collector electrode and the grills. In one embodiment, the driver electrode can be removable from the housing through a side portion of the housing. In one embodiment, the driver electrode can be insulated with a dielectric material and/or a catalyst. In one embodiment, a removable trailing electrode can be configured within the housing and downstream of the collector electrode. In one embodiment, a first voltage source can be electrically coupled to the emitter electrode and the collector electrode, and a second voltage source can be electrically coupled to the trailing electrode. The second

voltage source can be independently and selectively controllable of the first voltage source.

[0018] Additional features and advantages are described herein, and will be apparent from, the following Detailed Description and the figures.

BRIEF DESCRIPTION OF THE FIGURES

[0019] Figure 1A illustrates a plan, cross-sectional view of one embodiment of a prior art electro-kinetic air transporter-conditioner system.

[0020] Figure 1B illustrates a plan, cross-sectional view of one embodiment of a prior art electro-kinetic air transporter-conditioner system.

[0021] Figure 2A illustrates a perspective view of one embodiment of the an air transporter-conditioner system.

[0022] Figure 2B illustrates a perspective view of one embodiment of the system of Figure 2A with the removable collector electrode.

[0023] Figure 3 illustrates a perspective view of one embodiment of the system.

[0024] Figure 4 illustrates a perspective view of one embodiment of the ion generating unit.

[0025] Figure 5 illustrates a plan view of one embodiment of the ion generating unit.

[0026] Figure 6 illustrates a plan view of one embodiment of the ion generating unit.

[0027] Figure 7 illustrates a side view of one embodiment of the driver electrode.

[0028] Figure 8 illustrates an exploded view of one embodiment of the system.

[0029] Figure 9 illustrates a perspective cutaway view of one embodiment of the system.

[0030] Figure 10A illustrates a perspective view of one embodiment of the exhaust grill with the driver electrodes coupled thereto.

[0031] Figure 10B illustrates a detailed view of the embodiment shown in Figure 10A.

[0032] Figure 11A illustrates a perspective view of one embodiment of the system with an electrode assembly positioned therein.

[0033] Figure 11B illustrates a perspective view of one embodiment of the system with an electrode assembly partially removed.

[0034] Figure 12A illustrates a perspective view of one embodiment of the ion generating unit.

[0035] Figure 12B illustrates an exploded view of one embodiment of the ion generating unit.

[0036] Figure 13 illustrates an exploded view of one embodiment of the system.

[0037] Figure 14 illustrates a perspective view of one embodiment of the ion generating unit.

[0038] Figure 15A illustrates a perspective view of one embodiment of the system with collector electrodes removed.

[0039] Figure 15B illustrates an exploded view of one embodiment of the system with collector electrodes and driver electrodes removed.

[0040] Figure 15C illustrates a cross-sectional view of one embodiment of the system of Figure 15A taken along line C-C.

[0041] Figure 16 illustrates a perspective view of one embodiment of a the exhaust grill with trailing electrodes thereon.

[0042] Figure 17 illustrates an electrical block diagram of one embodiment of the high voltage power source.

[0043] Figure 18 illustrates an electrical block diagram of one embodiment of the high voltage power source.

DETAILED DESCRIPTION

[0044] Referring to Figure 2A and 2B, one embodiment of an air transporter-conditioner system 100 is illustrated. The air transporter-conditioner system 100 can include a housing 102 having an inlet or intake grill 104, an outlet or exhaust grill 106, and a base pedestal 108. The intake grill 104 can include vent grills or louvers that can be coupled to a rear end of the housing 102. The exhaust grill 106 can include vent grills or louvers that can be coupled to a front end of the housing 102. The housing 102 can stand upright from the base 108 and can have an elongated, vertical, and/or freestanding shape. As will be described in greater detail below, one or more of the intake grill 104 and the exhaust grill 106 can be removable from the housing 102.

Alternatively, a single grill can provide both an air intake and an air exhaust function, with an air inlet channel and an air exhaust channel in communication with the single grill and the air movement system within.

[0045] As shown in the embodiment of Figures 2A and 2B, the housing 102 can have a generally cylindrical and oval-shaped cross section. Alternatively, the housing 102 can include a differently shaped cross section such as, for example, a rectangular shape, a figure-eight shape, an egg shape, a tear-drop shape, or a circular shape. As will become apparent later, the housing 102 can be shaped to contain the air movement system. In one embodiment, the air movement system can be an ion generating unit 307 (Figure 4), as discussed further below. Alternatively or additionally, the air movement system can be a fan or other appropriate mechanism.

[0046] As shown in the embodiment of Figure 2B, the system 100 can include one or more emitter electrodes 232 and one or more collector electrodes 242, wherein the collector electrodes 242 can be removable, as discussed further below. In one embodiment, the intake and exhaust grills 104, 106 can be covered by fins or louvers 107 (Figure 3), wherein each fin 107 can be a thin ridge spaced-apart from an adjacent fin 107 so that each fin 107 can create minimal resistance as air flows through the housing 102. As shown in the embodiment of Figures 2A and 2B, the fins can be configured horizontally and perpendicular to the emitter and collector electrodes 232, 242. As such, the intake and exhaust fins can be aligned to give the unit a “see through” appearance so that a user can “see through” the system 100 from the inlet to the outlet or vice versa. The user may be unable to see moving parts within the housing 102, but may be able to observe only a quiet unit that cleans the air passing therethrough. Alternatively, as shown in the embodiment of Figure 3, the fins can be arranged vertically and can be directed along the length of the housing 102. Other orientations of fins and electrodes are contemplated in other embodiments including, for example, a configuration in which the user may be unable to “see through” the system 100, which can contain a germicidal lamp 290 (Figure 17) therein, without seeing the direct radiation from the lamp 290. The germicidal lamp 290 can reduce the amount of microorganisms exposed to the lamp 290 when passed through the system 100. In one embodiment, the germicidal lamp 290 (Figure 17) can be a UV-C lamp that can emit radiation having a wavelength of approximately 254 nm, which can be

effective in diminishing or destroying bacteria, germs, and/or viruses to which it is exposed. More details regarding this configuration and the germicidal lamp 290 are described in U.S. Patent Application 10/074,347, which is incorporated by reference herein. Alternatively, the system 100 can be configured without the germicidal lamp 290.

[0047] In one embodiment, an inner surface of the housing 102 can include an electrostatic shield to reduce detectable electromagnetic radiation. For example, a metal shield (not shown) can be disposed within the housing 102 or, alternatively, portions of the interior of the housing 102 can be coated with a metallic paint.

[0048] In one embodiment, there may not be a distinction between the intake grill 104 and the exhaust grill 106 except their location relative to the collector electrodes 242. Alternatively, in one embodiment, the intake and exhaust grills 104 and 106 can be configured differently and can be distinct from one another. The intake and exhaust grills 104, 106 can ensure that an adequate flow of ambient air can be drawn into or made available to the system 100 and that an adequate flow of ionized air, including appropriate amounts of ozone, flows out from the system 100 via the exhaust grill 106.

[0049] The housing 102 can further include one or more switches 300, a liftable handle 302, and a boost button 304, all of which may be located at a top surface 306 of the housing 102. The boost button 304, which can boost the ion output of the system 100, will be discussed further below.

[0050] Referring to Figure 3, an ion generating unit 307, also referred to as an electrode assembly, can be located internal to the housing 102. In one embodiment, the ion generating unit 307 can be powered by an AC:DC power supply that can be energizable or excitable by a switch S1. As shown in the embodiment of Figure 3, S1 can be conveniently located at the top surface 306 of the housing 102. The ion generating unit 307 can be self-contained such that, other than ambient air, nothing is required from beyond the housing 102 for operation except external operating potential. In one embodiment, a fan can be utilized to supplement and/or replace the movement of air caused by the operation of the ion generating unit 307, as described below.

[0051] The system 100 can be energized by activating the switch S1 at the top surface 306 of the housing 102. When the system 100 is energized by switch S1, high voltage or high potential output by a voltage generator 308 (Figure 4) can produce ions at the emitter electrodes 232, which can be attracted to the collector electrode 242. The ions can move from an "IN" direction (from the emitter electrodes 232) to an "OUT" direction (to the collector electrodes 242) and can be carried along with air molecules. In Figure 3, the "IN" notation denotes the intake of ambient air with particulate matter 310 through the intake grill 104, and the "OUT" notation denotes the outflow of cleaned air, which can be substantially devoid of the particulate matter 310, through the exhaust grill 106. In one embodiment, the system 100 can electro-kinetically produce an outflow of ionized air. In another embodiment, the system 100 can be an electro-static precipitator, whereby the system 100 can produce ions in an airflow created by a fan, for example, or other suitable device. In the process of generating the ionized airflow, appropriate amounts of ozone (O_3) may be beneficially produced.

[0052] Referring to Figure 4, a perspective view of one embodiment of the ion generating unit 307 is shown. As shown in the embodiment of Figure 7, the ion generating unit 307 can include a first electrode set 328 having one or more emitter electrodes 232, and can further include a second electrode set 330 having one or more collector electrodes 242. In one embodiment, the second electrode set 330 can be located downstream from the first electrode set 328. The number N1 of emitter electrodes 232 in the first electrode set 328 can differ by one relative to the number N2 of collector electrodes 242 in the second electrode set 330. In one embodiment, the system 100 can include a greater number of collector electrodes 242 than emitter electrodes 232. However, if desired, additional emitter electrodes 232 can be positioned at the outer ends of the first electrode set 328 such that $N1 > N2$, e.g., five emitter electrodes 232 compared to four collector electrodes 242. Alternatively, instead of multiple electrodes, single electrodes or single conductive surfaces can be substituted. It is to be understood that other numbers and arrangements of emitter electrodes 232 and/or collector electrodes 242 can alternatively be configured in the ion generating unit 307 in other embodiments.

[0053] As shown in the embodiment of Figure 4, the ion generating unit 307 can be electrically connected to a high voltage source unit such as, for example, the

high voltage pulse generator 308. In one embodiment, the positive output terminal of the high voltage source 308 can be coupled to the emitter electrodes 232, and the negative output terminal of high voltage source 308 can be coupled to the collector electrodes 242 as shown in Figure 4. This coupling polarity can work well and can minimize unwanted audible electrode vibration or hum. However, while generation of positive ions can be conducive to a relatively silent airflow, from a health standpoint it is desired that the output airflow be richer in negative ions than positive ions. It is to be understood that, in some embodiments, one port (for example, the negative port) of the high voltage pulse generator 308 can be the ambient air. Thus, the collector electrodes 242 need not be connected to the high voltage pulse generator 308 using a wire. Nonetheless, there can be an "effective connection" between the collector electrodes 242 and one output port of the high voltage pulse generator 308, in this instance, via ambient air. Alternatively the negative output terminal of the high voltage pulse generator 308 can be connected to the emitter electrodes 232, and the positive output terminal can be connected to the collector electrodes 242.

[0054] When voltage or pulses from the high voltage source 308 are generated across the emitter and collector electrodes 232, 242, a plasma-like field can be created surrounding the emitter electrodes 232. This electric field can ionize the ambient air between the emitter and collector electrodes 232, 242 and can establish an "OUT" airflow that can moves toward the collector electrodes 242. Ozone and ions can be generated simultaneously by the emitter electrodes 232 from the voltage potential provided by the high voltage source 308. Ozone generation can be increased or decreased by increasing or decreasing the voltage potential at the emitter electrodes 232. Coupling an opposite polarity potential to the collector electrodes 242 can accelerate the motion of ions generated at the emitter electrodes 232 and can thereby produce ions. Molecules and the particulates 310 in the air can thus become ionized with the charge emitted by the emitter electrodes 232 as they pass by the emitter electrodes 232. As the ions and ionized particulates 310 move toward or along the collector electrodes 242, the opposite polarity of the collector electrodes 242 can cause the ionized particulates 310 to be attracted and thereby move toward the collector electrodes 242. Therefore, the collector electrodes 242 can collect the ionized

particulates 310 in the air and can thereby allow the system 100 to output cleaner, fresher air.

[0055] Referring to Figure 5, a plan view schematic of one embodiment of the ion generating unit 307 is shown. Each of the collector electrodes 242 in the embodiment shown in Figure 5 can include a nose 317, two parallel trailing sides 318 and an end 319 opposite the nose 317. Additionally, the ion generating unit 307 can include one or more driver electrodes 320. The driver electrodes 320 can include two sides that are parallel to each other, as well as a front end and a rear end. In another embodiment, the driver electrodes 320 can be a wire or a series of wires configured in a line. Although two driver electrodes 320 are shown in the embodiment of Figure 5, any number of driver electrodes 320, including only one, can be used.

[0056] In the embodiment shown in Figure 5, the driver electrodes 320 can be located midway, interstitially between the collector electrodes 242. In one embodiment, the driver electrodes 320 can be positioned proximal to the trailing sides 318 of the collector electrodes 242, although not necessarily. In one embodiment, the driver electrodes 320 can be electrically connected to the positive terminal of the high voltage source 308, as shown in Figure 5. In another embodiment, the driver electrodes 320 can be electrically connected to the emitter electrodes 232. Alternatively, the driver electrodes 320 can have a floating potential or can alternatively be grounded. In one embodiment, ionized particles traveling toward the driver electrodes 320 can be repelled by the driver electrodes 320 toward the collector electrodes 242, especially in the embodiment in which the driver electrodes 320 are positively charged.

[0057] As shown in the embodiment of Figure 5, each of the driver electrodes 320 can include an underlying electrically conductive electrode 322 that is covered by a dielectric material 324. In one embodiment, the electrically conductive electrode 322 can be located on a printed circuit board (PCB) that can be covered by one or more additional layers of insulated dielectric material 324. Exemplary insulated PCBs are generally commercially available and may be found from a variety of sources such as, for example, Electronic Service and Design Corp, of Harrisburg, PA. Alternatively, the dielectric material 324 could be heat shrink tubing wherein during manufacture, heat shrink tubing can be placed over the conductive electrode 322 and then heated, which can cause the tubing to shrink to the shape of the conductive electrode 322. An

exemplary heat shrinkable tubing is type FP-301 flexible polyolefin tubing available from 3M of St. Paul, Minnesota.

[0058] Alternatively, the dielectric material 324 can be an insulating varnish, lacquer or resin. For example, after being applied to the surface of the conductive electrode 322, the varnish can dry and can form an insulating coat or film, a few mils (thousands of an inch) in thickness, covering the conductive electrode 322. The dielectric strength of the varnish or lacquer can be, for example, above approximately 1000 V/mil (volts per thousands of an inch). Such insulating varnishes, lacquers and resins are commercially available from various sources, such as from John C. Dolph Company of Monmouth Junction, New Jersey, and Ranbar Electrical Materials Inc. of Manor, Pennsylvania.

[0059] Other possible dielectric materials 324 that can be used to insulate the driver electrodes 320 can include ceramic, porcelain enamel and/or fiberglass. These are just a few examples of dielectric materials 324 that can be used to insulate the driver electrodes 320. Other insulating dielectric materials 324 can be used to insulate the driver electrodes 320.

[0060] As shown in the embodiment of Figure 5, the ion generating unit 307 can include one or more trailing electrodes 326 positioned downstream of the collector electrodes 242. In the embodiment of Figure 5, three trailing electrodes 326 can be positioned directly downstream and in-line with the collector electrodes 242. In another embodiment, the trailing electrodes 326 can be positioned adjacent to the collector electrodes 242. In another embodiment, the trailing electrodes 326 can be positioned adjacent to the driver electrodes 320. In one embodiment, the trailing electrodes 326 can be electrically connected to the negative terminal of the high voltage source 308, whereby the trailing electrodes 326 can promote additional negative ions into the air exiting the system 100. The trailing electrodes 326 can be configured to be wire shaped and can extend substantially along the length of the ion generating unit 307. The wire shaped trailing electrodes 326 are advantageous, because negative ions can be produced along the entire length of each of the trailing electrodes 326. This production of negative ions along the entire length of each of the trailing electrodes 326 can allow more ions to be freely dissipated in the air as the air flows

past the ion generating unit 307. Alternatively or additionally, the trailing electrodes 326 can be a triangular shape with pointed ends, instead of a wire.

[0061] Referring to Figure 6, a plan view of one embodiment of the ion generating unit 307 is shown. The ion generating unit 307 can include a first electrode set 328 including the emitter electrodes 232, and a second electrode set 330 including the collector electrodes 242. In one embodiment, the second electrode set 330 can be located downstream from the first electrode set 328. As shown in the embodiment of Figure 6, the ion generating unit 307 can also include one or more driver electrodes 320 located interstitially between the collector electrodes 242. In one embodiment, the ion generating unit 307 can further include one or more trailing electrodes 326 located downstream from the collector electrodes 242. The number N1 of emitter electrodes 232 in the first electrode set 328 can differ by one relative to the number N2 of collector electrodes 242 in the second electrode set 330. In one embodiment, the system 100 can include a greater number of collector electrodes 242 than emitter electrodes 232. However, if desired, additional emitter electrodes 232 can be positioned at the outer ends of the first electrode set 328 such that $N1 > N2$, e.g., five emitter electrodes 232 compared to four collector electrodes 242. Alternatively, instead of multiple electrodes, single electrodes or single conductive surfaces can be substituted. It is to be understood that other numbers and arrangements of emitter electrodes 232, collector electrodes 242, driver electrodes 320, and/or trailing electrodes 326 can alternatively be configured in the ion generating unit 307 in other embodiments.

[0062] The material(s) of the emitter and collector electrodes 232 and 242 can conduct electricity and can be resistant to the corrosive effects from the application of high voltage, but yet strong and durable enough to be cleaned periodically. In one embodiment, the emitter electrodes 232 can be fabricated from tungsten. Tungsten is sufficiently robust to withstand cleaning, has a high melting point to retard breakdown due to ionization, and has a rough exterior surface that can promote efficient ionization. In one embodiment, the collector electrodes 242 can have a highly polished exterior surface to minimize unwanted point-to-point radiation. As such, the collector electrodes 242 can be fabricated from stainless steel and/or brass, as well as other suitable materials. The polished surface of the collector electrodes 242 can also

promote ease of electrode cleaning. The materials and construction of the emitter and collector electrodes 232, 242 can allow the emitter and collector electrodes 232, 242 to be lightweight and easy to fabricate. Additionally, the emitter and collector electrodes 232, 242 can lend themselves to mass production due to their materials and construction. Further, the emitter and collector electrodes 232, 242 described herein can promote efficient generation of ionized air and appropriate amounts of ozone.

[0063] As shown in the embodiment of Figure 6, the system 100 can include a first high voltage source (HVS) 332 and a second high power voltage source 334. The positive output terminal of the first HVS 332 can be coupled to the emitter electrodes 232 in the first electrode set 328, and the negative output terminal of the first HVS 332 can be coupled to the collector electrodes 242 in the second electrode set 330. This coupling polarity has been found to work well to minimize unwanted audible electrode vibration or hum. It is to be understood that in some embodiments, one port such as, for example, the negative port of the high voltage power supply can be ambient air. Thus, the collector electrodes 242 in the second electrode set 330 need not be connected to the first HVS 332 with a wire. Nonetheless, there can be an “effective connection” between the collector electrodes 242 and one output port of the first HVS 332, in this instance, via ambient air. Alternatively the negative output terminal of the first HVS 332 can be connected to the emitter electrodes 232 in the first electrode set 328, and the positive output terminal can be connected to the collector electrodes 242 in the second electrode set 330, if desired.

[0064] When voltage or pulses from the first HVS 332 are generated across the first and second electrode sets 328 and 330, a plasma-like field can be created surrounding the emitter electrodes 232 in the first electrode set 328. This electric field can ionize the ambient air between the first and second electrode sets 328 and 330 and can establish the “OUT” airflow that moves toward the collector electrodes 242, which is herein referred to as the ionization region.

[0065] Ozone and ions can be generated simultaneously by the emitter electrodes 232 as a function of the voltage potential from the first HVS 332. Ozone generation can be increased or decreased by increasing or decreasing, respectively, the voltage potential at the first electrode set 328. Coupling an opposite polarity voltage potential to the collector electrodes 242 can accelerate the motion of ions from the first

electrode set 328 to the second electrode set 330, and can thereby produce the airflow in the ionization region. Molecules and particulates in the air can thus become ionized with the charge emitted by the emitter electrodes 232 as the molecules and particulates pass by the emitter electrodes 232. As the ions and ionized particulates move toward the second electrode set 330, the ions and ionized particles can push or move air molecules toward the second electrode set 330. The relative velocity of this motion can be increased by, for example, increasing the voltage potential at the second electrode set 330 relative to the potential at the first electrode set 328. Therefore, the collector electrodes 242 can collect the ionized particulates in the air and can thereby allow the system 100 to output cleaner, fresher air.

[0066] As shown in the embodiment of Figure 6, the trailing electrodes 326 can be electrically coupled to the second HVS 334. The trailing electrodes 326 can generate a substantial amount of negative ions because the trailing electrodes 326 can be coupled to relatively negative high potential. In one embodiment, the trailing electrodes 326 can be a wire positioned downstream from the collector electrodes 242. In one embodiment, the trailing electrodes 326 can have a pointed shape in its side profile such as, for example, a triangle shape. Alternatively, at least a portion of the trailing side 318 in the collector electrodes 242 can have a pointed electrode region that can emit supplemental negative ions, as described in U.S. Patent Application No. 10/074,347 which is incorporated by reference herein.

[0067] The negative ions produced by the trailing electrodes 326 can neutralize excess positive ions otherwise present in the output airflow such that the "OUT" flow can have a net negative charge. In one embodiment, the trailing electrodes 326 can be made of stainless steel, copper, or other suitable material. Although multiple trailing wire electrodes 326 are shown in the embodiment of Figures 5 and 6, the inclusion of one trailing electrode 326 can provide a sufficient number of output negative ions.

[0068] When the trailing electrodes 326 are electrically connected to the negative terminal of the second HVS 334, the positively charged particles within the airflow can be attracted to and collect on the trailing electrodes 326. In a typical ion generating unit 307 without trailing electrodes 326, most of the particles may collect on the surface area of the collector electrodes 242. However, some particles may pass through the system 100 without being collected by the collector electrodes 242. The

trailing electrodes 326 can also serve as a second surface area to collect the positively charged particles. Additionally, the energized trailing electrodes 326 can energize any remaining un-ionized particles leaving the system 100. While the energized particles may not be collected by the collector electrodes 242, they may be collected by other surfaces in the immediate environment such that collection may reduce the particles in the air in that environment.

[0069] The use of driver electrodes 320 can increase particle collection efficiency of the ion generating unit 307 and can reduce the percentage of particles that are not collected by the collector electrodes 242. This can be due to the driver electrodes 320 pushing particles in the airflow toward the trailing side 318 of adjacent collector electrodes 242, which is referred to herein as the collecting region. In one embodiment, the driver electrodes 320 can be insulated, which can further increase particle collection efficiency, as discussed further below with respect to Figure 7.

[0070] In one embodiment, the collecting region between the driver electrodes 320 and the collector electrodes 242 might not interfere with the ionization region between the emitter electrodes 232 and the collector electrodes 242. If this were to occur, the electric field in the collecting region might reduce the intensity of the electric field in the ionization region and thereby might reduce the production of ions and slow down the airflow rate. Accordingly, in one embodiment, the leading end (i.e., upstream end) of each of the driver electrodes 320 can be set back (i.e., downstream) from the leading end of the collector electrodes 242, as shown in the embodiment of Figures 5 and 6. Also, the downstream end of the driver electrodes 320 can be substantially even with the downstream end of the collector electrodes 242 as shown in the embodiment of Figures 5 and 6. Alternatively, the downstream end of the driver electrodes 320 can be positioned slightly upstream or downstream from the downstream end of the collector electrodes 242.

[0071] The emitter electrodes 232 and the driver electrodes 320 may or may not be at the same voltage potential, depending on which embodiment of the present invention is practiced. When the emitter electrodes 232 and the driver electrodes 320 are at the same voltage potential, arcing between the emitter electrodes 232 and the driver electrodes 320 might not occur.

[0072] As stated above, the system 100 can also produce ozone (O_3). In one embodiment, ozone production can be reduced by coating the internal surfaces of the housing 102 with an ozone reducing catalyst. In one embodiment, the driver electrodes 320 can be coated with an ozone reducing catalyst. Exemplary ozone reducing catalysts can include manganese dioxide and activated carbon. Commercially available ozone reducing catalysts such as, for example, PremAir™ manufactured by Englehard Corporation of Iselin, New Jersey, can alternatively be used. Some ozone reducing catalysts are electrically conductive, while others are not electrically conductive (e.g., manganese dioxide). In one embodiment, the ozone reducing catalysts can have a dielectric strength of at least approximately 1000 V/mil (one-hundredth of an inch).

[0073] Referring to Figure 7, a side view of an embodiment of a driver electrode 320 that is insulated is shown. The driver electrode 320 can be plate shaped and can have a top end 336 and a bottom end 338. As shown in the embodiment of Figure 7, a receiving hook 340, which can allow the driver electrode 320 to be attached to the housing 102, can be located near the top end 336 of the driver electrode 320. Additionally, a detent 342, which can secure the driver electrode 320 within the housing 102 and can prevent the driver electrode 320 from pivoting, can be located near the bottom end 338 of the driver electrode 320. In another embodiment, the driver electrode 320 can include a series of conductive wires arranged in a line parallel to the collector electrodes 242 as discussed in U.S. Patent No. 6,176,977, which is incorporated by reference herein.

[0074] As shown in the embodiment of Figure 7, the insulated driver electrode 320 can include an electrically conductive electrode 322 that is coated with an insulating dielectric material 324. In one embodiment, the driver electrode 320 can be made of a non-conducting substrate such as, for example, a printed circuit board (PCB) having a conductive member that is covered by one or more additional layers of dielectric material 324. Exemplary insulated PCBs are generally commercially available and may be found from a variety of sources, including for example Electronic Service and Design Corp, of Harrisburg, Pennsylvania. In embodiments where the driver electrode 320 is not insulated, the driver electrode 320 can include the electrically conductive electrode 322 only. As shown in the embodiment of Figure 7, the insulated driver electrode 320 can include a contact terminal 344 along the bottom

end 338 of the driver electrode 320. In another embodiment, the contact terminal 344 can be located along the top end 336 of the driver electrode 320 or elsewhere on the driver electrode 320. The contact terminal 344 can electrically connect the driver electrode 320 to a voltage potential (e.g., HVS), or alternatively to ground. In one embodiment, the electrically conductive electrode 322 can be connected to the contact terminal 344 by one or more conductive trace lines 346, as shown in the embodiment of Figure 7. Alternatively, the electrically conductive electrode 322 can be directly in contact with the contact terminal 344.

[0075] In one embodiment, the dielectric material 324 can be a heat shrink material. During manufacture, the heat shrink material can be placed over the electrically conductive electrode 322 and then heated, which can cause the dielectric material 324 to shrink to the shape of the conductive electrode 322. An exemplary heat shrinkable material can be type FP-301 flexible polyolefin material available from 3M[®] of St. Paul, Minnesota. It is to be understood that any other appropriate heat shrinkable material can be used. In another embodiment, the dielectric material 324 can be an insulating varnish, lacquer or resin. For example, after being applied to the surface of the underlying conductive electrode 322, a varnish can dry and can form an insulating coat or film, which can be a few mil (thousands of an inch) in thickness. The dielectric strength of the varnish or lacquer can be, for example, above approximately 1000 V/mil. Such insulating varnishes, lacquer and resins are commercially available from various sources such as, for example, John C. Dolph Company of Monmouth Junction, New Jersey and Ranbar Electrical Materials Inc. of Manor, Pennsylvania. Other possible dielectric materials 324 that can be used to insulate the driver electrode 320 can include, but are not limited to, ceramic, porcelain enamel or fiberglass.

[0076] The extent that the voltage difference (and thus, the electric field) between the collector electrodes 242 and an un-insulated driver electrodes 320 can be increased beyond a certain voltage potential difference can be limited due to arcing occurring between the collector electrodes 242 and the driver electrodes 320. However, when the driver electrodes 320 are insulated, the voltage potential difference that can be applied between the collector electrodes 242 and the driver electrodes 320 without arcing occurring can be significantly increased. The increased potential

difference can result in an increased electric field, which can also significantly increase particle collecting efficiency.

[0077] In one embodiment, the driver electrodes 320 can be electrically connected to ground, as shown in the embodiment of Figure 6. Although the grounded driver electrodes 320 may not receive a charge from either the first or second HVS 332, 334, the driver electrodes 320 can still deflect positively charged particles toward the collector electrodes 242. In another embodiment, the driver electrodes 320 can be positively charged. In particular, the driver electrodes 320 can be electrically coupled to the positive terminal of either the first or second HVS 332, 334 (Figure 5). The emitter electrodes 232 can apply a positive charge to particulate matter 310 passing by the emitter electrodes 232. In one embodiment, to clean the air of particle matter 310, the particulate matter 310 can stick to the collector electrodes 242 (which can later be cleaned). The electric fields produced between the driver electrodes 320 and the collector electrodes 242 can thus push the positively charged particles toward the collector electrodes 242. Generally, the greater the electric field between the driver electrodes 320 and the collector electrodes 242, the greater the migration velocity and the particle collection efficiency of the ion generating unit 306. In yet another embodiment, the driver electrodes 320 can be electrically coupled to the negative terminal of either the first or second HVS 332, 334, whereby, in yet another embodiment, the driver electrodes 320 can be charged at a voltage that is less than the negatively charged collector electrodes 242.

[0078] Referring to Figure 8, the driver electrodes 320 can be removable in one embodiment by removing the exhaust grill 106 from the housing 102. The removable exhaust grill 106 can allow the user convenient access to the ion generating unit 307 and the driver electrodes 320 to clean the ion generating unit 307 and/or other components. The exhaust grill 106 can be removable either partially or completely from the housing 102 as shown in Figure 8. Particularly, the exhaust grill 106 can include several L-shaped coupling tabs 350, which can secure the exhaust grill 106 to the housing 102. The housing 102 can include a number of receiving slots 352, which can be positioned to receive and engage the L-shaped coupling tabs 350 when the exhaust grill 106 is coupled to the housing 102. The exhaust grill 106 can be removed from the housing 102 by lifting the exhaust grill 106 in an upward, vertical direction

relative to the housing 102 to raise the L-shape coupling tabs 350 from the corresponding receiving slots 352 on the housing 102. Once the L-shaped coupling tabs 350 are disengaged, the user can be able to pull the exhaust grill 106 laterally away from the housing 102 to expose the ion generating unit 307 within the housing 102. In one embodiment, the exhaust grill 106 can be coupled to the housing 102 by any alternative mechanism. For example, the exhaust grill 106 can be attached to the housing 102 on a set of hinges, whereby the exhaust grill 106 can pivotably open with respect to the housing 102 to allow access to the ion generating unit 307. In one embodiment, the driver electrodes 320 and collector electrodes 242 can be configured to allow the collector electrodes 242 to be vertically lifted while the driver electrodes 320 can remain within the housing 102.

[0079] Referring to Figure 9, one embodiment of a cutaway view of a back end 354 of the housing 102 is shown. As shown in the embodiment of Figure 9, the ion generating unit 307 can be positioned within the housing 102 and the exhaust grill 106 can be coupled thereto. As shown in the embodiment of Figure 9, the collector electrodes 242 of the ion generating unit 307 can include a top mount 356, a bottom mount 358, and several collector electrodes 242 positioned therebetween. Particularly, a number of collector electrodes 242 can be coupled to the top mount 356 and the bottom mount 358 and positioned therebetween. In one embodiment, the collector electrodes 242 can be positioned parallel to one another. Additionally, as shown in the embodiment of Figure 9, two driver electrodes 320 can be located within the housing 102 and can be positioned in between the parallel collector electrodes 242. The collector electrodes 242 and driver electrodes 320 can be positioned proximal to the exhaust grill 106 to cause the air to flow out of the system 100 through the exhaust grill 106. Additionally, the ion generating unit 307 can include one or more emitter electrodes 232, which can be attached to emitter electrode pillars 360 disposed on the top and bottom mounts 356 and 358, respectively. The emitter electrodes 232 are shown in dashed lines in Figure 9 for clarity purposes.

[0080] Referring to Figure 10A, a perspective view of one embodiment of the removable exhaust grill 106 is shown. As shown in the embodiment of Figure 10A, the exhaust grill 106 can include a top end 362 and a bottom end 364. In one embodiment, the exhaust grill 106 can have a concave shape, and the length of the exhaust grill 106

can be substantially the height of the elongated housing 102, although it is not necessary. The driver electrodes 320 can be securely coupled to one or more clips 366 disposed on the interior surface of the exhaust grill 106 as shown in the embodiment of Figure 10A. In one embodiment, the clips 366 can be located on the inside of the exhaust grill 106 to position the driver electrodes 320 in between the collector electrodes 242, as discussed above, when the exhaust grill 106 is coupled to the housing 102. In one embodiment, the driver electrodes 320 can be removably coupled to the clips 366 by a friction fit. The driver electrodes 320 can be removable from the clips 366 by any other method or mechanism. In one embodiment, the driver electrodes 320 may not be removable from the clips 366 of the exhaust grill 106.

[0081] In one embodiment, the driver electrodes 320 can be coupled to the negative terminal or ground (Figure 6) of the high voltage pulse generator 308 via a pair of conductors located on the top mount 356 and/or bottom mount 358. Alternatively the conductors can be positioned elsewhere on the housing 102. The conductors can provide voltage to or ground the driver electrodes 320 when the exhaust grill 106 is coupled to the housing 102. The conductors can come into contact with the driver electrodes 320 when the exhaust grill 106 is coupled to the housing 102. Thus, the driver electrodes 320 can be energized or grounded when the exhaust grill 106 is secured to the housing 102. In contrast, the driver electrodes 320 may not be energized when the exhaust grill 106 is removed from the housing 102 because the driver electrodes 320 may not be in electrical contact with the conductors. This can allow the user to clean the driver electrodes 320. It is to be understood that any other method can alternatively be used to energize the driver electrodes 320.

[0082] In one embodiment, the exhaust grill 106 can include the trailing electrodes 326, which can be disposed downstream of the driver electrodes 320 and near the inner surface of the exhaust grill 106. An illustration of the trailing electrodes 326 is shown in Figure 10B. It is to be understood that the trailing electrodes 326 are present in Figure 10A, although not shown for clarity purposes. In the embodiment in which the driver electrodes 320 can be removable from the exhaust grill 106, the user may be able to access the trailing electrodes 326 for cleaning purposes. In another embodiment, the driver electrodes 320 may not be removable, and the trailing electrodes 326 can include a cleaning mechanism (not shown) such as, for example, a

slidable member, a bead, or the like, as described above with respect to cleaning the emitter electrodes 232 in U.S. Patent Nos. 6,350,417 and 6,709,484, which are incorporated by reference herein.

[0083] In one embodiment, the trailing electrodes 326 can be secured to the interior of the exhaust grill 106 by a number of coils 368, as shown in the embodiment of Figures 10A and 10B. As shown, the coils 368 and the trailing electrodes 326 can be coupled to an attaching member 370. The attaching member 370 can be secured to the inner surface of the exhaust grill 106, whereby the attaching member 370 and trailing electrodes 326 can remain with the exhaust grill 106 when the exhaust grill 106 is removed from the housing 102. Although not shown in the Figures, a set of coils 368 can also be positioned near the top end 362 of the exhaust grill 106, whereby the coils 368 can hold the trailing electrodes 326 taut against the inside surface of the exhaust grill 106. Alternatively, the length of the trailing electrodes 326 can be longer than the distance between the coils 368 on opposite ends of the exhaust grill 106. Therefore, the trailing electrodes 326 can be slack against the inside surface of the exhaust grill 106. Although three sets of coils 368 and three trailing electrodes 326 are shown in Figures 10A and 10B, any number of trailing electrodes 326, including only one trailing electrode 326, can alternatively be used.

[0084] In one embodiment, the attaching member 370 can be conductive and can electrically connect the trailing electrodes 326 to the second high voltage pulse generator 334 (Figures 5 and 6) when the exhaust grill 106 is coupled to the housing 102. The attaching member 370 can come into contact with a terminal of the second high voltage pulse generator 334 when the exhaust grill 106 is coupled to the housing 102. Thus, the trailing electrodes 326 can be energized when the exhaust grill 106 is secured to the housing 102. In contrast, the trailing electrodes 326 may not be energized when the exhaust grill 106 is removed from the housing 102 because the attaching member 370 may not be in electrical contact with the second high voltage pulse generator 334. This can allow the user to clean the trailing electrodes 326. It is to be understood that any other method can alternatively be used to energize the trailing electrodes 326.

[0085] Although the trailing electrodes 326 are shown coupled to the interior surface of the exhaust grill 106 in the Figures, the trailing electrodes 326 can

alternatively be configured to be free-standing and can be located downstream from the collector electrodes 242. Thus, the trailing electrodes 326 can remain stationary with respect to the housing 102 when the exhaust grill 106 and/or the collector electrodes 242 of the ion generating unit 307 is removed from the system 100. In one embodiment, the freestanding trailing electrodes 326 can be attached to a set of brackets (not shown), whereby the brackets can be removable from within the housing 102. Alternatively, the brackets can be secured to the housing 102, and the trailing electrodes 326 may not be removable from within the housing 102.

[0086] In operation, once the exhaust grill 106 is removed from the housing 102, the user can remove the driver electrodes 320 from the clips 366 by simply pulling on the driver electrodes 320. Alternatively, the driver electrodes 320 can be disengaged from the clips 366 by any other appropriate known method or mechanism. Alternatively, the driver electrodes 320 can be secured to the exhaust grill 106 and can be cleaned when secured to the exhaust grill 106. As discussed above, in one embodiment, the user may also be able to clean the trailing electrodes 326 (Figure 10B) once the driver electrodes 320 are disengaged from the clips 366.

[0087] With the exhaust grill 106 removed, the ion generating unit 307 within the housing 102 can be exposed. In one embodiment, the user may be able to clean the emitter electrodes 232 and the collector electrodes 242 while the emitter and collector electrodes 232 and 242 are positioned within the housing 102. In one embodiment, the user may be able to vertically lift the handle 302 and pull the collector electrodes 242 telescopically out through the upper portion of the housing 102 without having to remove the exhaust grill 106. The user may thereby be able to remove the collector electrodes 242 completely from the housing 102 and can have complete access to the collector electrodes 242. Once the collector electrodes 242 are cleaned, the user may then be able to re-insert the collector electrodes 242 vertically downward, with the assistance of gravity, into the housing 102 until the collector electrodes 242 are secured inside the housing 102. With the driver electrodes 320 secured to the exhaust grill 106, the user may be able to couple the exhaust grill 106 to the housing 102 in the manner discussed above. Thus, the collector electrodes 242 and the exhaust grill 106 can be independently removable from the housing 102 to clean the electrodes. In one embodiment, the ion generating unit 307 can include a mechanism that can include a

flexible member and a slot for capturing and cleaning the emitter electrodes 232 whenever the ion generating unit 307 is inserted and/or removed. More details regarding the mechanism is provided in U.S. Patent No. 6,709,484 which is incorporated by reference herein.

[0088] Referring to Figures 11A and 11B, another embodiment of the air transporter-conditioner system 100 is shown. The embodiment of Figures 11A and 11B is similar to that described in Figures 8, 9, 10A, and 10B; however, the driver electrodes 320 in the embodiment of Figures 11A and 11B can be removably secured to the second electrode set 330 and can be removable from the housing 102 with the second electrode set 330. In one embodiment, the exhaust grill 106 may not be removable from the housing 102. In another embodiment, the exhaust grill 106 can be removable from the housing 102 in the manner described above with respect to Figures 8, 9, 10A, and 10B.

[0089] In the embodiment of Figures 11A and 11B, the collector electrodes 242 of the second electrode set 330 can be removable from the housing 102 by lifting the handle 302 in a vertical direction and pulling the second electrode set 330 telescopically out of the housing 102. The driver electrodes 320 can then be removed from the second electrode set 330 after the collector electrodes 242 have been removed from the housing 102, as will be discussed below. In another embodiment, the driver electrodes 320 can be removable telescopically out of the housing 102 independently of the second electrode set 330. In one embodiment, the driver electrodes 320 can thus be removed from the housing 102 while the second electrode set 330 remains in the housing 102. In another embodiment, the driver electrodes 320 can be removed from the housing 102 after the second electrode set 330 has been removed.

[0090] Referring to Figures 12A and 12B, a perspective view of one embodiment of the collector electrodes 242 of the second electrode set 330 is shown. As shown in the embodiment of Figure 12A, the second electrode set 330 can include one or more collector electrodes 242 and driver electrodes 320 positioned adjacent to the collector electrodes 242. As shown in the embodiment of Figure 12A, the collector electrodes 242 can be coupled to a top mount 356 and a bottom mount 358, whereby the top and bottom mounts 356, 358 can arrange the collector electrodes 242 in a fixed, parallel configuration. The liftable handle 302 can be coupled to the top mount 356.

The top and bottom mounts 356, 358 can be designed to allow the collector electrodes 242 to be inserted and removed from the housing 102. The top and/or the bottom mounts 356, 358 can include one or more contact terminals, which can electrically connect the collector electrodes 242 to the high voltage source 308 when the collector electrodes 242 are inserted in the housing 102. In one embodiment, the contact terminals can come out of contact with the corresponding terminals within the housing 102 when the collector electrodes 242 are removed from the housing 102.

[0091] In the embodiment of Figure 12A, three collector electrodes 242 can be positioned between the top mount 356 and the bottom mount 358. However, any number of collector electrodes 242 can alternatively be positioned between the top mount 356 and the bottom mount 358. The collector electrodes 242 and driver electrodes 320, as shown in the embodiment of Figure 12A, can be symmetrical about a vertical axis, which is designated as the axis parallel to the collector electrodes 242 and the driver electrodes 320 in one embodiment. Alternatively or additionally, the collector electrodes 242 and the driver electrodes 320 can be symmetrical about a horizontal axis, which is designated as the axis perpendicular to and across the collector electrodes 242 and the driver electrodes 320. Alternatively, the ion generating unit 307 can be non-symmetrical with respect to the vertical and/or the horizontal axis.

[0092] Additionally, as shown in the embodiment of Figure 12A, the driver electrodes 320 can be positioned between a top driver mount 372 and a bottom driver mount 374. Although two driver electrodes 320 are shown between the top driver mount 372 and the bottom driver mount 374 in Figure 12A, any number of driver electrodes 320, including only one driver electrode 320, can be used. The top driver mount 372 and the bottom driver mount 374 can be configured to allow the driver electrodes 320 to be removed from the collector electrodes 242, as discussed below. In one embodiment, the top driver mount 372 and the bottom driver mount 374 can include a set of contact terminals, which can deliver voltage from the high voltage pulse generator 308 to the driver electrodes 320 when the driver electrodes 320 are coupled to the collector electrodes 242. Alternatively, the driver electrodes 320 can be grounded. Accordingly, the top driver mount 372 and/or the bottom driver mount 374 can include contact terminals, which can come into contact with the contact terminals

of the mounts 356, 358 when the driver electrodes 320 are coupled to the collector electrodes 242.

[0093] In one embodiment, the second electrode set 330 can include a release mechanism 376 located at the top collector mount 356. The release mechanism 376, when depressed, can release the locking mechanism, which secures the top and bottom driver mounts 372, 374 to the top and bottom collector mounts 356, 358. Any appropriate type of locking mechanism, which is well known in the art, can be used. In one embodiment, the release mechanism 376 can unfasten the top driver mount 372 from the second electrode set 330 and can thus allow the top driver mount 372 to pivot out and release the bottom driver mount 374 from a protrusion that the bottom driver mount 374 can be fitted over and held in place by. Thus, the driver electrodes 320 can be removable, as shown in the embodiment of Figure 12B. Alternatively, the bottom driver mount 374 can include protrusions 378 that can retain the driver electrodes 320 in the bottom collector mount 358 of the second electrode set 330. In another embodiment, the driver electrodes 320 can be removed from the second electrode set 330 by being slid in a direction perpendicular to the elongated length of the second electrode set 330 as shown in the embodiment of Figure 12B. The release mechanism 376 can alternatively be located elsewhere in the second electrode set 330. As shown in the embodiment of Figure 12B, the driver electrodes 320 can be removed by lifting or pulling the driver electrodes 320 from the collector electrodes 242 upon activating the release mechanism 376. Particularly, the top driver mount 372 and/or the bottom driver mount 374 can be lifted from the top and bottom mounts 356, 358. The removed driver electrodes 320 can then be able to be cleaned easily. Additionally, removal of the driver electrodes 320 can increase the amount of space between the collector electrodes 242 and can thereby allow the user to clean the collector electrodes 242 easily.

[0094] In one embodiment, by securing the driver electrodes 320 to the top and bottom collector mounts 356, 358, the user can align the bottom driver mount 374 with the bottom collector mount 358. Once aligned, the user can pivot the top driver mount 372 toward the top collector mount 356 until the locking mechanism can engage the corresponding features in the top and/or bottom mounts. The driver electrodes 320 can then be secured to the rest of the second electrode set 330, whereby the second

electrode set 330 can then be inserted back into the housing 102 as one piece. In another embodiment, the driver electrodes 320 can be secured to the top and bottom collector mounts 356, 358 by aligning the top and bottom driver mounts 372, 374 with the top and bottom collector mounts 356, 358 and laterally inserting the top and bottom driver mounts 372, 374 into the receptacles of the top and bottom collector mounts 356, 358 until the locking mechanism can engage the corresponding features in the top and/or bottom collector mounts 356, 358.

[0095] As stated above, the driver electrodes 320 can be symmetrical about the vertical and/or horizontal axis. In one embodiment, the top and bottom driver mounts 372, 374 can be configured such that the driver electrodes 320 can be reversibly coupled to the top and bottom collector mounts 356, 358. Thus, the bottom driver mount 374 can couple to the top collector mount 356, and the top driver mount 372 can couple to the bottom collector mount 358. This feature can allow the driver electrodes 320 to operate properly irrespective of whether the driver electrodes 320 are right-side-up or upside down. In another embodiment, less than all of the driver electrodes 320 can be removable from the top and bottom collector mounts 356, 358, whereby one or more of the driver electrodes 320 can be independently removable from one another.

[0096] In another embodiment, the driver electrodes 320 can be removable from the collector electrodes 242 without first removing the entire second electrode set 330 from the housing 102. For example, the user can remove the exhaust grill 106 and can actuate the release mechanism 376, whereby the driver electrodes 320 can be pulled out through the front of the housing 102. The user can then be able to clean the collector electrodes 242 still positioned with the housing 102. The user can also alternatively be able to then lift the collector electrodes 242 out of the housing 102 by lifting the handle 302, as discussed above.

[0097] Referring to Figure 13, an exploded view of one embodiment of the system 100 is shown. As shown and previously discussed, the upper surface of housing 102 can include a user-liftable handle 302 to lift the collector electrodes 242 from the housing 102. In the embodiment shown in Figure 13, the liftable handle 302 can lift the collector electrodes 242 upward and can thereby cause the collector electrodes 242 to telescope out of an aperture 380 in the top surface 306 of the housing 102 and, if

desired, out of the housing 102 for cleaning. Additionally, the driver electrodes 320 can be removable from the housing 102 horizontally (Figure 16B). In one embodiment, the driver electrodes 320 can be exposed within the housing 102 when the exhaust grill 106 is removed from the housing 102. In another embodiment, the driver electrodes 320 can be exposed within the housing 102 when the intake grill 104 and the collector electrodes 242 are removed from the housing 102. When exposed within the housing 102, the driver electrodes 320 can be removed in a lateral direction, whereby the driver electrodes 320 can be removed independent of the collector electrodes 242.

[0098] In one embodiment, the collector electrodes 242 can be lifted vertically out of the housing 102 while the emitter electrodes 232 (Figure 9) can remain in the housing 102. In another embodiment, the entire ion generating unit 307 can be configured to be lifted out of the housing 102, whereby the first electrode set 328 and the second electrode set 330 can be lifted together or, alternatively, independent of one another. As shown in the embodiment of Figure 13, the top ends of the collector electrodes 242 can be connected to the top collector mount 356, whereas the bottom ends of the collector electrodes 242 can be connected to the bottom collector mount 358. In another embodiment, a mechanism can be coupled to the bottom collector mount 358, which can include a flexible member and a slot for capturing and cleaning the emitter electrodes 232 when the collector electrodes 242 are moved vertically by the user. More details regarding the cleaning mechanism is provided in the U.S. Patent No. 6,709,484, which is incorporated by reference herein.

[0099] As shown in the embodiment of Figure 13, the intake grill 104 and the exhaust grill 106 can be removable from the housing 102 to allow access to the interior of the housing 102. The intake grill 104 and the exhaust grill 106 can be removable either partially or fully from the housing 102. Particularly, as shown in the embodiment in Figure 13, the exhaust grill 106 and the intake grill 104 can include several L-shaped coupling tabs 350, which can secure the intake and exhaust grills 104, 106 to the housing 102. The housing 102 can include a number of L-shaped receiving slots 352 (Figure 8), which can be positioned to receive the corresponding L-shaped coupling tabs 350 of the intake grill 104 and the exhaust grill 106. Alternatively, the intake grill 104 and the exhaust grill 106 can be removable from the

housing 102 using other suitable mechanisms. For example, the exhaust grill 106 can be pivotably coupled to the housing 102, whereby the user can be given access to the ion generating unit 307 upon swinging open the exhaust grill 106.

[00100] Referring to Figure 14, a perspective view of one embodiment of the collector electrodes 242 of the second electrode set 330 is shown. As shown in the embodiment of Figure 14, the second electrode set can include one or more collector electrodes 242 coupled between the top collector mount 356 and the bottom collector mount 358. In one embodiment, the top and bottom collector mounts 356, 358 can arrange the collector electrodes 242 in a fixed, parallel configuration. The liftable handle 302 can be coupled to the top collector mount 356. The top collector mount 356 and the bottom collector mount 358 can include one or more contact terminal, which can electrically connect the collector electrodes 242 to the first high voltage source 332 when the collector electrodes 242 are inserted in the housing 102. In one embodiment, the contact terminals can come out of contact with the corresponding terminals within the housing 102 when the collector electrodes 242 are removed from the housing 102.

[00101] In the embodiment of Figure 14, three collector electrodes 242 can be positioned between the top collector mount 356 and the bottom collector mount 358. However, any number of collector electrodes 242 can alternatively be positioned between the top collector mount 356 and the bottom collector mount 358. As shown in the embodiment of Figure 14, the top collector mount 356 can include a set of indents 382, and the bottom collector mount 358 can also include a set of indents 384. The indents 382 and 384 in the top and bottom collector mounts 356 and 358, respectively can allow the collector electrodes 242 and the driver electrodes 320 to be inserted and removed from the housing 102 without interfering or colliding with one another. As stated above, the driver electrodes 320 can be positioned interstitially between adjacent collector electrodes 242 (Figures 5 and 6). Thus, the indents 382, 384 can allow the collector electrodes 242 to be vertically inserted or removed from the housing 102 while the driver electrodes 320 can remain positioned within the housing 102. Likewise, the indents 382, 384 can allow the driver electrodes 320 to be horizontally inserted or removed from the housing 102 while the collector electrodes 242 can remain positioned within the housing 102. In summary, the driver electrodes 320 can be inserted and removed from the housing 102 in a horizontal direction, whereas the

collector electrodes 242 can be inserted and removed from the housing 102 in a vertical direction. Further, in the embodiment of Figure 14, a driver electrode 320 can be positioned in the indents 384 in the bottom collector mount 358 when both the driver electrodes 320 and the collector electrodes 242 are positioned in the housing 102.

[00102] Referring to Figures 15A-15C, the driver electrodes 320 can be removable from the housing 102 in one embodiment. As shown in Figures 15A and 15B, a front section 386 can be located within the housing 102 near the top of the housing 102 and can have aperture guides 388 therethrough. The aperture guides 388 can be in communication with engaging tracks 390 (Figure 15C) within the housing 102, whereby the aperture guides 388 can allow the driver electrodes 320 to be inserted properly and removed from the engaging tracks 390 (Figure 15C). Although the driver electrodes 320 are shown to be insertable and removable from the front section 386 of the housing 102, as shown in Figure 15B, the driver electrodes 320 can, alternatively, be insertable and removable from the rear of the housing 102.

[00103] Referring to Figure 15C, a cross-sectional view of one embodiment of the air transporter-conditioner system 100 of Figure 15A along line C-C is shown. As shown in Figure 15C, the top end 336 of each of the driver electrodes 320 can fit, with a friction fit, in between the engaging tracks 390 proximal to the top end 336 and the protrusion 394 proximal to the bottom end 338 of the housing 102. In one embodiment, the engaging tracks 390 can be electrically connected to the high voltage source 334. In another embodiment, the engaging tracks 390 can be electrically connected to ground. The tracks 390 can include a terminal, which can come into contact with the terminal 396 when the driver electrodes 320 are secured within the housing 102. Thus, in one embodiment, when the driver electrodes 320 can be coupled to the engagement tracks 390, voltage can be applied to the driver electrodes 320 from the high voltage source 334, if desired. In one embodiment, the engaging tracks 390 can provide an adequate ground connection with the driver electrodes 320 when the driver electrodes 320 are secured thereto.

[00104] In one embodiment, the driver electrodes 320 can be inserted and removed from the housing 102 in a horizontal direction. In another embodiment, the driver electrodes 320 can be inserted into the housing 102 by first coupling the

bottom end 338 to the housing 102 and pivoting each driver electrode 320 about its bottom end 338 to couple the hook 398 to a securing rod 399 within the housing 102. Particularly, the detent 342 in the bottom end 338 of the driver electrodes 320 can be mated with the protrusion 394, and the driver electrodes 320 can be able to pivot about the protrusion 394 until the securing rod 399 is secured within the securing area 400. When the driver electrodes 320 are in the resting position, the protrusion 394 can be engaged to the detent 342, and the secondary protrusion 402 can be in contact with the bottom end 338 of the driver electrodes 320. Additionally, the top end 336 of the driver electrodes 320 can be engaged with the engaging track 390 in a friction fit, for example, whereby the terminal 396 can be electrically coupled to the high voltage source 334 or ground. The driver electrodes 320 can thus be secured within the securing area 400 and may not be able to be inadvertently removed. Removal of the driver electrodes 320 can be performed in the reverse order. It should be understood that insertion and/or removal of the driver electrodes 320 may not be limited to the method described above. For example, the driver electrodes 320 can be inserted or removed from the housing 102 in a slidable manner. Additionally, the driver electrodes 320 can be coupled to and removed from the housing 102 using other appropriate mechanisms and may not be limited to the protrusion 394 and engaging tracks 390, as discussed above. Thus, each driver electrode 320 can be independently and individually removable and insertable with respect to one another as well as with respect to the exhaust grill 106 and collector electrodes 242. Therefore, the driver electrodes 320 can be exposed when the intake grill 104 and/or exhaust grill 106 are removed, and can also be cleaned without needing to be removed from the housing 102. However, if desired, any one of the driver electrodes 320 can be able to be removed while the collector electrodes 242 remain within the housing 102.

[00105] Referring to Figure 16, a perspective view of one embodiment of the exhaust grill 106 with trailing electrodes 326 thereon is shown. As shown in the embodiment of Figure 16, the trailing electrodes 326 can be coupled to an inner surface of the exhaust grill 106. This arrangement can allow the user to clean the trailing electrodes 326 from the housing 102 by simply removing the exhaust grill 106. Additionally, placement of the trailing electrodes 326 along the inner surface of the exhaust grill 106 can allow the trailing electrodes 326 to emit ions directly out of the

system 100 with the least amount of airflow resistance. More details regarding cleaning of the trailing electrodes 326 are described in U.S. Patent Application No. 60/590,735, which is incorporated by reference herein.

[00106] The operation of cleaning the system 100 will now be discussed. The exhaust grill 106 can be first removed from the housing 102. This can be done by lifting the exhaust grill 106 vertically and then pulling the exhaust grill 106 horizontally away from the housing 102. Additionally, the intake grill 104 can be removable from the housing 102 in the same manner. In one embodiment, once the exhaust grill 106 is removed from the housing 102, the trailing electrodes 326 can be exposed, and the user may be able to clean the trailing electrodes 326 on the interior of the exhaust grill 106. In one embodiment, the user may be able to clean the collector electrodes 242 and the driver electrodes 320 while the collector and emitter electrodes 242, 320 are positioned within the housing 102. In another embodiment, the user may be able to pull the collector electrodes 242 telescopically out through an aperture 380 in the top surface 306 of the housing 106 (as shown in Figure 13) and can have access to the driver electrodes 320.

[00107] The driver electrodes 320 may be able to be cleaned while positioned within the housing 102 or, alternatively, by removing the driver electrodes 320 laterally from the housing 102 (Figure 15B). In one embodiment, this can be done by slightly lifting the driver electrodes 320 and pulling the driver electrodes 320 along the engaging tracks 390 (Figure 15C) out through the aperture guides 388 in the front section 386 of the housing 102. In another embodiment, the driver electrodes 320 can be removable via the back side of the housing 102 by first removing the intake grill 104. Upon removing the driver electrodes 320, the user may be able to clean the driver electrodes 320 by wiping them with a cloth. The driver electrodes 320 can be removable from the housing 102 when the collector electrodes 242 are either present or removed from the housing 102. Additionally, the driver electrodes 320 can be individually removable or insertable into the housing 102.

[00108] In one embodiment, once the collector electrodes 242 and driver electrodes 320 are cleaned, the user can then insert the collector and driver electrodes 242, 320 back into the housing 102. In one embodiment, this can be done by moving the collector electrodes 242 vertically downward through the aperture 380 in the top

surface 306 of the housing 102. Additionally, the driver electrodes 320 can be inserted horizontally into the housing 102, as discussed above. The user may then be able to couple the intake grill 104 and the exhaust grill 106 to the housing 102 in an opposite manner from that discussed above. The intake and exhaust grills 104, 106 can alternatively be coupled to the housing 102 before the collector electrodes 242 are inserted. Also, the second electrode set 330 can be removed from the housing 102 while the intake and/or exhaust grill 104, 106 can remain coupled to the housing 102.

[00109] Referring to Figure 17, one embodiment of an electrical circuit diagram for the system 100 is shown. The system 100 can have an electrical power cord that can plug into a common electrical wall socket to provide a nominal 110 VAC. An electromagnetic interference (EMI) filter 450 can be placed across the incoming nominal 110 VAC line to reduce and/or eliminate high frequencies generated by the various circuits within the system 100 such as, for example, the electronic ballast 452. In one embodiment, the electronic ballast 452 can be electrically connected to the germicidal lamp 290 (e.g., an ultraviolet lamp) to regulate or control the flow of current through the lamp 290. A switch 454 can be used to turn the lamp 290 on or off. The EMI filter 450 is well known in the art and does not require a further description. In another embodiment, the system 100 does not include the germicidal lamp 290, whereby the circuit diagram shown in Figure 17 would not include the electronic ballast 452, the germicidal lamp 290, or the switch 454 used to operate the germicidal lamp 290.

[00110] The EMI filter 450 can be coupled to a DC power supply 456. The DC power supply 456 can be coupled to the first HVS 332 and to the second high voltage power source 334. The first and second high voltage power sources 332, 334 can also be referred to as pulse generators. The DC power supply 456 can also be coupled to a micro-controller unit (MCU) 458. The MCU 458 can be, for example, a Motorola 68HC908 series micro-controller available from Motorola. Alternatively, any other type of MCU can be used. As shown in the embodiment of Figure 17, the MCU 458 can receive a signal from the switch S1 and a boost signal from the boost button 304. The MCU 458 can also include an indicator light 460, which can specify when the ion generating unit 307 is ready to be cleaned.

[00111] The DC power supply 456 can be designed to receive the incoming nominal 110 VAC and to output a first DC voltage (e.g., approximately 160 VDC) to the first HVS 332. The DC power supply 456 voltage (e.g., approximately 160 VDC) can also be stepped down to a second DC voltage (e.g., approximately 12 VDC) for powering the micro-controller unit (MCU) 458, the second HVS 334, and other internal logic of the system 100. The voltage can be stepped down through a resistor network, transformer or other suitable component.

[00112] As shown in the embodiment of Figure 17, the first HVS 332 can be coupled to the first electrode set 328 and the second electrode set 330 to provide a potential difference between the first and second electrode sets 328, 330. In one embodiment, the first HVS 332 can be electrically coupled to the driver electrodes 320, as described above. Additionally, the first HVS 332 can be coupled to the MCU 458, whereby the MCU 458 can receive arc sensing signals 462 from the first HVS 332 and can provide low voltage pulses 464 to the first HVS 332. As also shown in the embodiment of Figure 17, the second HVS 334 can provide a voltage to the trailing electrodes 326. Additionally, the second HVS 334 can be coupled to the MCU 458, whereby the MCU 458 can receive arc sensing signals 462 from the second HVS 334 and can provide low voltage pulses 464 to the second HVS 334.

[00113] In one embodiment, the MCU 458 can monitor the stepped down voltage (e.g., approximately 12 VDC) , which can be referred to as the AC voltage sense signal 466 in the embodiment of Figure 17, to determine if the AC line voltage is above or below the nominal 110 VAC, and can sense changes in the AC line voltage. For example, if a nominal 110 VAC increases by approximately 10 % to 121 VAC, then the stepped down DC voltage can also increase by approximately 10 %. The MCU 458 can sense this increase and then can reduce the pulse width, duty cycle and/or frequency of the low voltage pulses 464 to maintain the output power provided to the first HVS 332 to be the same or nearly the same as when the line voltage is at approximately 110 VAC. Conversely, when the line voltage drops, the MCU 458 can sense this decrease and can appropriately increase the pulse width, duty cycle and/or frequency of the low voltage pulses 464 to maintain a constant output power. Such voltage adjustment features can also enable the same system 100 to be used in

different countries that have different nominal voltages than in the United States (e.g., in Japan the nominal AC voltage is 100 VAC).

[00114] Referring to Figure 18, a schematic block diagram of one embodiment of the high voltage pulse generator 308, which includes the first HVS 332 and the second HVS 334, is shown. For the present description, the first and second HVSs 332, 334 can include the same or similar components as that shown in Figure 17. However, it is to be understood by one skilled in the art that the first and second HVSs 332, 334 can alternatively include different components from each other as well as from those shown in Figure 9.

[00115] In the embodiment of Figure 18, the first and second HVSs 332, 334 can include an electronic switch 468, a step-up transformer 470 and a voltage multiplier 472. The primary side of the step-up transformer 470 can receive the DC voltage from the DC power supply 456. For the first HVS 332, the DC voltage received from the DC power supply 456 can be approximately 160 Vdc. For the second HVS 334, the DC voltage received from the DC power supply 456 can be approximately 12 Vdc. The electronic switch 468 can receive low voltage pulses 464 (of perhaps approximately 20 -25 KHz frequency) from the MCU 458. Such a switch is shown as an insulated gate bipolar transistor (IGBT) 468. The IGBT 468, or other appropriate switch, can couple the low voltage pulses 464 from the MCU 458 to the input winding of the step-up transformer 470. The secondary winding of the step-up transformer 470 can be coupled to the voltage multiplier 472, which can output the high voltage pulses to the associated emitter, collector, or trailing electrodes 232, 242, 326. For the first HVS 332, the associated electrodes can be the emitter and collector electrodes 232, 242. For the second HVS 334, the associated electrodes can be the trailing electrodes 326. In general, the IGBT 468 can operate as an electronic on/off switch. Such a transistor is well known in the art and is, thus, not discussed further.

[00116] When driven, the first and second HVSs 332, 334 can receive the low input DC voltage from the DC power supply 456 and the low voltage pulses 464 from the MCU 458 and can generate high voltage pulses of at least approximately 5 KV peak-to-peak with a repetition rate of approximately 20 to 25 KHz in one embodiment. The voltage multiplier 472 in the first HVS 332 can output between approximately 5 to 9 KV to the first electrode set 328 and between approximately -6 to

-18 KV to the second electrode set 330. In one embodiment, the emitter electrodes 232 can receive approximately 5 to 6 KV, whereas the collector electrodes 242 can receive approximately -9 to -10 KV. The voltage multiplier 472 in the second HVS 334 can output approximately -12 KV to the trailing electrodes 326. In one embodiment, the driver electrodes 320 can be connected to ground as discussed above. The voltage multiplier 472 can produce greater or smaller voltages. In one embodiment, the high voltage pulses can have a duty cycle of approximately 10%-15%, but may have other duty cycles, including a 100% duty cycle.

[00117] The MCU 458 can be coupled to a control dial or switch S1, as discussed above, which can be set to a LOW, MEDIUM or HIGH airflow setting (as shown in the embodiment of Figure 17). The MCU 458 can control the amplitude, pulse width, duty cycle and/or frequency of the low voltage pulse signals 464 to control the airflow output of the system 100 based on the setting of the control dial S1. To increase the airflow output, the MCU 458 can be set to increase the amplitude, pulse width, frequency and/or duty cycle. Conversely, to decrease the airflow output rate, the MCU 458 can reduce the amplitude, pulse width, frequency and/or duty cycle. In one embodiment, the low voltage pulse signals 464 can have a fixed pulse width, frequency and duty cycle for the LOW setting, another fixed pulse width, frequency and duty cycle for the MEDIUM setting, and a further fixed pulse width, frequency and duty cycle for the HIGH setting.

[00118] In one embodiment, the low voltage pulse signals 464 can modulate between a predetermined duration of a "high" airflow signal and a "low" airflow signal. In one embodiment, the low voltage pulse signals 464 can modulate between a predetermined amount of time when the airflow can be at the greater "high" flow rate, followed by another predetermined amount of time in which the airflow can be at the lesser "low" flow rate. This can be executed by adjusting the voltages provided by the first HVS 332 to the first and second electrode sets 328, 330 for the greater flow rate period and the lesser flow rate period. This can produce an acceptable airflow output while limiting the ozone production to acceptable levels, regardless of whether the control dial S1 is set to HIGH, MEDIUM or LOW. For example, the "high" airflow signal can have a pulse width of approximately 5 microseconds and a period of approximately 40 microseconds (i.e., an approximately 12.5% duty cycle),

and the “low” airflow signal can have a pulse width of approximately 4 microseconds and a period of approximately 40 microseconds (i.e., an approximately 10% duty cycle).

[00119] In general, the voltage difference between the first electrode set 328 and the second electrode set 330 can be proportional to the actual airflow output rate of the system 100. Thus, a greater voltage differential can be created between the first and second electrode sets 328, 330 by the “high” airflow signal, whereas a lesser voltage differential can be created between the first and second electrode sets 328, 330 by the “low” airflow signal. In one embodiment, the airflow signal can cause the voltage multiplier 472 to provide between approximately 5 and 9 KV to the first electrode set 328 and between approximately -9 and -10 KV to the second electrode set 330. For example, the “high” airflow signal can cause the voltage multiplier 472 to provide approximately 5.9 KV to the first electrode set 328 and approximately -9.8 KV to the second electrode set 330. In the example, the “low” airflow signal can cause the voltage multiplier 472 to provide approximately 5.3 KV to the first electrode set 328 and approximately -9.5 KV to the second electrode set 330. The MCU 458 and the first HVS 332 can produce voltage potential differentials between the first and second electrode sets 328 and 330 other than the values provided above and are in no way limited by the values specified.

[00120] In one embodiment, when the control dial S1 is set to HIGH, the electrical signal output from the MCU 458 can continuously drive the first HVS 332 and the airflow, whereby the electrical signal output can modulate between the “high” and “low” airflow signals stated above (e.g., approximately 2 seconds “high” and approximately 10 seconds “low”). When the control dial S1 is set to MEDIUM, the electrical signal output from the MCU 458 can cyclically drive the first HVS 332 (i.e., airflow can be “On”) for a predetermined amount of time (e.g., approximately 20 seconds), and then drop to zero or a low voltage for a further predetermined amount of time (e.g., approximately 20 seconds). In one embodiment, the cyclical drive when the airflow is “On” can be modulated between the “high” and “low” airflow signals (e.g., approximately 2 seconds “high” and approximately 10 seconds “low”), as stated above. When the control dial S1 is set to LOW, the signal from the MCU 458 can cyclically drive the first HVS 332 (i.e., airflow can be “On”) for a predetermined

amount of time (e.g., approximately 20 seconds), and then drop to zero or a low voltage for a longer time period (e.g., approximately 80 seconds). Again, in one embodiment, the cyclical drive when the airflow is "On" can be modulated between the "high" and "low" airflow signals (e.g., approximately 2 seconds "high" and approximately 10 seconds "low"), as stated above. It is to be understood that the HIGH, MEDIUM, and LOW settings can drive the first HVS 332 for longer or shorter periods of time. It is to be also understood that the cyclic drive between the "high" and "low" airflow signals can be durations and voltages other than that described herein.

[00121] Cyclically driving airflow through the system 100 for a period of time, followed by little or no airflow for another period of time (i.e., MEDIUM and LOW settings) can allow the overall airflow rate through the system 100 to be slower than when the dial S1 is set to HIGH. Additionally, cyclical driving can reduce the amount of ozone emitted by the system 100 since little or no ions may be produced during the period in which lesser or no airflow is being output by the system 100. Further, the duration in which little or no airflow is driven through the system 100 can provide the air already inside the system 100 a longer dwell time and can, thereby increase particle collection efficiency. In one embodiment, the long dwell time can allow air to be exposed to the germicidal lamp 290, if present.

[00122] Regarding the second HVS 334, approximately 12 volts DC can be applied to the second HVS 334 from the DC power supply 456. The second HVS 334 can provide a negative charge (e.g., approximately - 12 KV) to one or more trailing electrodes 326 in one embodiment. However, the second HVS 334 can provide a voltage in the range of, and including approximately -10 KV to approximately -60 KV in other embodiments. In one embodiment, other voltages produced by the second HVS 334 can be used.

[00123] In one embodiment, the second HVS 334 can be controlled independently from the first HVS 332 (such as, for example by the boost button 304) to allow the user to variably increase or decrease the amount of negative ions output by the trailing electrodes 326 without correspondingly increasing or decreasing the amount of voltage provided to the first and second electrode sets 328, 330. The second HVS 334 can thus provide freedom to operate the trailing electrodes 326 independently of the remainder of the ion generating unit 307 to reduce static

electricity, eliminate odors and the like. Additionally, the second HVS 334 can allow the trailing electrodes 326 to operate at a different duty cycle, amplitude, pulse width, and/or frequency than the first and second electrode sets 328, 330. In one embodiment, the user may be able to vary the voltage supplied by the second HVS 334 to the trailing electrodes 326 at any time by actuating the boost button 304. In one embodiment, the user may be able to turn on or turn off the second HVS 334, and thus the trailing electrodes 326 without affecting operation of the ion generating unit 307 and/or the germicidal lamp 290. The second HVS 334 can also be used to control electrical components other than the trailing electrodes 326 (e.g., the driver electrodes 320 and/or the germicidal lamp 290).

[00124] As discussed above, the system 100 can include a boost button 304. In one embodiment, the trailing electrodes 326 and the first and second electrode sets 328, 330 can be controlled by the boost signal from the boost button 304 input into the MCU 458. In one embodiment, the boost button 304 can cycle through a set of operating settings upon actuation of the boost button 304. In the example embodiment discussed below, the system 100 can include three operating settings. However, any number of operating settings can be used.

[00125] The following is a discussion of methods of operation of the boost button 304 which are variations of the methods discussed above. Particularly, the system 100 can operate in a first boost setting when the boost button 304 is pressed once. In the first boost setting, the MCU 458 can drive the first HVS 332 as if the control dial S1 was set to the HIGH setting for a predetermined amount of time (e.g., approximately 6 minutes), even if the control dial S1 is set to LOW or MEDIUM (in effect overriding the setting specified by the dial S1). The predetermined time period may be longer or shorter than approximately 6 minutes. For example, the predetermined period can also be approximately 20 minutes if a higher cleaning setting for a longer period of time is desired. This can cause the system 100 to run at a maximum airflow rate for the predetermined boost time period. In one embodiment, the low voltage signal can modulate between the "high" airflow signal and the "low" airflow signal for predetermined amounts of time and voltages, as stated above, when operating in the first boost setting. In another embodiment, the low voltage signal may not modulate between the "high" and "low" airflow signals.

[00126] In the first boost setting, the MCU 458 can also operate the second HVS 334 to operate the trailing electrodes 326 to generate ions, for example negative ions, into the airflow. In one embodiment, the trailing electrodes 326 can repeatedly emit ions for approximately one second and then terminate for approximately five seconds for the entire predetermined boost time period. The increased amounts of ozone from the boost level can further reduce odors in the entering airflow and can increase the particle capture rate of the system 100. At the end of the predetermined boost period, the system 100 can return to the airflow rate previously selected by the control dial S1. It should be understood that the on/off cycle at which the trailing electrodes 326 can operate is not limited to the cycles and periods described above.

[00127] In the example, once the boost button 304 is pressed again, the system 100 can operate in the second setting, which can be an increased ion generation or "feel good" mode. In the second setting, the MCU 458 can drive the first HVS 332 as if the control dial S1 was set to the LOW setting, even if the control dial S1 is set to HIGH or MEDIUM (in effect overriding the setting specified by the dial S1). Thus, the airflow may not be continuous, but "On" and then at a lesser or zero airflow for a predetermined amount of time (e.g., approximately 6 minutes). Additionally, the MCU 458 can operate the second HVS 334 to operate the trailing electrodes 326 to generate negative ions into the airflow. In one embodiment, the trailing electrodes 326 can repeatedly emit ions for approximately one second and then can terminate for approximately five seconds for the predetermined amount of time. It should be understood that the on/off cycle at which the trailing electrodes 326 can operate may not be limited to the cycles and periods described above.

[00128] In the example, upon the boost button 304 being pressed again, the MCU 458 can operate the system 100 in a third operating setting, which can be a normal operating mode. In the third setting, the MCU 458 can drive the first HVS 332 depending on the which setting the control dial S1 is set to (e.g., HIGH, MEDIUM or LOW). Additionally, the MCU 458 can operate the second HVS 334 to operate the trailing electrodes 326 to generate ions, for example negative ions, into the airflow at a predetermined interval. In one embodiment, the trailing electrodes 326 can repeatedly emit ions for approximately one second and then can terminate for approximately nine

seconds. In another embodiment, the trailing electrodes 326 may not operate at all in this mode. The system 100 can continue to operate in the third setting by default until the boost button 304 is pressed. It should be understood that the on/off cycle at which the trailing electrodes 326 can operate may not be limited to the cycles and periods described above.

[00129] In one embodiment, the system 100 can operate in an automatic boost mode upon the system 100 being initially plugged into the wall and/or initially being turned on after being off for a predetermined amount of time. Particularly, upon the system 100 being turned on, the MCU 458 can automatically drive the first HVS 332 as if the control dial S1 was set to the HIGH setting for a predetermined amount of time, as discussed above, even if the control dial S1 is set to LOW or MEDIUM and can thereby cause the system 100 to run at a maximum airflow rate for the predetermined amount of time. Additionally, the MCU 458 can automatically operate the second HVS 334 to operate the trailing electrodes 326 at a maximum ion emitting rate to generate ions, for example negative ions, into the airflow for the same amount of time. This configuration can allow the system 100 to clean stale, pungent, and/or polluted air in a room effectively that the system 100 has not been continuously operating in. This feature can improve the air quality at a faster rate while emitting negative “feel good” ions to eliminate any odor in the room quickly. Once the system 100 has been operating in the first setting boost mode, the system 100 can automatically adjust the airflow rate and ion emitting rate to the third setting (i.e., normal operating mode). For example, in this initial plug-in or initial turn-on mode, the system 100 can operate in the high setting for approximately 20 minutes to enhance the removal of particulates and to clean the air more rapidly and deodorize the room.

[00130] Additionally, the system 100 can include an indicator light that can inform the user what mode the system 100 is operating in when the boost button 304 is actuated. In one embodiment, the indicator light can be the same as the cleaning indicator light 460 discussed above. In another embodiment, the indicator light can be a separate light from the cleaning indicator light 460. For example, the indicator light can emit a blue light when the system 100 operates in the first setting. Additionally, the indicator light can emit a green light when the system 100 operates in the second

setting. In the example, the indicator light may not emit a light when the system 100 is operating in the third setting.

[00131] In one embodiment, the MCU 458 can provide various timing and maintenance features. For example, the MCU 458 can provide a cleaning reminder feature (e.g., a 2 week timing feature) that can provide a reminder to clean the system 100 (e.g., by causing indicator light 460 to turn on amber, and/or by triggering an audible alarm that can produce a buzzing or beeping noise). The MCU 458 can also provide arc sensing, suppression and indicator features, as well as the ability to shut down the first HVS 332 in the case of continued arcing. Details regarding arc sensing, suppression and indicator features are described in U.S. Patent Application No. 10/625,401 which is incorporated by reference herein.

[00132] It should be understood that various changes and modifications to the presently preferred embodiments described herein will be apparent to those skilled in the art. Such changes and modifications can be made without departing from the spirit and scope of the present subject matter and without diminishing its intended advantages. It is therefore intended that such changes and modifications be covered by the appended claims.

CLAIMS

The invention is claimed as follows:

1. An air-conditioning device comprising:
a housing;
a grill coupled to the housing;
an ion generator located in the housing and configured to create ions in a flow of air; and
a driver electrode located within the housing and removable from the housing, the driver electrode being located on an interior surface of the grill.
2. The device of claim 1, wherein the grill is removably coupled to the housing.
3. The device of claim 2, wherein the housing has a side, the grill configured to be removable from the side of the housing.
4. The device of claim 2, wherein the driver electrode remains in the housing upon removal of the removable grill.
5. The device of claim 2, wherein a portion of the ion generator is configured to be removable from the housing.
6. The device of claim 5, wherein the driver electrode is configured to be removable from the housing independent of the removable portion of the ion generator and the removable grill.
7. The device of claim 1, wherein the driver electrode is fixedly mounted to the grill.
8. The device of claim 1, wherein the driver electrode is insulated.

9. The device of claim 1, wherein the driver electrode is coated with an ozone reducing catalyst.

10. The device of claim 1, wherein the ion generator comprises:
an emitter electrode;
a collector electrode located downstream of the emitter electrode; and
a high voltage source operatively connected to at least one of the emitter electrode and the collector electrode.

11. The device of claim 10, further comprising a removable inlet grill and a removable outlet grill, the driver electrode configured to remain in the housing upon removal of at least one of the inlet grill and the outlet grill.

12. The device of claim 11, wherein the driver electrode is configured to remain in the housing after at least one of the inlet grill, the outlet grill or the collector electrode is removed from the housing.

13. The device of claim 10, wherein the collector electrode comprises three collector electrodes located in the housing, wherein the collector electrodes are vertically removable from the housing.

14. The device of claim 10, wherein the collector electrode is configured to be removable from the housing.

15. The device of claim 10, wherein the housing is at least one of elongated or upstanding, and wherein the housing comprises an upper portion, the collector electrode configured to be removable from the housing through the upper portion.

16. The device of claim 15, wherein the collector electrode comprises at least two collector electrodes.

17. The device of claim 16, wherein the at least two collector electrodes are removable from the housing through the upper portion.

18. The device of claim 15, wherein the driver electrode comprises at least two spaced apart driver electrodes, each driver electrode being configured to be removable independent of one another.

19. The device of claim 18, wherein at least one of the driver electrodes comprises a body having a non-conducting substrate having a conductive member disposed thereon.

20. The device of claim 18, wherein the housing further comprises a side portion, wherein the at least two collector electrodes are configured to be removable from the housing through an aperture in the upper portion and the driver electrode is configured to be removable through a side portion.

21. The device of claim 18, wherein each driver electrode comprises a first end and a second end, the first end having a hook adapted to couple the driver electrode to a securing feature in the housing.

22. The device of claim 18, wherein the driver electrode is configured to be removable from the housing in a direction perpendicular to the collector electrode.

23. The device of claim 1, further comprising a voltage source, the driver electrode being configured to be electrically coupled with the voltage source upon the grill being coupled to the housing.

24. The device of claim 1, further comprising a germicidal lamp within the housing, wherein the germicidal lamp is removable.

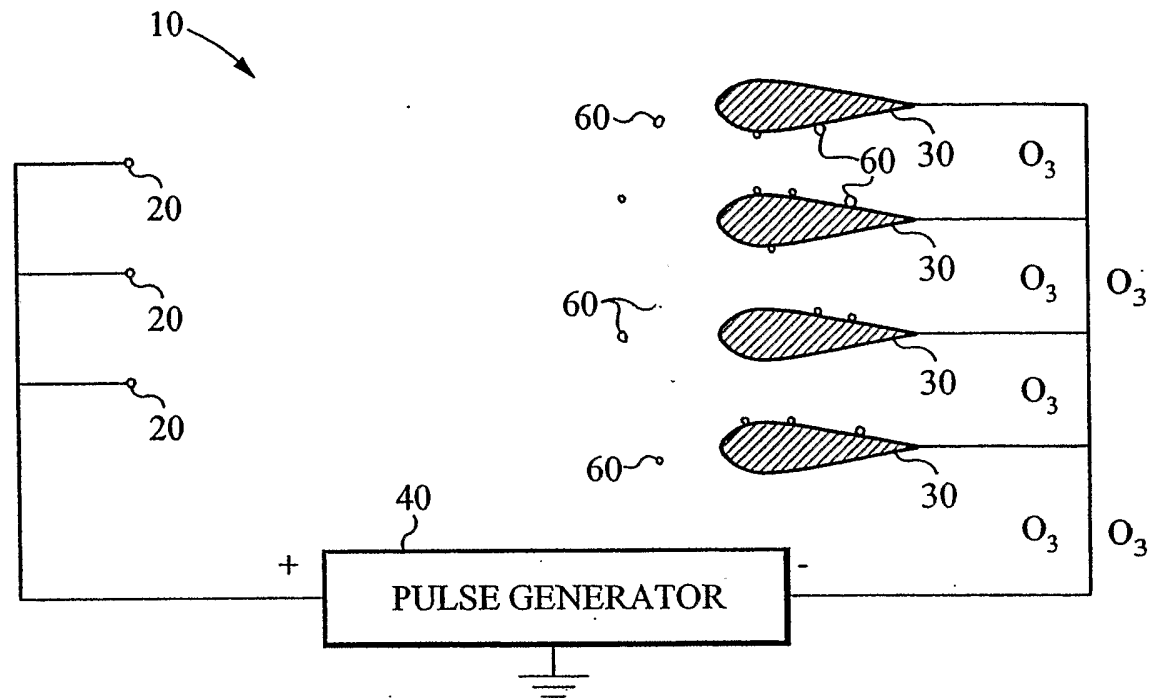


Fig. 1A (PRIOR ART)

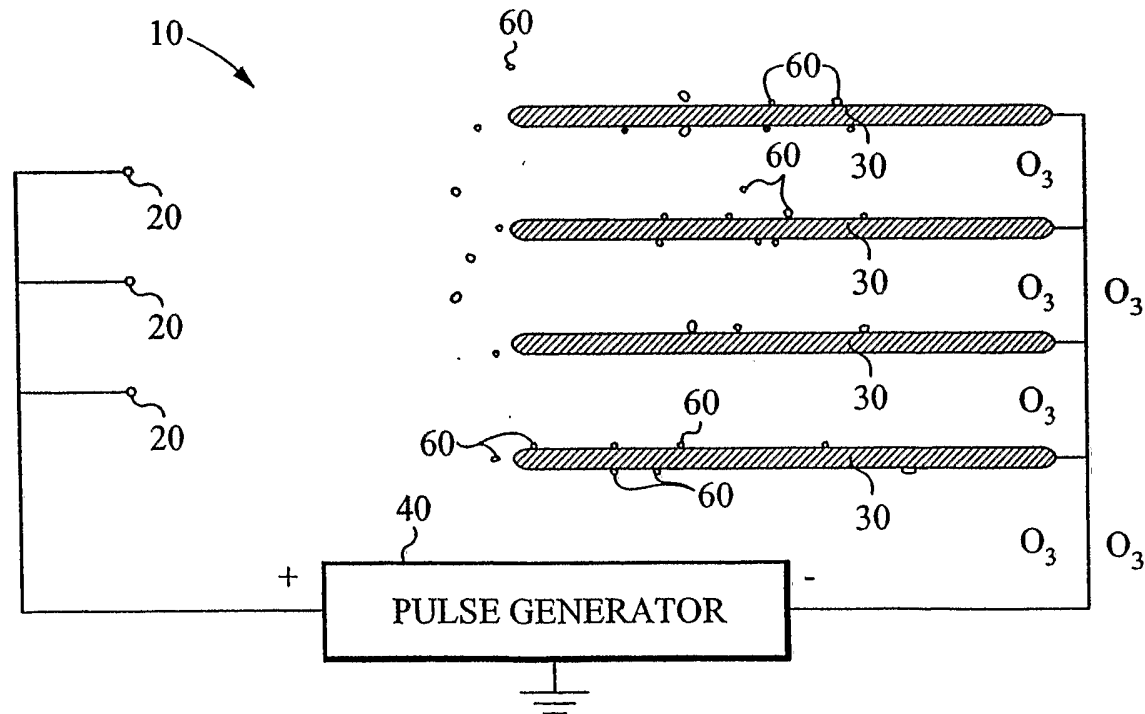


Fig. 1B (PRIOR ART)

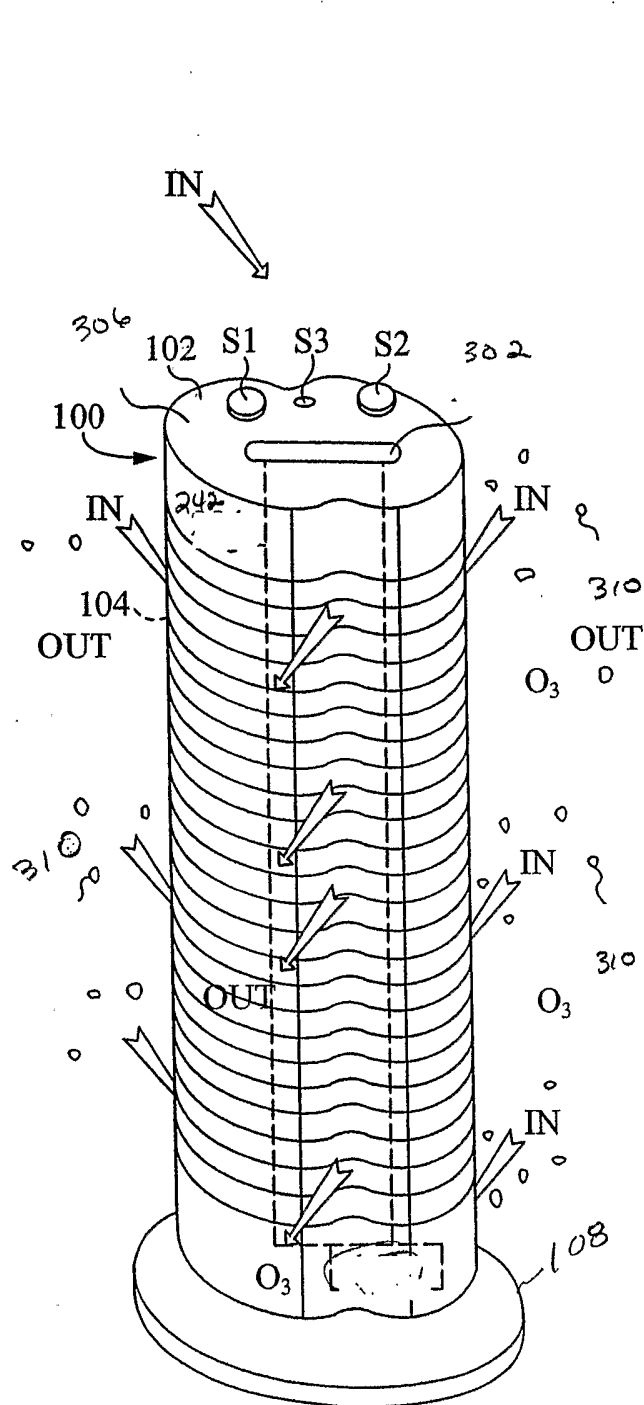


Fig. 2A

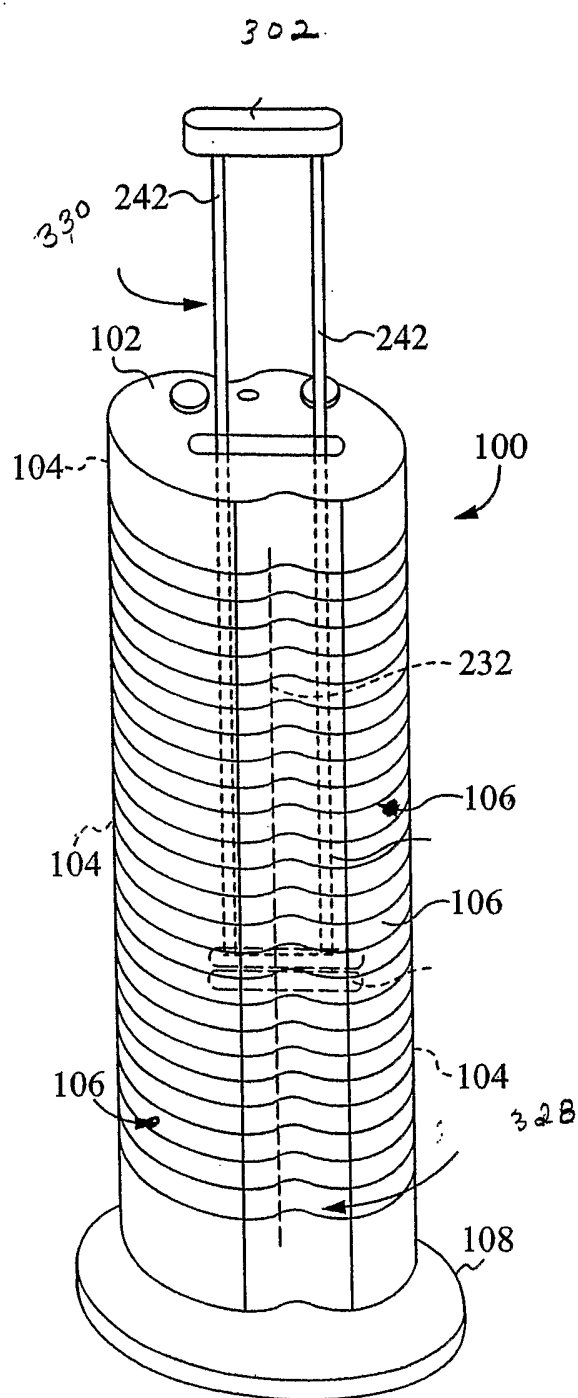


Fig. 2B

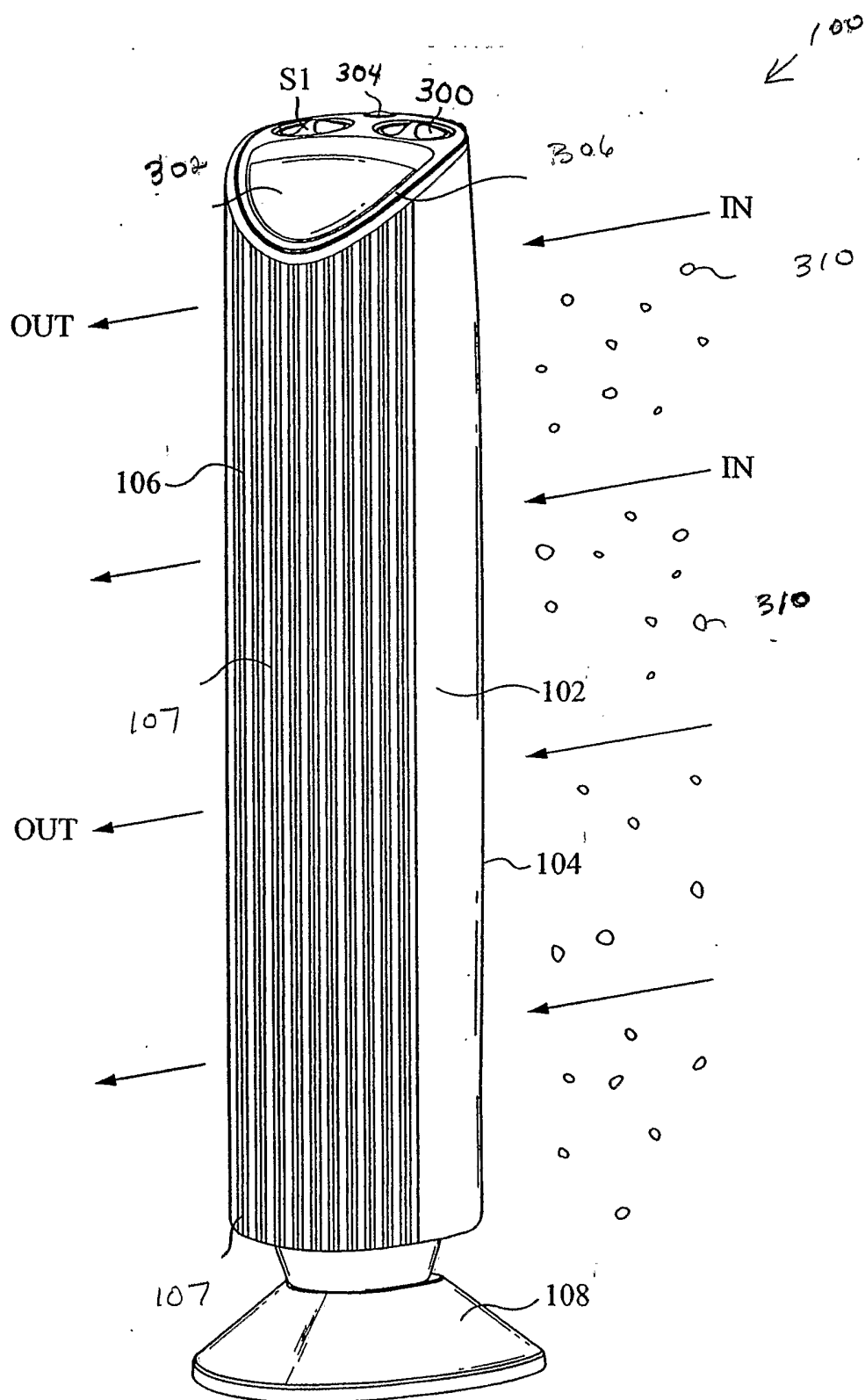


Fig. 3

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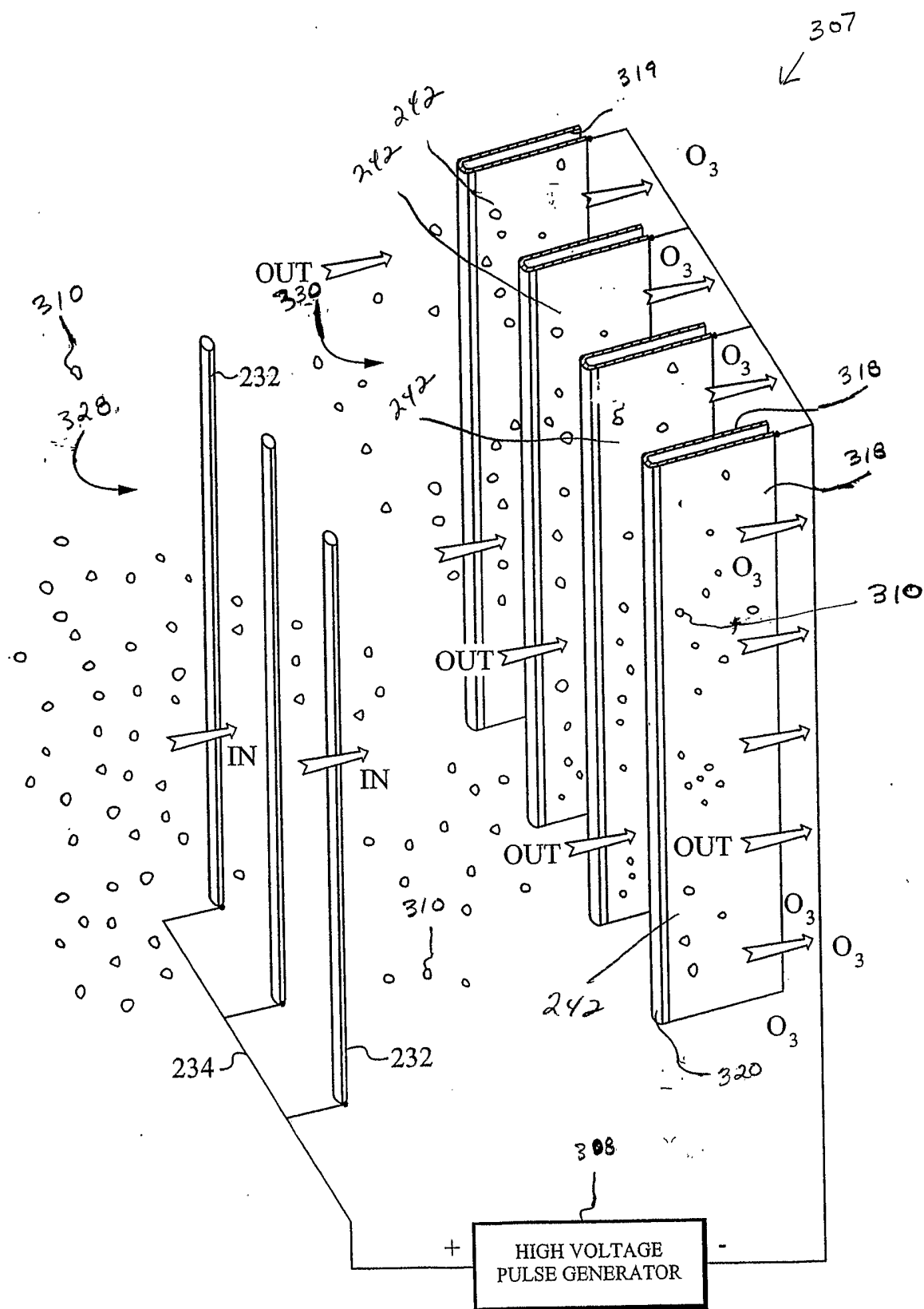


Fig. 4

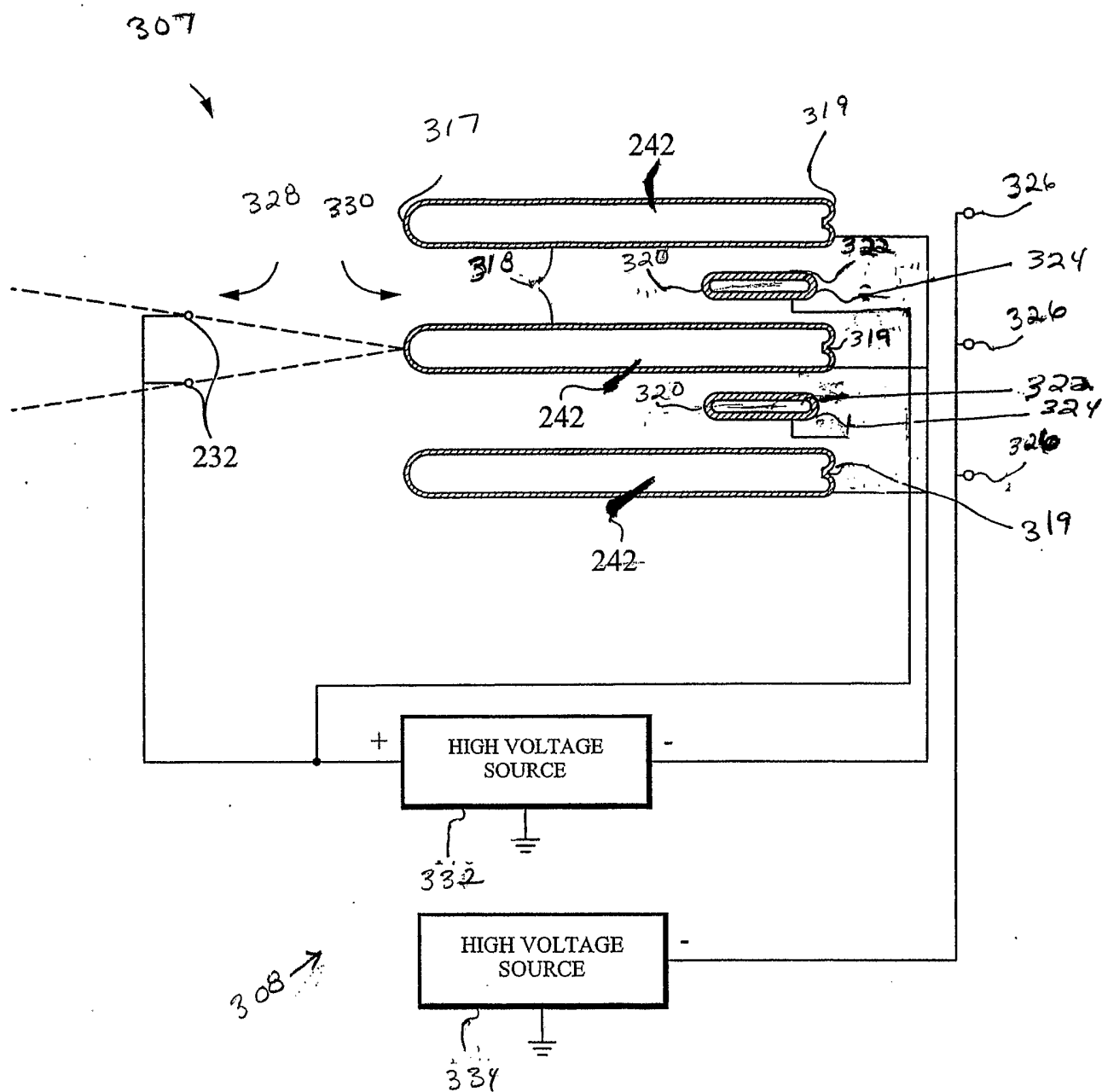


Fig. 5

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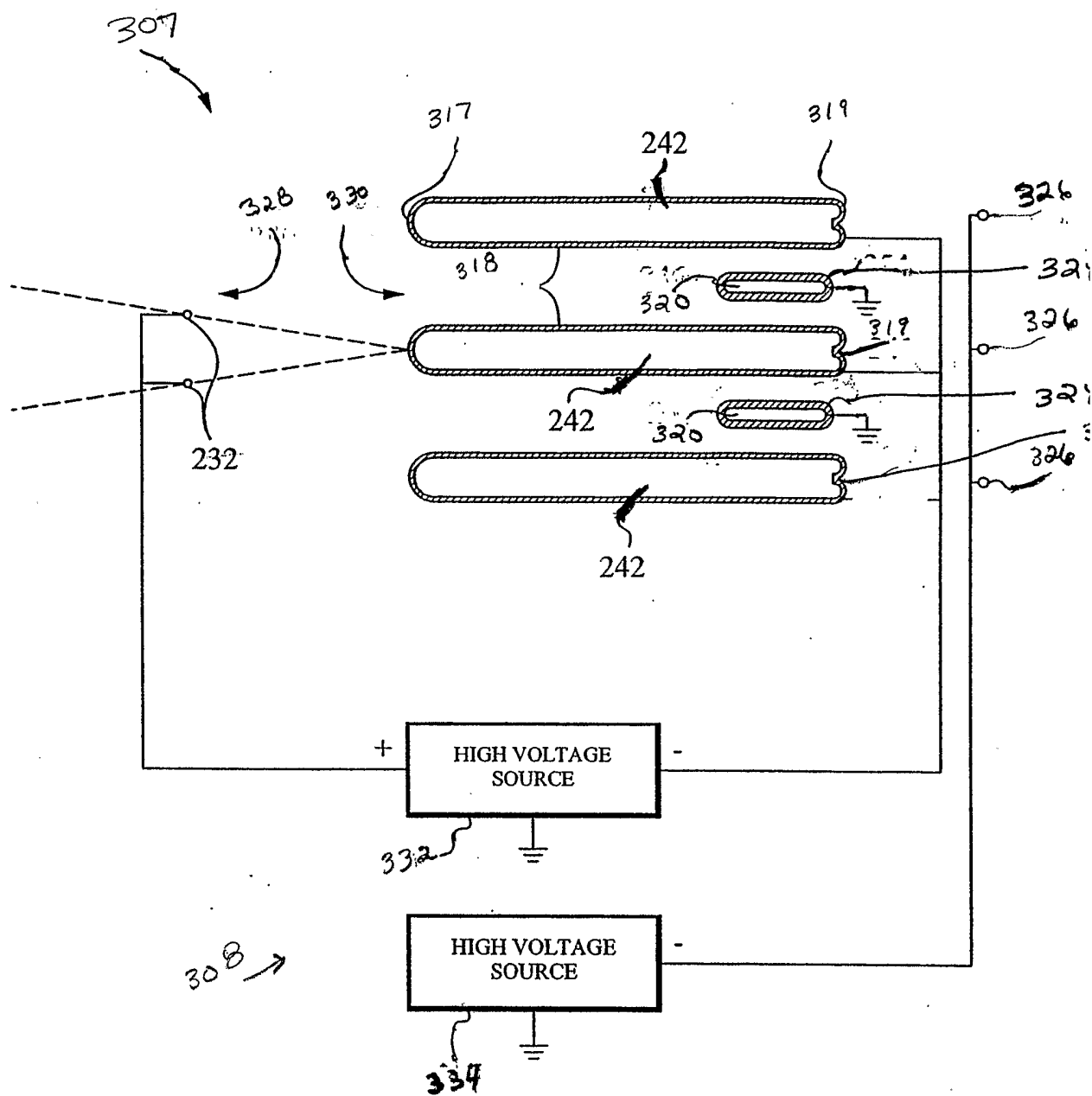
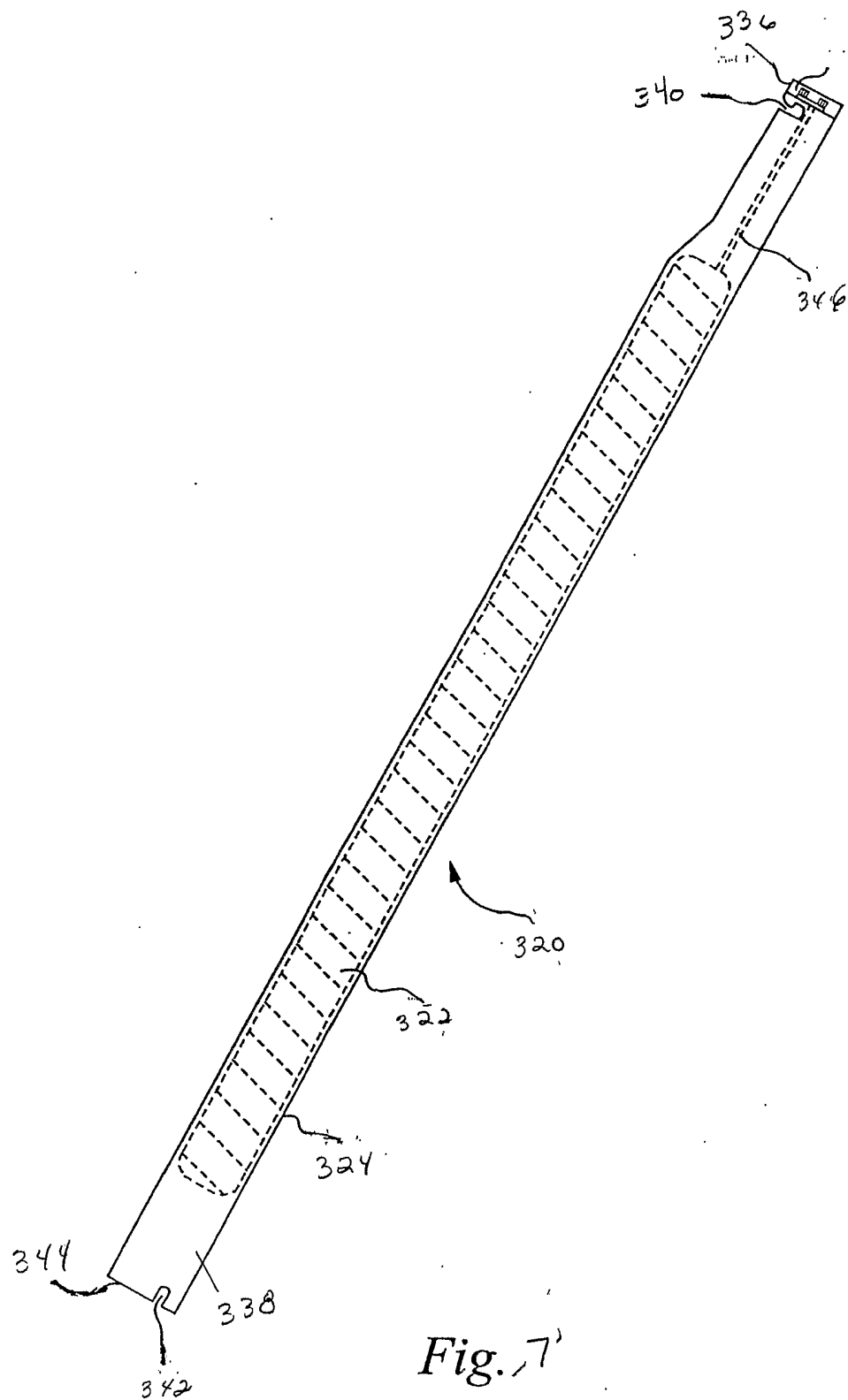


Fig. 6

*Fig. 7*

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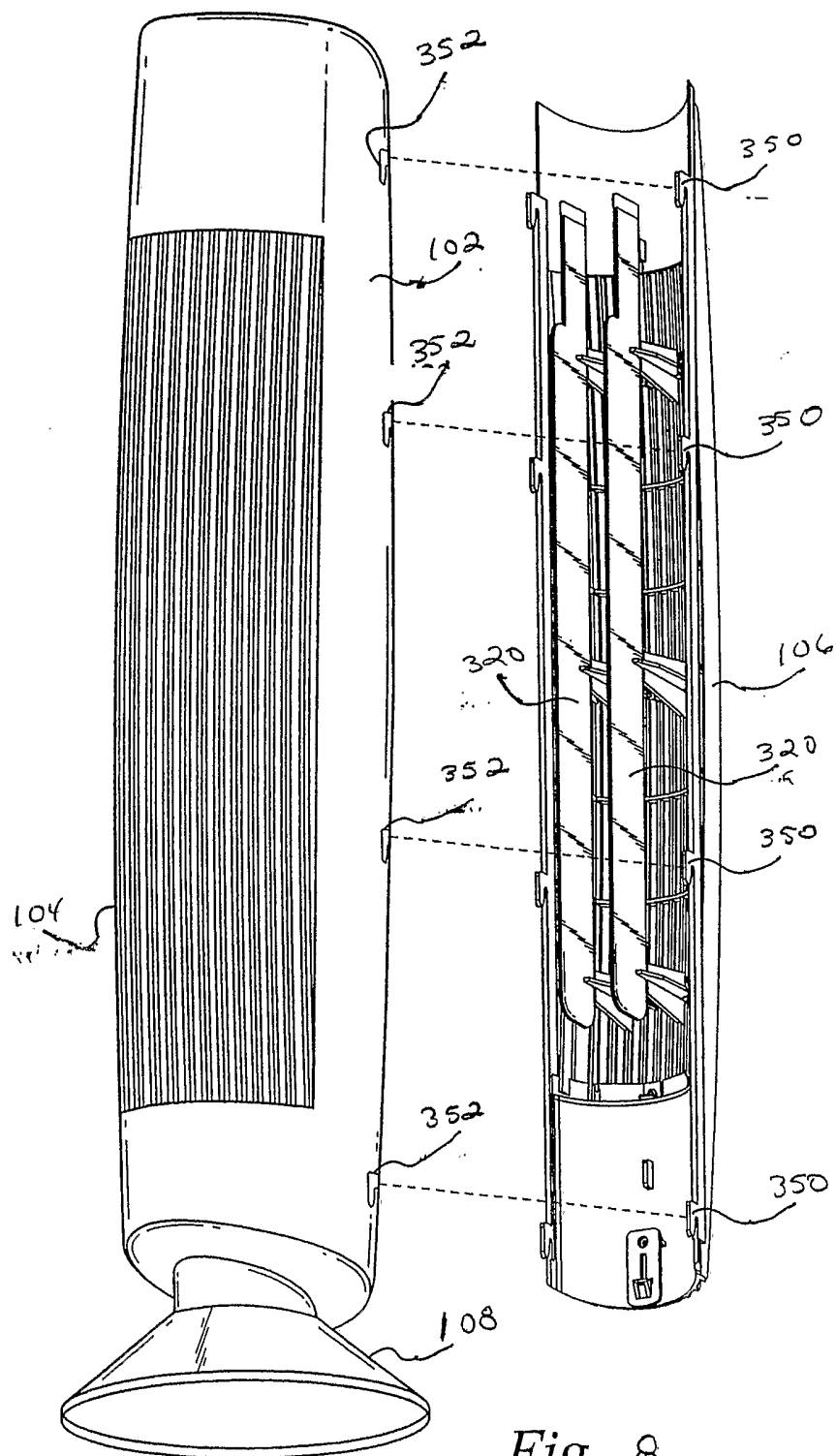


Fig. 8

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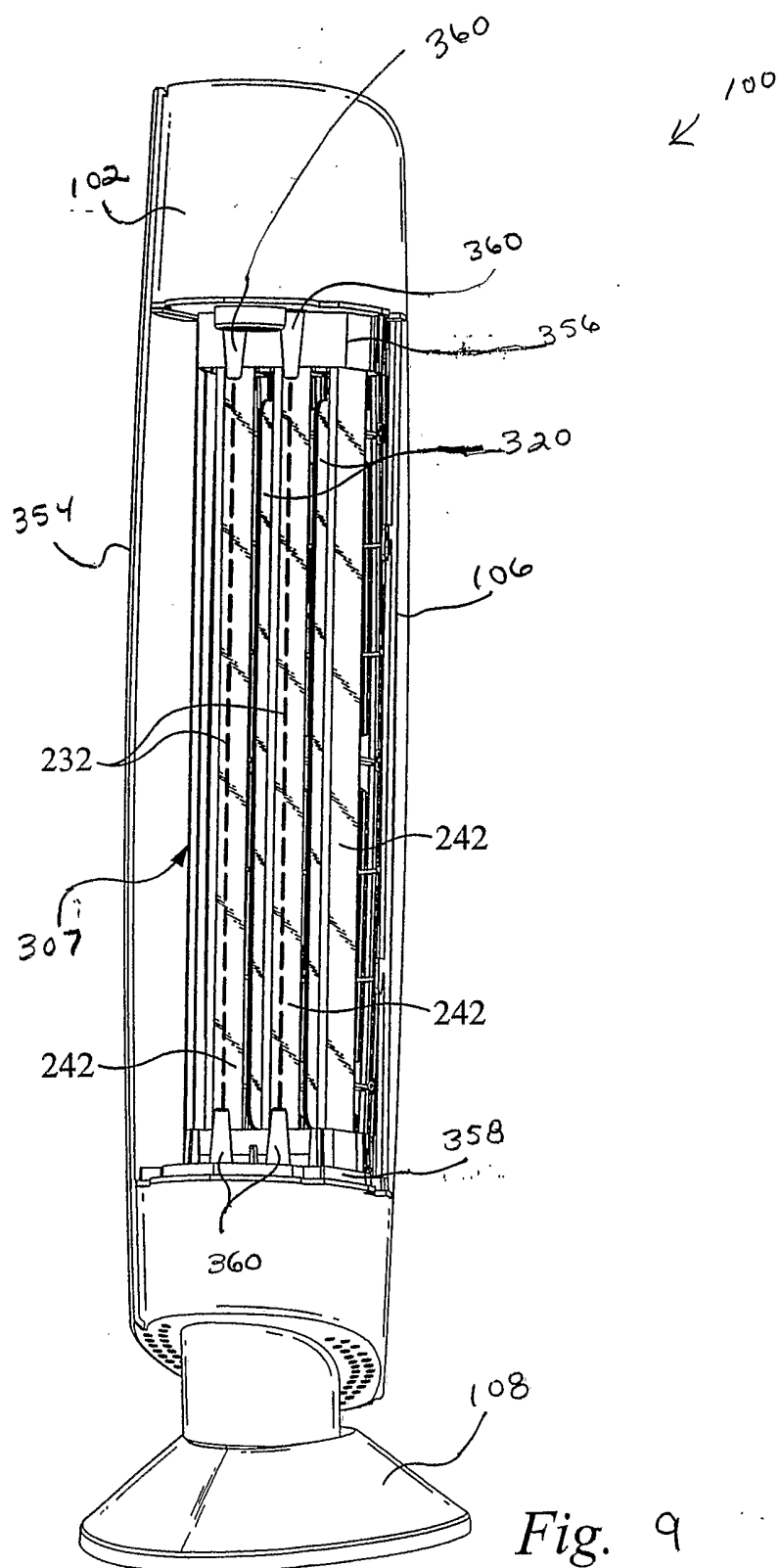
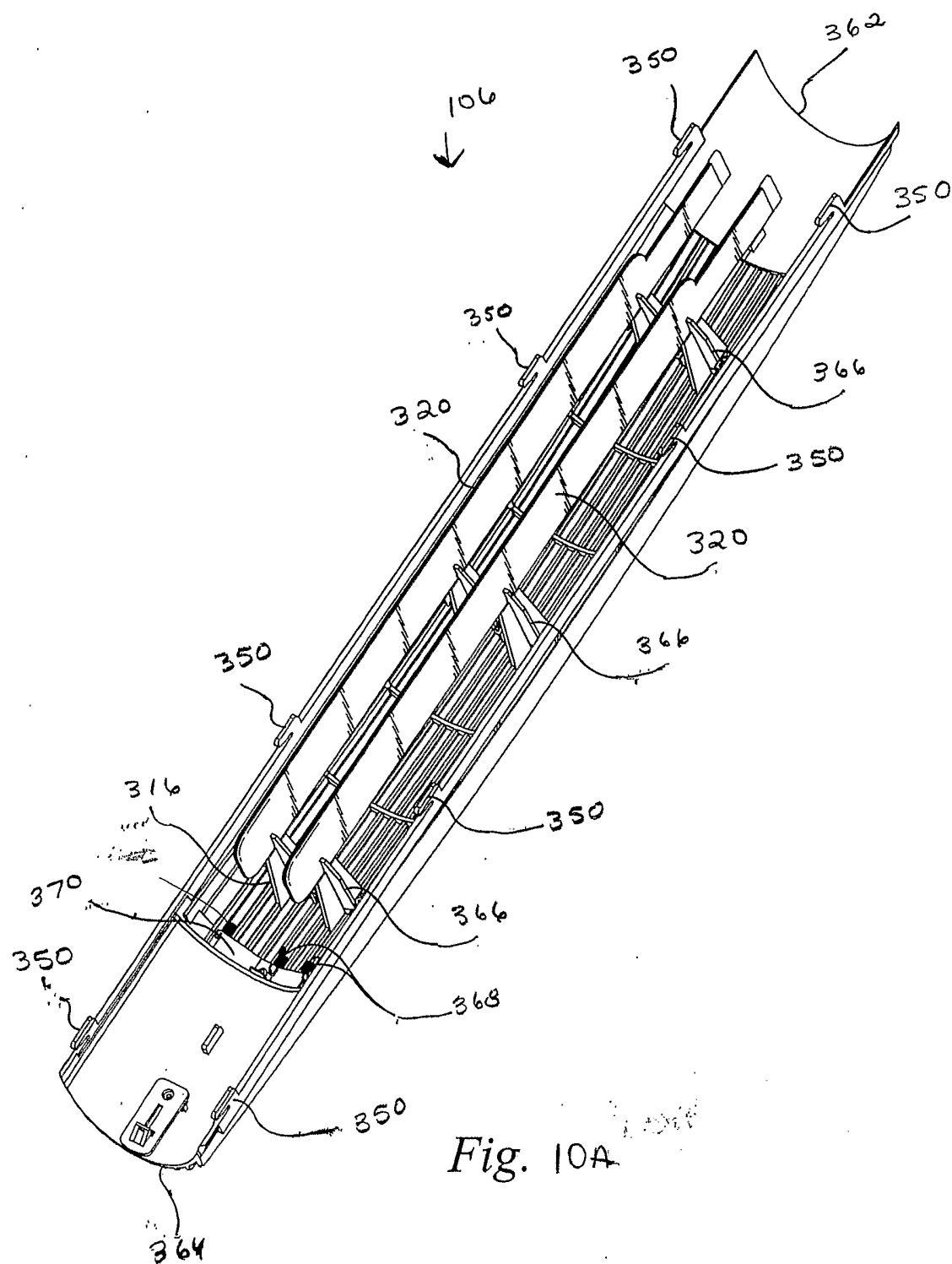


Fig. 9

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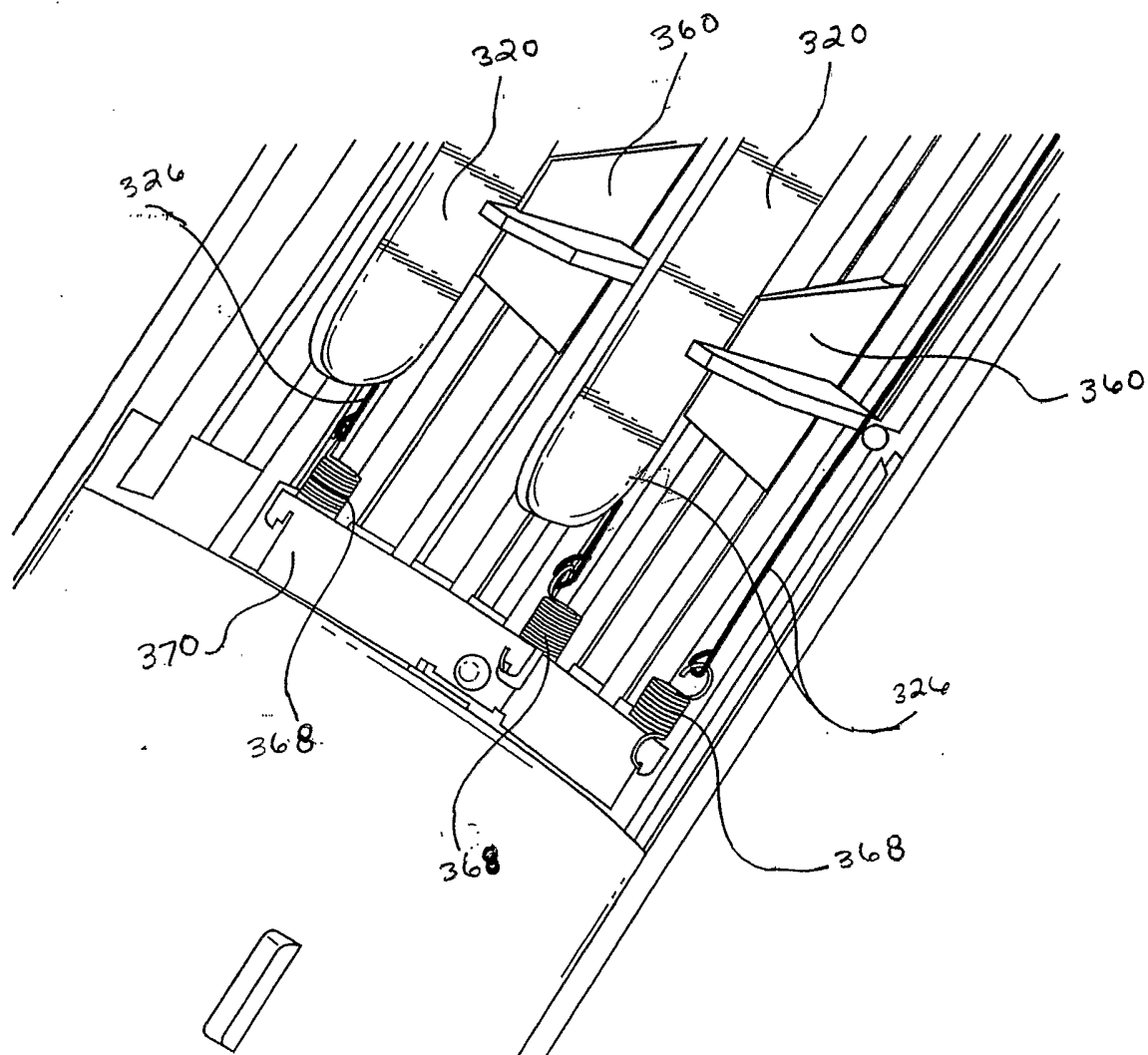


Fig. 10B

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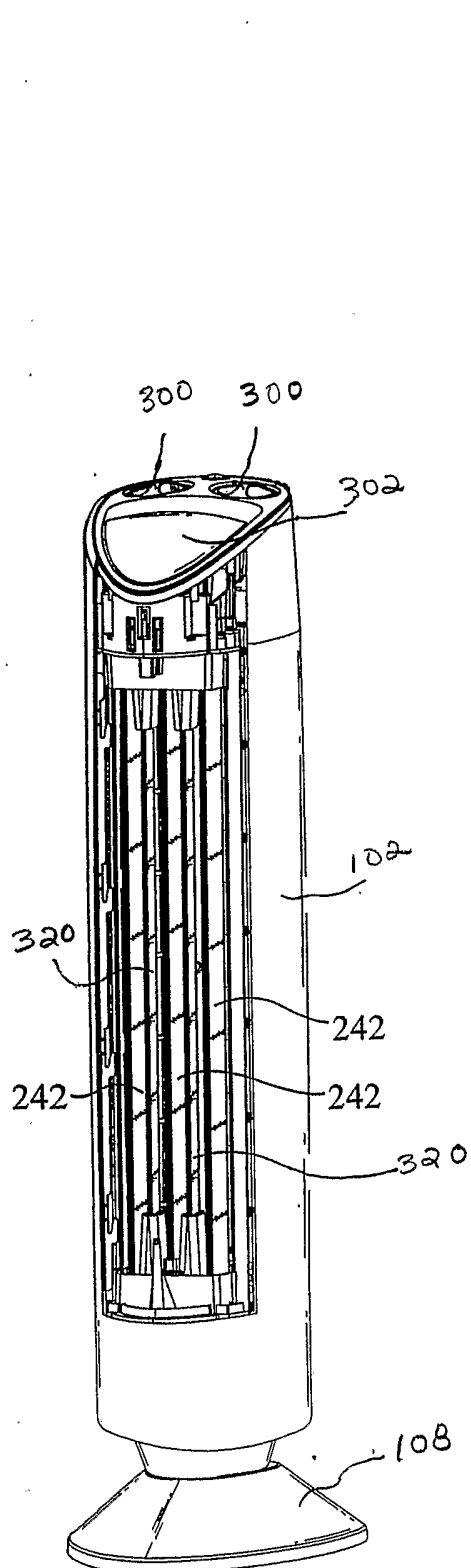


Fig. 11A

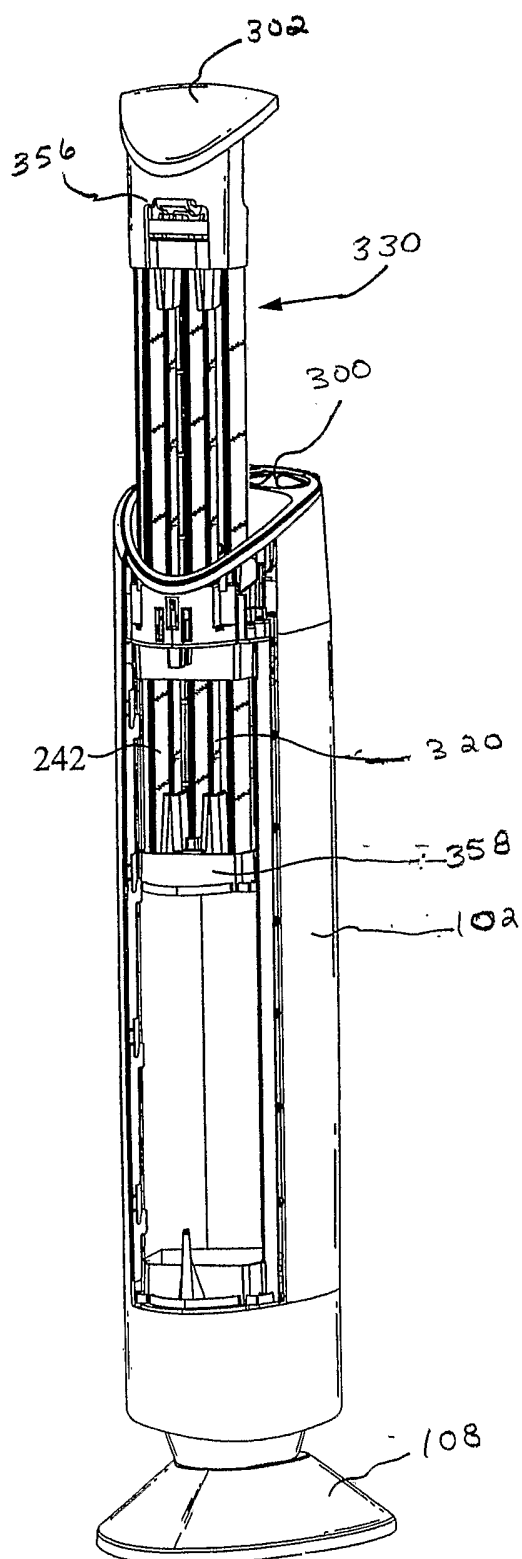
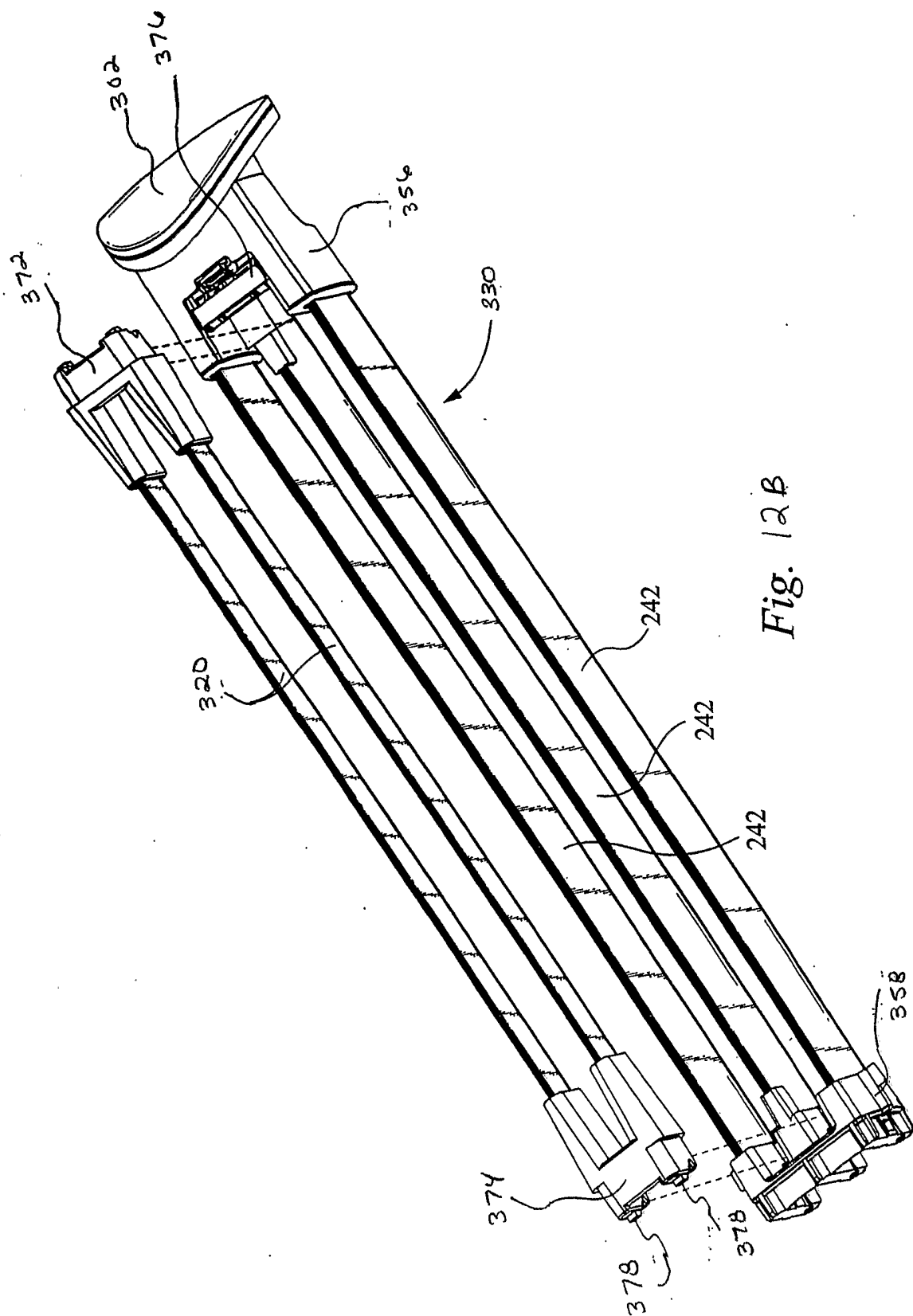
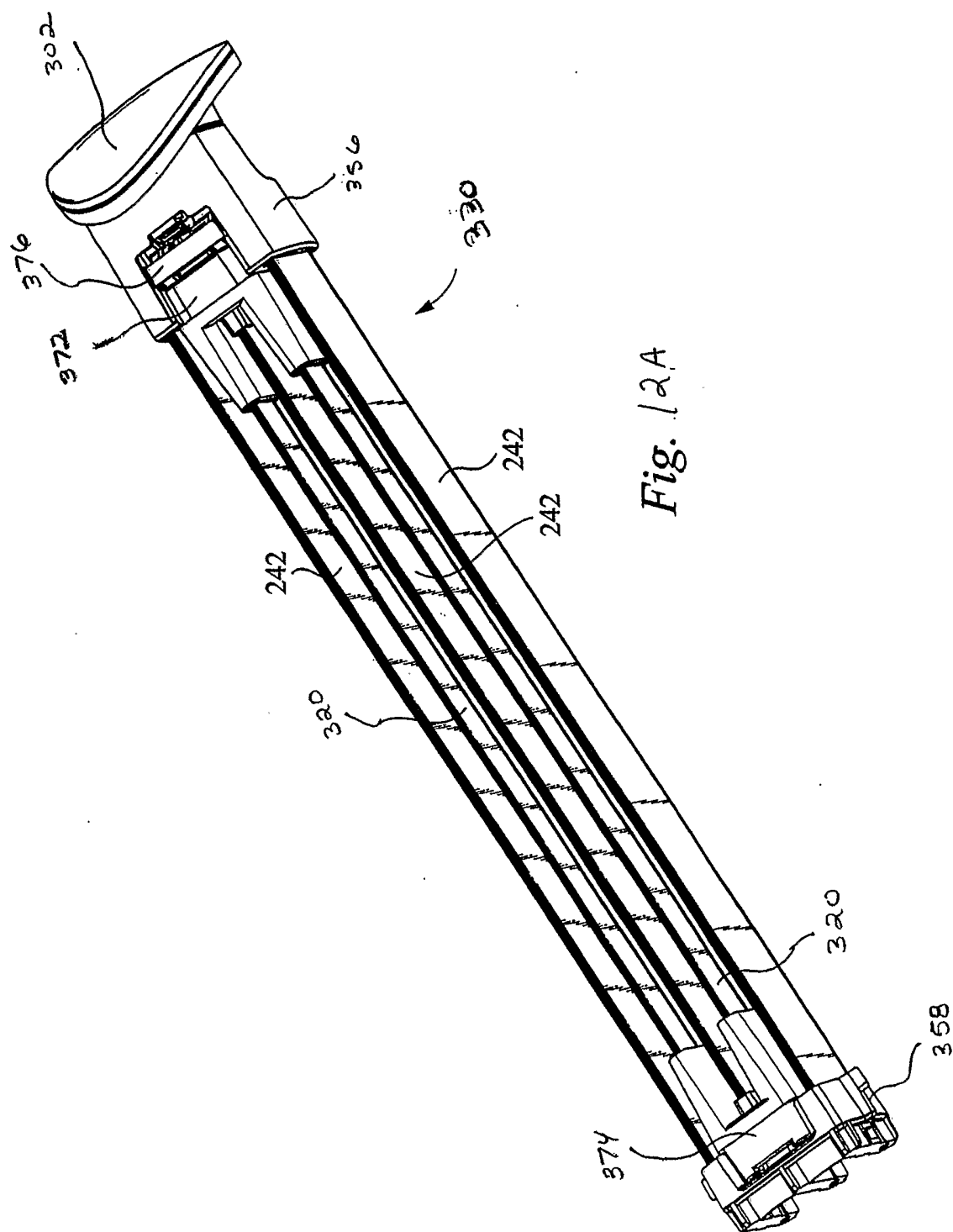
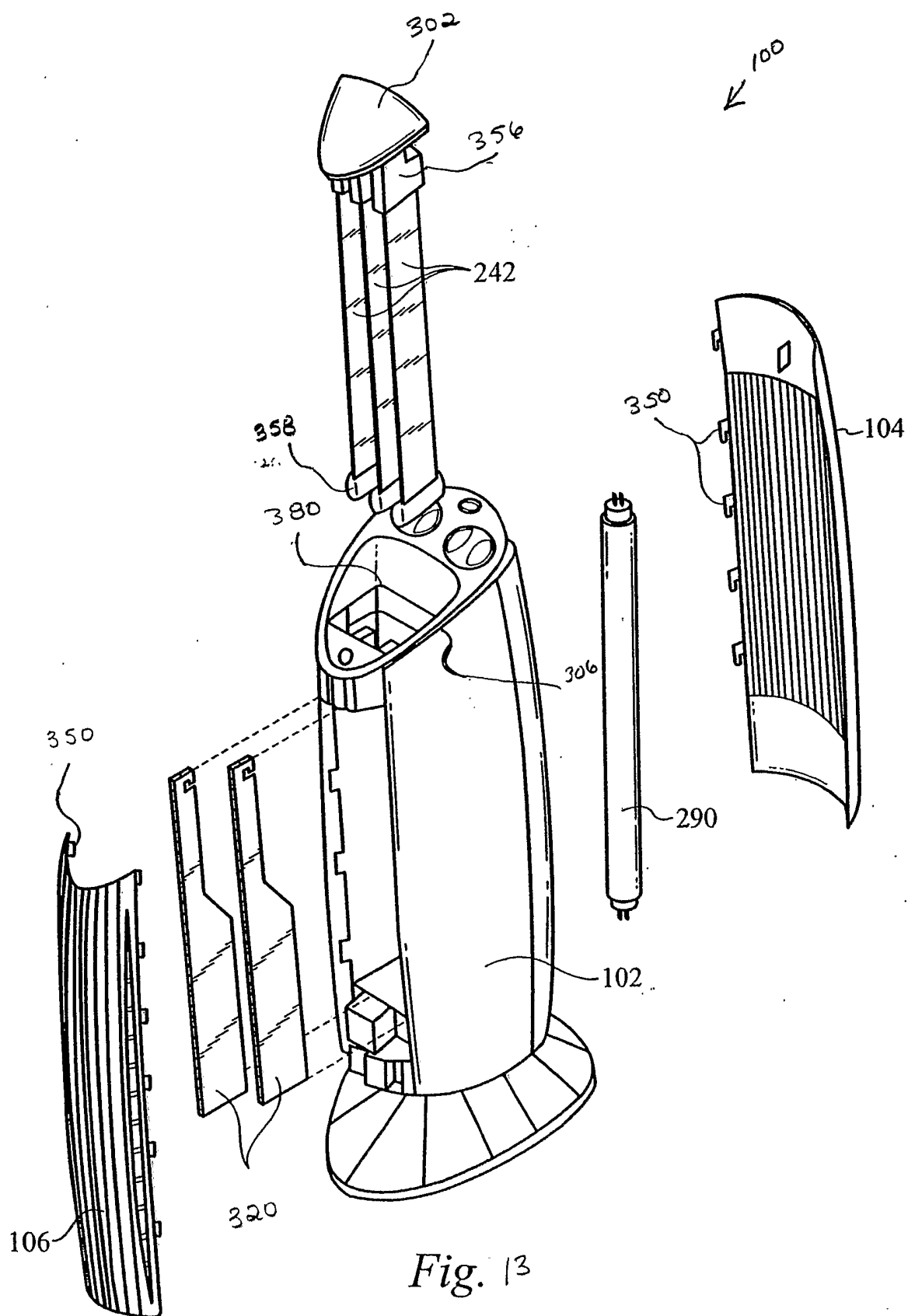


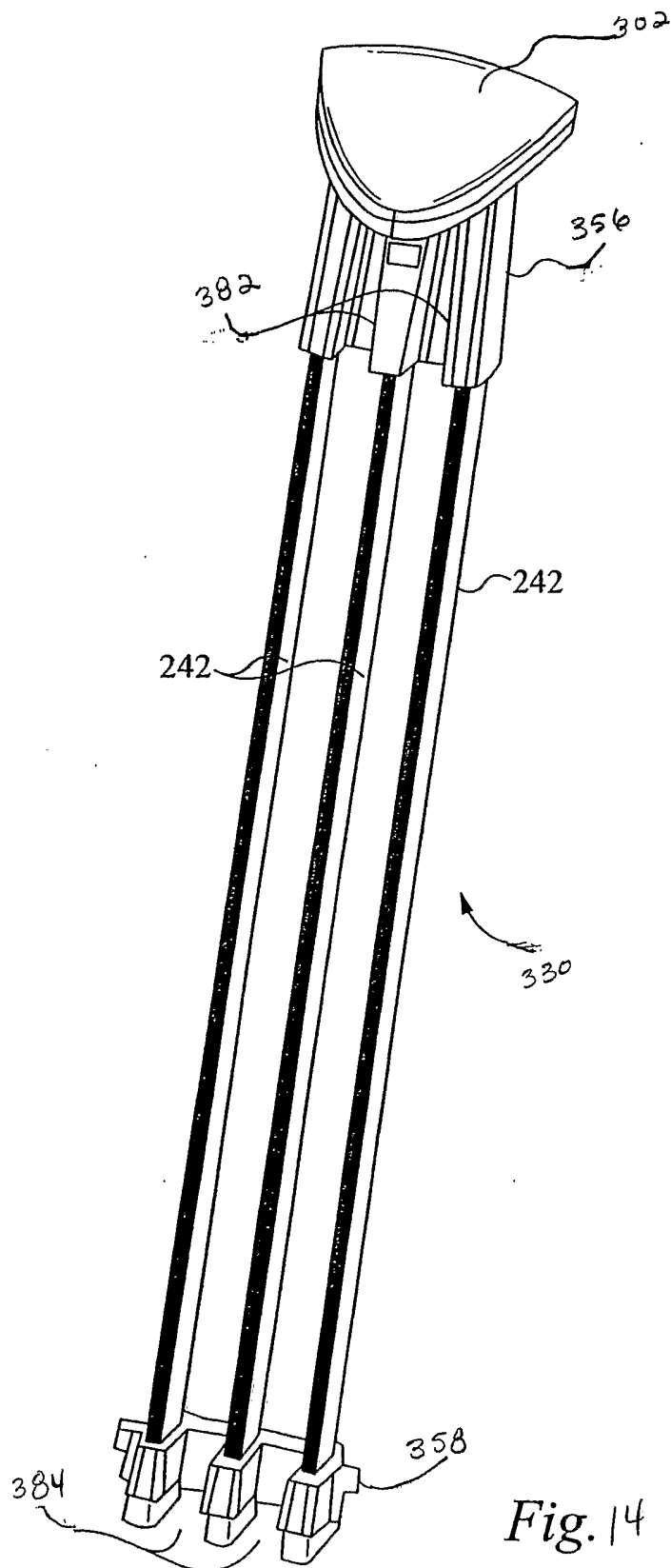
Fig. 11B

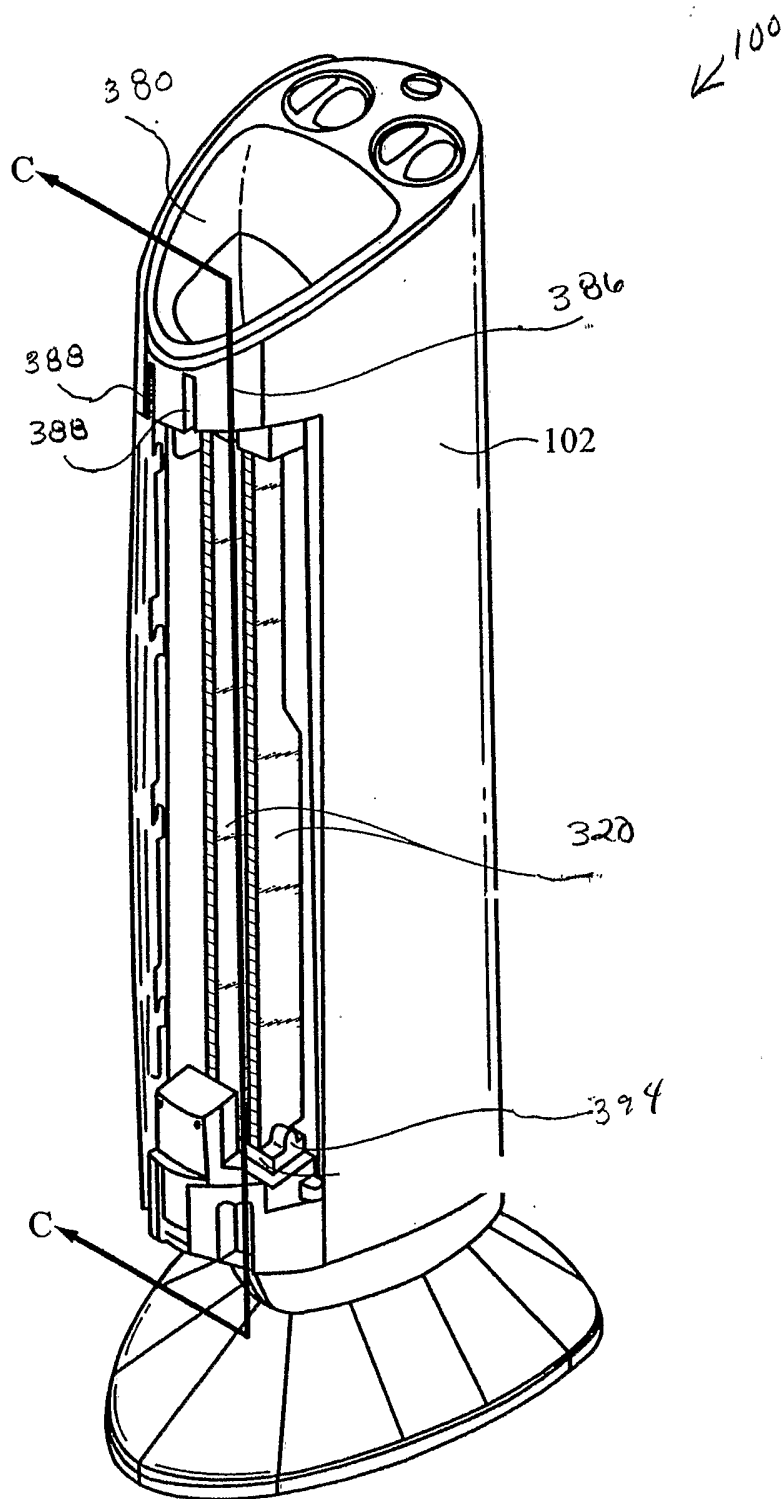


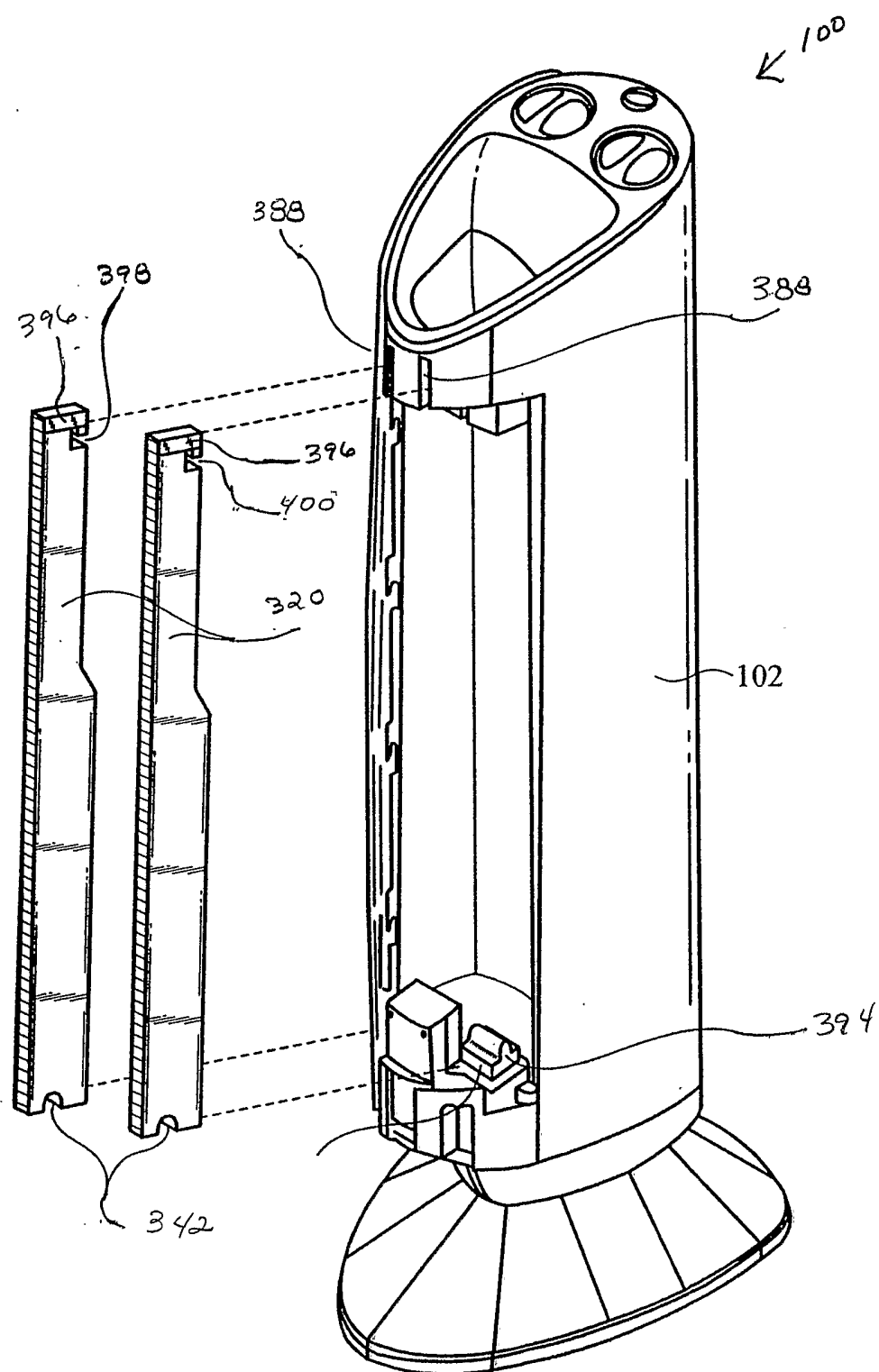


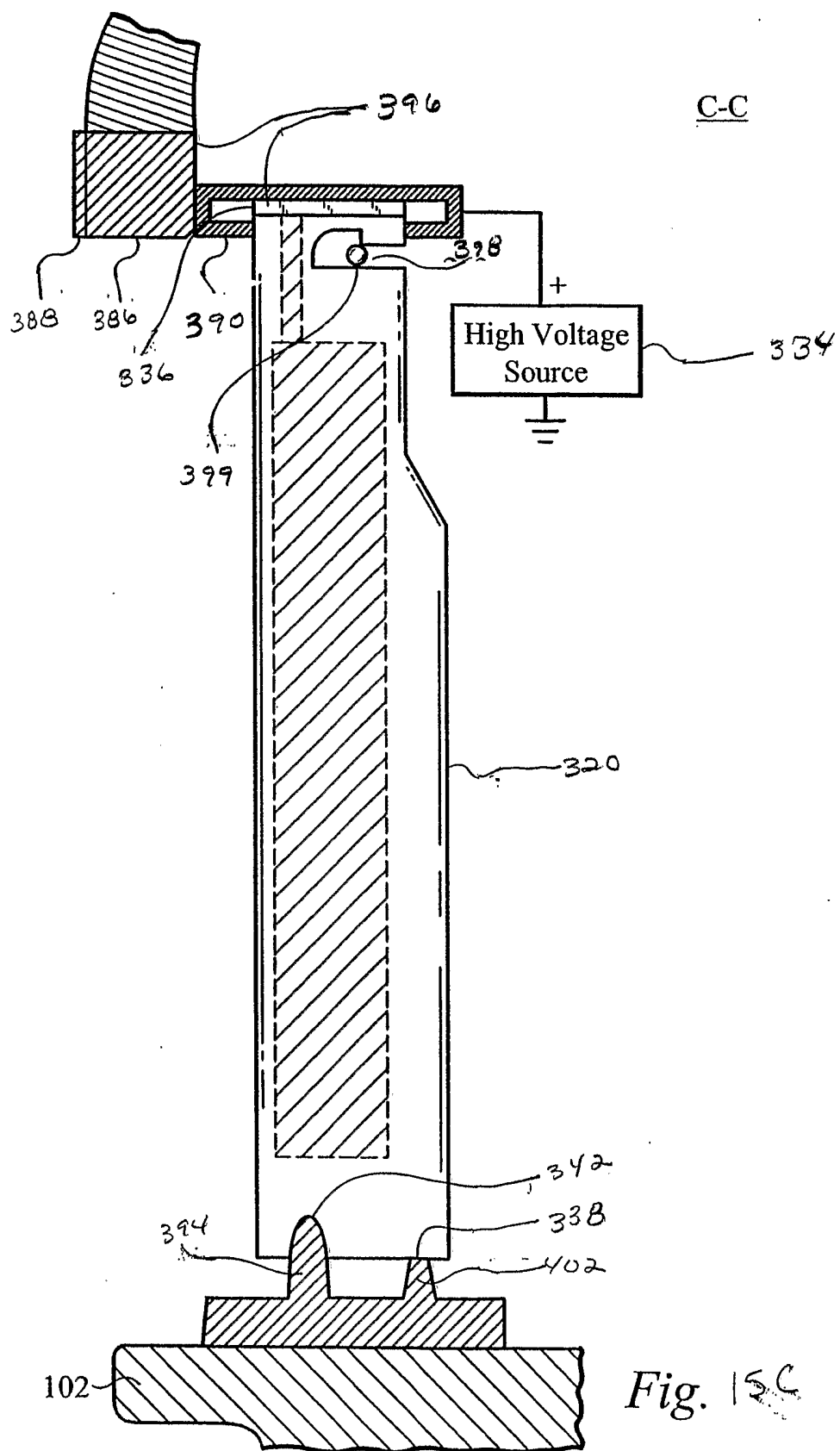


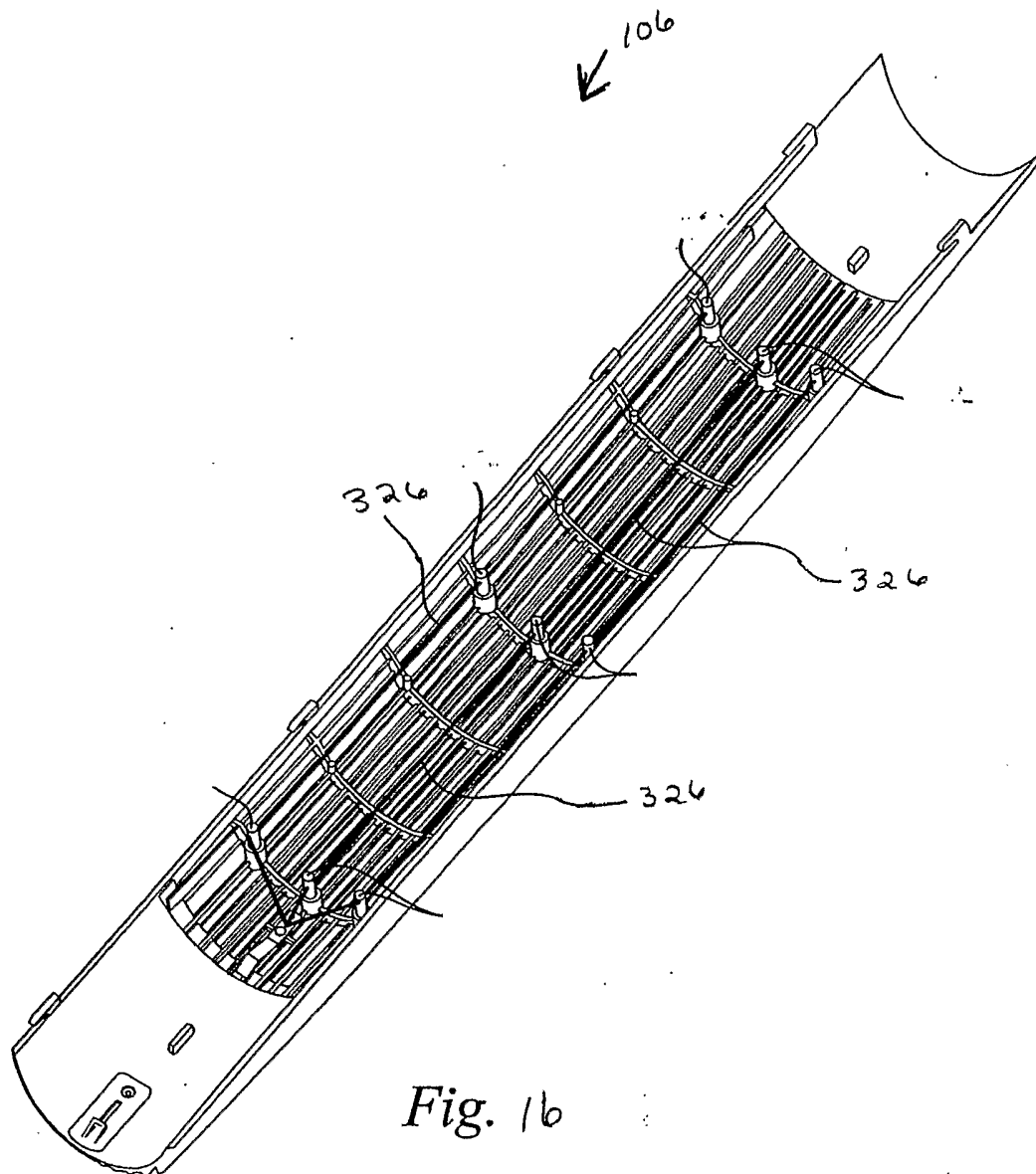
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*Fig. 14*

*Fig. 15A*

*Fig. 15B*



*Fig. 1b*

