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(54) **ELECTROSTATIC SPRAY NOZZLE SYSTEM**

ELEKTROSTATISCHES SPRÜHDÜSENSYSTEM

SYSTEME DE BUSE DE PULVERISATION ELECTROSTATIQUE

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EP 1 817 112 B1

Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority from and incorporates by reference the entire disclosure of U.S. Provisional Application No. 60/627,191 filed November 12, 2004 and bearing Docket No. 32272-00153USPL and U.S. Provisional No. 60/627,480 file November 12, 2004 and bearing Docket No. 32272-00152USPL.

BACKGROUND OF THE INVENTION

TECHNICAL FIELD

[0002] This invention relates to electrostatic spraying nozzles. Specifically it relates to electrostatic spray nozzle systems utilizing induction charging or contact charging methods to apply static charge to atomized liquids operating in environments with untrained operators.

BACKGROUND

[0003] Electrostatic charging nozzles are well known and in widespread use in a number of commercial applications. Nearly every vehicle manufactured worldwide is painted electrostatically. Most of these industrial electrostatic spray systems charge spray by ionization and dispense powder or non-conductive liquids. There is a need for electrostatic spray devices that can reliably charge electrically conductive formulations, such as those that are water based. Several types of induction charging nozzles have been developed to produce electrostatically charged water sprays. U.S. Patent No. 4,004,733 to Law shows an induction charging nozzle having a conductive ring surrounding a liquid jet inside a channel where high velocity air impacts the liquid stream, thereby creating a fine spray. Commercial versions of the nozzle described in the Law patent have been manufactured with deviations that include a liquid tip made from an insulating material, upstream grounding of the liquid, and lengthening the electrode to near the full length of the atomization channel. These modifications have made the nozzle of U.S. Patent No. 4,004,733 reliable for use with water-based materials in most environments where the nozzle surfaces do not become excessively coated with conductive spray residue during a spraying operation. The conductive coatings on the surfaces of the nozzle can cause current leakage which reduces power supply voltage, damages surfaces, and reduces the internal charging field by elevating the voltage of the liquid stream.

[0004] Further patents to Cooper and Law, U.S. Patent Nos. 5,704,554 and 5,765,761, utilize a fluid tip that is integral to the nozzle body, and utilize unique outside nozzle surface shapes to attempt to address some of the problems of stray electrical currents due to internal and external nozzle surface contamination. The fixed tip requires that the entire nozzle body be replaced in the event of mis-manufacturing, damage or wear, thereby increasing the cost and the effort of nozzle maintenance. The electrode portion of these nozzles is permanently pressed into the retaining cover. This does not allow replacement of the electrode alone - the entire cover assembly must be replaced. U.S. Patent No. 4,343,433A to Sickles describes an induction charging nozzle with a fixed tip which utilizes air jets positioned around the main spray jet to prevent nozzle surfaces from becoming coated by spray. This method requires a significant amount of additional air energy, and the fixed tip and fixed electrode do not allow for adjusting for wear, machining tolerance, or replacing individual parts.

[0005] A series of electrostatic nozzle patents, U.S. Patent Numbers 6,003,794, 6,138,922 and 6,227,466, to Hartman use an induction charging principle and liquid tip and air channel geometry that are similar to the above mentioned patents by Law, Cooper and Sickles. U.S. Patent No. 6,003,794 describes nozzles having many components with stacked tolerances. These nozzles have a replaceable electrode but do not allow for adjustment. The nozzles mentioned in the above-identified patents charge well when made to precis, but expensive, machining tolerances, use matched components and are operated within a narrow range of liquid viscosities and liquid and air flow rates for a given internal spacing of components.

[0006] Variations in geometry of components causes charging variations which are due to improper droplet size or contact of the spray liquid with the walls of the induction electrode channel. Very small deviations in the internal spacing and dimensions of the atomization channel and liquid tip length have been observed to greatly diminish charging unless the air and liquid flows are within a narrow tolerance. These deviations occur due to nozzle manufacturing, from damage to components, and normal wear of components during use. Nozzle manufacturing deviations require that nozzle components be matched for optimal initial performance. This presents a problem since individual nozzle components wear over use and the entire nozzle often needs to be replaced with matching components. Measurements of spray charging from commercial versions of some typical nozzles with cost effective machining tolerances, but without using matched components, show over 30% variation from the same manufacturing run.

[0007] All of the above mentioned nozzles use air-atomizing induction-charging principles. With these nozzles the spray is charged to the opposite polarity as the electrode. Neither the liquid emitted from the tip nor the atomized spray is meant to contact the electrode. The advantage of such a system is that it produces high spray charging with very low electrode voltage and power. The disadvantage is that spray is attracted back to the nozzle surfaces. The wetted surfaces become conductive and reach the same polarity of the electrode, further attracting liquid spray droplets. The moisture deposits on the nozzle

surface form into peaked shapes in response to the spray cloud space charge. The sharp points formed on these water droplets emit air ions that discharge large portions of the spray charge in the cloud. This effect can be minimized by adjusting the spray jet to a narrow column, using the air energy to force the spray a distance away from the nozzle. Another solution when this becomes a problem is to utilize contact charging principles. With contact charging types of nozzles the liquid stream is raised to a high voltage. This renders nozzle surfaces the same polarity as the spray cloud space charge and droplets are electrically repelled from the nozzle. The disadvantage is that the liquid container holding the spray liquid is also raised to high voltage, and as a result small containers should be used or isolation systems must be employed.

[0008] Operation of electrostatic charging nozzles in situations where contact with the nozzle by humans is possible, such as in applications of spray booths used for sunless-tanning, presents additional safety considerations in their design. One consideration is in limiting the exposure by humans to the electrode itself during operation. Another consideration is the reduction of the amount of leakage current from any portion of the nozzle where human contact could be made. The previously mentioned nozzles by Law and Cooper use an electrode which is embedded between layers of plastic or ceramic. This is an effective method for reducing the chance of direct contact with the electrode. However, commercial versions of the nozzle of U.S. Patent No. 5,704,554 use an electrical contactor that is exposed when the cover is removed. This pointed contactor can be touched with the fingers and a shock can be received. The current from this contactor is in the range of 1 mA, capable of producing a shock intense enough to make the person involuntarily draw back very quickly and risk injury. Nozzles such as those described by Cooper and Law, Sickles, Hartman, and U.S. Patent No. 4,664,315 to Parmentar et al. are induction charging devices and have the unfortunate characteristic of attracting spray back to the nozzle itself. This causes wetting of the nozzle face. Wetting by conductive liquids, near the jet outlet, can cause a conductive bridge to form to the electrode and cause shock when these forward nozzle surfaces are touched, even though the nozzle parts are made from insulating materials. The nozzle of Hartman, which is mounted with the electrode through a hole in a PVC tube structure, is particularly susceptible to leakage currents forward from the electrode. After a period of use black electrical tracking lines are evident on the surface of the tube. In addition the thin electrode cover may be easily removed during use causing direct exposure to the electrode.

[0009] Accordingly, there is a need for an air-atomizing charging nozzle for conductive liquids that has adjustable components to allow tuning for optimized spray quality and charging levels for a wide range of liquid viscosities and flow rates. It is desirable that the nozzle be manufactured with cost effective machining tolerances and not require component matching. It is also desirable that these tuning adjustments can be made while the nozzle is operating. It is also desirable that these adjustments remain set in place during normal nozzle operation. In addition, it is desirable to be able to easily replace and interchange nozzle components without adversely affecting charging and spray quality. Furthermore it is desirable to have the option to use the same nozzle as a contact charging device when necessary. Safety design considerations dictate that the nozzle have reduced leakage currents on all nozzle surfaces, particularly those interior and exterior surfaces which are easily touched by untrained operators.

[0010] Electrostatic charging of spray is well known in many agricultural and industrial processes. Electrostatic spray nozzles have been successfully developed to increase the deposition efficiency of powder and liquid formulations of agricultural pesticides, paints, and other coatings. Recently electrostatic spray devices have been developed for use by the consumer for applying cosmetics and for sunless tanning. A recent publication by the University of Georgia describes a method for applying decontamination sprays to humans utilizing electrostatic spray nozzles (See, Law and Cooper, 2002 Institute of Physics Conference, Edinburgh, Scotland UK).

[0011] Although electrostatic spray nozzles have been used for many years in a variety of applications, they are generally used in industrial environments with operators trained in the possible hazards associated with the high voltage devices. Electrostatic nozzles have not generally been used in consumer applications where the user is untrained and is unaware of any hazard. Many electrostatic nozzles are operated at voltage levels which can cause an electrical shock hazard. The hazard can come from contact with the high voltage electrode or from wetted nozzle surfaces which create conductive pathways to the high voltage electrode. The safety hazards may be due to contact with the electrical current itself, but more likely the hazard is the reaction to the shock, which may result in bodily harm from falling or contact with an object during involuntary movement away from the source of the shock.

[0012] Wetted or otherwise contaminated nozzle surfaces can cause diminished spray charging due to electrical leakage currents from the electrode to ground. These electrical currents, if excessive, may reduce power supply voltage causing reduced spray charge. In induction charging types of nozzles, such as that of U.S. Patent Number 4,004,733 to Law modified with a dielectric twin-fluid tip and the invention of U.S. Patent Number 5,765,761 to Law and Cooper, leakage currents may contact the liquid stream and cause reduced charging by decreasing the electrical field between electrode and liquid. This problem is addressed in U.S. Patent Number 5,704,554 to Cooper and Law. In this nozzle an annular cavity surrounds the nozzle body and a cover to provide for reduced leakage currents. In addition, the liquid stream is insulated by providing a liquid tip which is an

integral, non-removable part of the nozzle body.

[0013] These aforementioned nozzles utilize an electrode embedded between layers of insulating material along the atomization channel. This design is safe from operator shock since the embedded electrode design prevents human contact with the electrode. However, gross contamination of the surfaces of these aforementioned nozzles can cause leakage currents from the embedded electrode to elevate the voltage of the upstream-grounded liquid stream. This reduces the internal electric field which is critical for proper induction charging. U.S. Patent Number 5,704,554 to Cooper and Law addresses solutions to internal and external electrical leakage to the liquid channel from the electrode, but does not address electrical contact from other sources such as from the high voltage connector at the rear of the nozzle. The wire connectors, once contaminated with conductive spray residues, create current pathways to the liquid connections at the rear of the nozzle. In some applications these nozzles have been mounted to panels, tubes or oscillating drums. The lack of a seal between the nozzle surface and the mounting surface causes spray residue to eventually cover both high voltage and low voltage sections of the nozzle.

[0014] A series of patents to Hartman, U.S. Patent Numbers 6,003,794, 6,138,922 and 6,227,466, show a set of nozzles encased in a nonconductive tube. This device does not provide a barrier between the high voltage and low voltage sections of a nozzle system as evidenced by the design which has an electrode conductor in contact with the tube wall and penetrating through an opening in the tube. The design includes a non-insulated conductive air conduit and non-insulated conductive nozzle bodies within the tube shell that serve as conductors connected to the electrode voltage. Conductors to the electrode which extend through the tube and contact the exterior portion of the tube are covered on one face with a nozzle cap that does not provide an electrically tight sealing surface between inner and outer portions of the tube. The exposed conductors within the shell are in the vicinity of the liquid channels which are meant to be maintained at earth potential. The non-insulated high voltage air tube and nozzle bodies are likely to allow leakage currents to travel through threaded seams in the liquid channels. This effect will draw excessive electrode current, elevate the liquid electrical potential by contact and reduce charging. In addition, the non-insulated high voltage conduits may pose a significant hazard to those adjusting or maintaining the assembly while it is operating.

[0015] In commercial applications of the nozzle of US Patent 5,704,554 to Cooper and Law, where the nozzles are mounted to an oscillating drum for applications of sunless tanning liquids, the lack of a sealing surface on the nozzle eventually causes liquid to reach the inside of the drum. The presence of this conductive liquid inside the drum provides electrical leakage paths to the liquid channel of the nozzle. Electrical potentials on the liquid have been observed on commercial versions of this system to reach a level of over 80% of the induction electrode voltage. Conductive liquid tube fittings used on the rear of the nozzle accelerate this problem. Because the liquid is near the electrode potential rather than held at ground potential, the induction-charging electric field within the nozzle is greatly reduced, and spray charging is much less than necessary for electrostatic spray deposition. Once the nozzle surfaces have become contaminated they are very difficult to clean to the level necessary to prevent electrical leakage.

[0016] Induction charging nozzles, such as those previously mentioned, also have the inherent drawback of spray being attracted back to the nozzle itself and to surrounding mounting fixtures. The electrode is of opposite polarity to the charged spray cloud. Once the dielectric nozzle surfaces become slightly wetted or otherwise conductive, the surfaces assume the electrode polarity and attract spray from the oppositely charged spray cloud. Excessive liquid returning to the nozzle not only contaminates the nozzle surface further, it causes spray cloud discharge as the liquid pulls into a peaked shape in the direction of the spray cloud space charge field. The point on the liquid droplet peak will produce air ions that can discharge an estimated 1/3 of the spray charge.

[0017] US-A-4 934 602 discloses a spray nozzle in accordance with the precharacterising portion of claim 1. This prior art nozzle does not provide for electrostatic charging. Moreover, it does not provide a convenient arrangement for coupling the liquid inlet to the nozzle body and for adjusting the liquid tip within the nozzle.

BRIEF SUMMARY OF THE INVENTION

[0018] The present invention provides an electrostatic spray charging nozzle comprising:

a nozzle cap having an outlet;
a nozzle body having a first bore;
a fluid tip assembly extending at least partially through the first bore, and having a liquid inlet adapted to be connected to a source of liquid, and a liquid outlet adapted to dispense the liquid through the outlet of the nozzle body; and
an adjustment mechanism 50 operable to move the fluid tip assembly within the first bore so as to adjust a longitudinal distance between the liquid outlet of the fluid tip assembly and the outlet of the nozzle cap;
wherein the fluid tip assembly comprises:

a liquid inlet connector having a first end adapted to be coupled to a second side of the nozzle body, and a second end adapted to be connected to the source of liquid; and
a fluid tip having a liquid tip inlet adapted to be coupled to the first end of the liquid inlet connector, and a liquid tip outlet adapted to dispense the liquid through the outlet of the nozzle cap;
characterised in that:

the first end of the liquid inlet connector (30) includes adjustment threads coupling the first end of the liquid inlet connector to the second side of the nozzle body (60), and the adjustment threads are adapted to adjust the longitudinal distance between the liquid outlet of the fluid tip and the outlet of the nozzle cap by rotation of the liquid inlet connector.

[0019] Referred features and advantages of the invention will be apparent from the following description and the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020]

FIGURE 1 is an exploded perspective view of one embodiment of the nozzle of the present invention shown disassembled to view the key components;
FIGURE 2A is a side view of the one embodiment of the nozzle of the present invention shown assembled;
FIGURE 2B is a section view of another embodiment of a nozzle of the present invention;
FIGURE 2C shows a section view of the liquid tip area of the nozzle of FIGURE 2B;
FIGURE 3 shows one embodiment of the nozzle according to the present invention in which the fluid tip is removable from the front of the nozzle;
FIGURE 4 shows one embodiment of the nozzle according to the present invention in which the fluid tip is removable from the rear of the nozzle;
FIGURE 5 show a front view of the fluid tip of one embodiment of the present invention;
FIGURE 6 shows an embodiment of the nozzle according to the present with the addition of a non-conductive element to the inside of the retaining cap;
FIGURE 7 is a configuration for a tool to insert or remove the liquid tip in the nozzle not part of the present invention;
FIGURE 8 shows components of a panel-mounted electrostatic nozzle system according to an embodiment of the present invention;
FIGURE 9 shows the nozzle system of an embodiment of the present invention mounted to the insulating panel by attaching the non-conductive nozzle body to the panel;
FIGURE 10 shows an embodiment of the nozzle system of the present invention mounted to the insulating panel by attaching the non-conductive nozzle cap to the panel;
FIGURE 11 shows an embodiment of the nozzle system of the present invention with nozzles mounted to an oscillating drum;
FIGURE 12 shows an embodiment of the nozzle system of the present invention with nozzles mounted to a dielectric panel such as may be used in a spray booth; and
FIGURE 13 illustrates a ball and socket mounting of the nozzle system according to an embodiment of the present invention to allow angular positioning of the spray.

DETAILED DESCRIPTION OF THE INVENTION

[0021] Referring now to FIGURE 1, an embodiment of a nozzle of the present invention is illustrated in which a fluid tip 10 having a fluid tip base 20 with a threaded end is screwed into an inner threaded portion of a liquid inlet connector 30. In accordance with some embodiments of the present invention, the fluid tip can be comprised of a dielectric material. A sealing boss 40 on the fluid tip 10 provides for liquid sealing between the fluid tip 10 and the liquid inlet connector 30. The liquid inlet connector 30 is further provided with fluid tip length adjustment threads 50 along an outer circumference. The liquid inlet connector 30 is adapted to be connected to a source of spray liquid. The fluid tip length adjustment threads 50 are adapted to allow the liquid inlet connector 30 to be threaded into a back surface of a nozzle body 60. With the fluid tip 10 mounted to the liquid inlet connector 30, the selective threading of the liquid inlet connector 30 result in an adjustment in the axial/longitudinal positioning of the fluid tip 10 within a central air-channel bore 70 of the nozzle body 60.

[0022] In various embodiment of the present invention, the fluid tip 10 is a dual fluid tip that allows for the passage of air as well as a spray fluid. In an embodiment of the present invention, the fluid tip 10 is provided with air path cuts 75 in the sides which longitudinally extend to allow air to flow through the central air-channel bore 70 between the fluid tip 10 and the walls of the central air-channel bore 70. This allows for the passage of air while still allowing for concentric alignment of the fluid tip 10 with the central air channel. This design improves air flow uniformity in the atomization channel and helps prevent spray contact with the channel walls. The directed air within the nozzle further produces a narrow directed spray which provides concentrated air energy at the jet outlet of the nozzle and greatly reduces the return of charged spray to the nozzle and nozzle mounting components. The nozzle body 60 is further provided with an air inlet 80 for providing a flow of air or other gas from an external source through to the central air-channel bore 70. An air cap 90 (or electrode) having a bore or channel is further positioned at a front end of the nozzle body 60 to form an atomization/electrode charmel. An electrode wire 100 is provided to apply a charge to the air cap 90 when the nozzle is to be used for induction charging, and the air cap 90 is made from conductive materials. For a contact charging configuration, the spray liquid itself is raised to a high voltage and the air cap 90 may be made from insulating materials. In this configuration, the electrode wire 100 may be omitted. A nozzle cap 110 (or

retaining cap) is further provided to retain the air cap 90 in the nozzle assembly. In accordance with some embodiments of the present invention, the nozzle cap 110 may be comprised of a hemispherical nozzle cap. In accordance with still other embodiments of the present invention, the nozzle cap may have alternate shapes. The nozzle cap 110 can be further provided with an aperture or recess adapted to removably receive the air cap 90. In accordance with an embodiment of the present invention the air cap 90 is adapted to rotate freely about the fluid tip assembly, and is removable for repair and/or replacement if necessary.

[0023] Adjustment of the depth that the fluid tip 10 penetrates into the atomization channel is made by turning the liquid inlet connector 30 attached to the back of the nozzle body 60. The thread pitch of the liquid inlet connector 30 determines the amount of axial/longitudinal movement that is provided with respect to the placement and positioning of the fluid tip 60 in the atomization/electrode channel for each turn of the liquid inlet connector 30. The threads of the liquid inlet connector 30 act as an adjustment mechanism such that the longitudinal or axial distance between the liquid outlet of the fluid tip 10 and the outlet of the nozzle cap 10 can be adjusted within a predetermined range.

[0024] The nozzle of various embodiments of the present invention allows for components of the nozzle to be removed and interchanged easily, for example for cleaning or replacement. The removable and interchangeable components of the nozzle include the fluid tip 10, the nozzle cap 110, the air cap 90, and the nozzle body 60. For example, it may be desirable to replace the air cap 90 with one having a larger bore in order to permit more air flow. It also may be desirable to replace the fluid tip 10 with one of different outside and inside diameters to provide different spray characteristics such as droplet size, spray pattern and spray volume. Nozzle cap 110 can be replaced to change its outside surface size and/or shape.

[0025] FIGURE 2A illustrates a side view of one embodiment of a nozzle in accordance with the present invention shown in an assembled form. In the nozzle of FIGURE 2A, the nozzle cap 110 is coupled to a front side of the nozzle body 60, and the liquid inlet connector 30 is coupled to a back side of the nozzle body 60. The nozzle of FIGURE 2A may be further provided with a spacer ring 120 placed between the nozzle cap 110 and the nozzle body 60. In alternate embodiment of the nozzle of FIGURE 2A, the spacer ring 120 may be removed for mounting of the nozzle to a panel.

[0026] FIGURE 2B shows a section view of another embodiment of a nozzle in accordance with the present invention. In this mounting configuration, the panel occupies the space previously occupied by the spacer ring 120. Adjustment of the length of the fluid tip 10 is made by turning a fitting on the liquid inlet connector 30 connected to the back of the nozzle. The thread pitch of the fluid tip length adjustment threads 50 of the liquid inlet connector 30 controls the length of axial/longitudinal movement of the fluid tip 10 per turn. These fluid tip length adjustment threads 50 have been proven to seal the air very well even after many adjustment rotations have been made. The fluid tip 10 is shown inserted into the central air channel bore 70 of the nozzle body 60. The fluid tip 10 is held concentric in the air channel by ridges formed on the sides of the fluid tip 10.

[0027] FIGURE 2C shows a section view of the fluid tip 10 area of the nozzle of FIGURE 2B. One aspect in accordance with embodiments of the present invention is that tightening the nozzle cap 110 pushes a ledge on the inside of the air cap 90 against a front face of the nozzle body 60 to cause a seal. This design reduces stacked tolerances seen in previous designs, since only the air cap 90 inside dimension need be made with tight tolerances and the nozzle cap 110 and nozzle body 60 can be made with loose, non-critical tolerances. Any variation due to manufacturing of the nozzle parts can be taken out by adjusting the fluid tip 10 by turning the fitting of the liquid inlet connector 30 on the rear of the nozzle. By rotation of the fitting of the liquid inlet connector 30, the fluid tip 10 is made to move in an axial direction 95, thereby changing a length 105 of the fluid tip 10 that is exposed from the nozzle body 60, as well as a depth 115 that the tip end penetrates into the channel of the air cap 90.

[0028] FIGURE 3 shows one embodiment of the nozzle according to the present invention in which the fluid tip 10 is removable from the front of the nozzle assembly. This is accomplished by first removing nozzle cap 110, and then rotating fluid tip 10 to disengage the fluid tip 10 from the liquid inlet connector 30 while the liquid inlet connector 30 remains in place. Removal of the fluid tip 10 from the front is desirable in instances where the front of the nozzle is more accessible for maintenance. For instance, if the nozzle is panel mounted and closed in on the backside. The nozzle assembly of FIGURE 3 further illustrates the fluid tip base 20 of the fluid tip 10 as having threads 130 to facilitate removable of the fluid tip 10 from the liquid inlet connector 30. The nozzle assembly of FIGURE 3 is further provided with an electrode wire 100 to provide a high voltage to the spray liquid during a spraying operation.

[0029] FIGURE 4 shows one embodiment of the nozzle according to the present invention in which a fluid tip assembly 150 comprised of a fluid tip 10 and liquid inlet connector 30 is removable from the rear of the nozzle body 60. This is accomplished by rotating the liquid inlet connector 30 to detach the liquid inlet connector 30 from nozzle body 60 while the fluid tip 10 remains attached to the liquid inlet connector 30. In accordance with some embodiments of the present invention, the fluid tip can be comprised of a dielectric material. Removal of the fluid tip 10 from the rear of the nozzle body 60 may be desirable is some situations. For instance, if the nozzle were operating alongside other nozzles and only one nozzle needed service, the fluid tip 10 could be removed from

the rear of the nozzle body 60 without interfering in the spray of the adjacent nozzles.

[0030] FIGURE 5 shows a front view of a fluid tip 10 of one embodiment of a nozzle body of the present invention. The fluid tip 10 is removable and inserted into the central air channel bore 70. Cuts along the length of the side of the fluid tip 10 allow air to flow evenly around a liquid outlet 160 of the fluid tip 10 and mate the tip concentric with the inner wall of the central air channel bore 70. The ridges formed on the length of the fluid tip 10 hold the fluid tip 10 concentric with the central air channel bore 70 of the nozzle body 60 and provide for air channels 170 through which air or another gas can flow. This arrangement improves the concentricity of the removable liquid tip 10 with the nozzle body 60 and the air cap 90. An electrode contactor 180 is provided in the case of induction charging nozzles where a conductive air cap 90 is used in order to couple a high voltage from electrode wire 100 to the air cap 90. The electrode contactor 180 includes a contact pad adapted to contact a surface of the air cap 90. In one embodiment of the present invention, the contact pad may be comprised of a spring-loaded contact pad. The electrode contactor 180 is recessed in a ring cavity 190 or channel of the nozzle body 60 to prevent touching with fingers while operating. The ring cavity 190 allows for the seating of air cap 90 as can also be seen in FIGURES 2B and 2C. Although the embodiment of FIGURE 5 is illustrated as having a ring cavity 190, it should be understood that in other embodiments a nozzle body can be used that does not have a ring cavity.

[0031] FIGURE 6 illustrates an embodiment of the present invention which includes the addition of a non-conductive element 200 to the inside of the nozzle cap 10 positioned between the ends of the retaining cap 110 and a top surface of the air cap 90. The function of the non-conductive element 200 is to increase human safety by reducing shock hazard at the nozzle tip area by providing an electrical isolation between the air cap 90 and the nozzle cap 110. The non-conductive element 200 further acts to reduce leakage currents from surfaces surrounding of the jet outlet 210 of the nozzle cap 110 that may be touched by human hands in certain applications. In accordance with various embodiments, the non-conductive element 200 is a non-conductive or substantially non-conductive disc. It is preferred that the non-conductive element 200 be a material with low electrical conductivity and low surface wettability, such as Teflon or UHMW Nylon. The addition of the non-conductive element 200 can be made without affecting any critical geometry or performance of the nozzle. The jet outlet hole 210 of the non-conductive element 200 is preferably made larger than the hole of the air cap 90 so as not to introduce any discontinuities along the wall of the air channel. Although the embodiment of FIGURE 6 is illustrated as having a non-conductive element 200, it should be understood that in other embodiments the non-conductive element 200 may be omitted.

[0032] FIGURE 7 illustrates a configuration of a tool 220 used to insert or remove the fluid tip 10 in the nozzle according to the present invention. The tool 220 does not form part of the present invention but represents background art that is useful for understanding the invention. The tool 220 has an inside bore 230 of a similar shape as the outside of the sides of the fluid tip 10. The tool 220 is positioned over the fluid tip 10 such that a portion of the fluid tip 10 extends through the inside bore 230 of the tool 220. The tool 220 is then turned by hand to tighten or loosen the fluid tip 10 from the liquid inlet connector 30 as needed. An advantage provided by an embodiment of the tool 220 is that it contacts only the sides of the fluid tip 10 in order to prevent any damage to the liquid outlet end of the fluid tip 10.

[0033] Referring now to FIGURE 8, components of a panel mounted electrostatic spray charging system in accordance with an embodiment of the present invention is illustrated. These components are illustrated as suited for an air atomizing induction charging system. However, it should be understood that the system could be easily configured for contact charging by applying voltage directly to the liquid rather than an induction electrode. The main components of an induction charging system as shown include a nozzle body 310, removable liquid tip 320, an electrode retaining cap 330, an electrode air cap 340 having an air cap outlet 345, a sealing surface 350a, 350b on the nozzle body 310 and/or the electrode retaining cap 330, and an electrically insulating panel 360. In accordance with various embodiments of the present invention, the electrically insulating panel is substantially electrically non-conductive. In accordance with various embodiments of the invention, the insulating panel may be made of a plastic material. In a preferred embodiment of the invention, the insulating panel is made of an insulating material such that electrical resistance of the insulating panel to earth ground is greater than 2 Megaohms. The nozzle body 310 is preferably made from insulating material. The nozzle body 310 itself does not contain a fluid channel but instead includes a central air channel bore so that it allows the insertion of the removable liquid tip 320 in such a way that air from an air inlet 400 is caused to flow around the removable liquid tip 320 inserted into the central air channel bore. In accordance with various embodiments, the removable liquid tip 320 is positioned into and held concentric with the central air channel bore. Preferably the central air channel bore is such that the removable liquid tip 320 may be inserted or removed from either the front or rear sides of the nozzle body 310. The air inlet 400 is adapted to receive a supply of air or other gas from a source. In various embodiments, the removable liquid tip 320 includes at least one air channel cut 325 (see FIGURES 9 and 10) along a length of the removable liquid tip 320 for allowing air to flow around a liquid outlet of the removable liquid tip 320.

[0034] The insulating panel 360 is further provided with a plurality of mounting holes 365. In one embodiment of the present invention, the nozzle body 310 is fixedly

mounted to the insulating panel 360 using mounting hardware that is coupled to the nozzle body 310 and passes through the mounting holes 365. In still another embodiment, the retaining cap 330 is mounted to the insulating panel 360 using mounting hardware that is coupled to the retaining cap 330 and passes through the mounting holes 365. In accordance with an embodiment of the invention, the mounting hardware can include bolts, screws, rods, attachment clips, etc. In still other embodiments of the invention, the nozzle body 310 and/or the retaining cap 330 can be affixed to the insulating panel 360 using an adhesive. The insulating panel 360 further includes a void 375 for allowing a portion of the nozzle body 310 to be mounted therethrough. In some embodiments of the present invention, a portion of the retaining cap 330 in contact with the insulating panel 360 is of a diameter such that the mounting holes 365 are covered by the retaining cap 330 to inhibit charge leakage through the mounting holes 365.

[0035] Still referring to FIGURE 8, the electrostatic spray charging system further includes a liquid inlet 370 adapted to be connected to a source of spray liquid and supply the spray liquid to the removable liquid tip 320. The electrostatic spray charging system still further includes an electrode wire 380 adapted to supply an electrostatic charge to the induction electrode air cap 340. The electrode retaining cap 330 is provided with an spray outlet 390 allowing for a spray of electrostatically charged liquid to be sprayed from the spray nozzle assembly.

[0036] At the beginning of a spraying operation, deposition of a small amount of spray on the surface of the insulating panel 360 causes the insulating panel 360 to be charged by accumulation to the same polarity as the spray cloud. As a result, during the remaining portion of the spraying operation the spray cloud is repelled from the insulating panel 360, resulting in a reduction in the amount of spray returning to the spray nozzle and surrounding surfaces, as well as blocking nozzle surfaces from becoming coated with conductive residues.

[0037] The sealing surface 350a and/or the sealing surface 350b functions to prevent, or at least to inhibit, current flow between the electrode air cap 340 of the electrostatic spray nozzle assembly and a pathway to an electrical potential difference, such as a ground. The sealing surface 350a and/or the sealing surface 350b serves to prevent or inhibit the formation of charge leakage paths, the presence of which will inhibit optimal charging of the spray by the electrode air cap 340. The prevention or inhibition of current flow between the electrode air cap 340 and components of the electrostatic spray nozzle assembly that are positioned on the opposite side of the insulating panel 360 from the electrode air cap 340 provided by sealing surface 350a and/or sealing surface 350b also serves to isolate a person that may come in contact with these components from electrical shock. In various embodiments of the present invention, the spray is charged to a negative charge potential with respect to ground, whereas in other embodiments the spray may be charged to a positive charge value with respect to ground.

[0038] Referring now to FIGURE 9, a side view of an embodiment of the present invention in which a mounting of the nozzle by attaching the nozzle body 310 to the insulating panel 360 is illustrated. In this embodiment, a sealing surface 350a is located between the nozzle body 310 and the insulating panel 360, and may be fixedly mounted to the insulating panel 360. An example situation in which it may be desirable to implement the embodiment of FIGURE 9 is in situations where it is desired to service the nozzle components from the spray outlet side of the insulating panel 360. In this case, removal of the nozzle cap 330 allows access to the removable electrode air cap 340 and the removable liquid tip 320. In this embodiment it is preferable that the sealing surface 350a be a flat surface of the nozzle body 310 that contacts the insulating panel 360.

[0039] FIGURE 10 illustrates a mounting of the nozzle assembly in accordance with an embodiment of the present invention in which the nozzle cap 330 is attached to the insulating panel 360. This mounting configuration is useful when it is desired to have the serviceable components accessible from the rear of the insulating panel 360. One instance in which this may be desirable may be for use in a spray booth where a service door is provided on the rear of the spray booth. Another instance in which rear access is desirable is in a multiple-nozzle spray panel in which adjacent nozzles are continuously operating while an individual nozzle is serviced or its components are replaced or repaired. In the mounting scenario of FIGURE 10 it is desirable that the sealing surface 350b is on a flat area of the fixed nozzle cap 330 that contacts the insulating panel 360.

[0040] FIGURE 11 illustrates an embodiment of the present invention in which a nozzle assembly is mounted on an oscillating spray nozzle drum 410. The nozzle drum 410 is mounted on a pivot axis 420 which allows the nozzle drum to oscillate during a spraying operation, which allows the nozzle drum 410 to be pivoted to create a sweeping spray effect. In accordance with the embodiment of the invention of FIGURE 11, the outer surfaces of the nozzle drum 410 are constructed of electrically insulating material through which are mounted one or more nozzle assemblies each comprised of a nozzle cap 330 (or electrode retaining cap), an electrode air cap 340, a removable liquid tip 320, and a nozzle body 310. An example application of the embodiment of FIGURE 11 is for use in spray booths that provide for the application of sunless tanning media onto humans. In an embodiment of the present invention, a sealing surface 350a may be provided between the nozzle body 310 and the mounting surface of the nozzle drum 410 and/or a sealing surface 350b may be provided between the nozzle cap 330 and the mounting surface of the nozzle drum 410. In still another embodiment, the nozzle system can be mounted either with the nozzle cap 330 or the nozzle body 310 providing the sealing surface.

[0041] FIGURE 12 illustrates a multiple nozzle spray panel in accordance with an embodiment of the present invention such as may be used in a spray booth. The spray system of FIGURE 12 includes one or more nozzle assemblies each comprised of a nozzle cap 330, an electrode air cap 340, and a nozzle body 310, mounted to through the surface of an insulating plastic panel 430. A sealing surface may further be provided between the nozzle body 310 and the plastic panel 430 and/or between the nozzle cap 330 and the plastic panel 430. In still other embodiment of the present invention, the nozzle system can be mounted by the nozzle cap 330 or the nozzle body 310 depending on which side of the plastic panel 430 it is desired to have service access.

[0042] FIGURE 13 illustrates a nozzle assembly mounted within a socket in an insulating (or non-conductive) panel. As illustrated in FIGURE 13, the nozzle assembly includes a nozzle cap 440 and a sealing surface 460 mounted on a first side of an insulating panel 360, and a nozzle body 470 mounted on a second side of the insulating panel 360. The nozzle cap 440 includes a jet outlet 450 which allows a spray of spray liquid to exit the nozzle assembly during a spraying operation.

[0043] The sealing surface 460 functions to prevent, or at least to inhibit, current flow between an electrode (not shown) of nozzle assembly and a pathway to an electrical potential difference, such as a ground. The sealing surface 460 serves to prevent or inhibit the formation of charge leakage paths, the presence of which will inhibit optimal charging of the spray by the electrode. The prevention or inhibition of current flow between the electrode and components of the electrostatic spray nozzle assembly that are positioned on the opposite side of the insulating panel 360 from the electrode provided by sealing surface 460 also serves to isolate a person that may come in contact with these components from electrical shock. In various embodiments of the present invention, the spray is charged to a negative charge potential with respect to ground, whereas in other embodiments the spray may be charged to a positive charge value with respect to ground.

[0044] This mounting arrangement allows the nozzle to pivot against the sealing surface 460 of the spherically-shaped nozzle to allow adjustment of the direction angle of the spray jet such that the nozzle can be set at a particular orientation. Position A of FIGURE 13 illustrates the nozzle assembly in which the jet outlet 450 has been rotated in an up position. Position B of FIGURE 13 illustrates the nozzle assembly in which the jet outlet 450 has been rotated in a midway position. Position C of FIGURE 13 illustrates the nozzle assembly in which the jet outlet 450 has been rotated in a down position. In various embodiments of the invention, the nozzle is pivotally mounted such that the side to side orientation of the nozzle can be changed. Although the embodiment of FIGURE 13 illustrates a nozzle body pivotally mounted within a socket of an insulating panel, it should be understood that other methods of pivotally mounting the nozzle body can be used such as using a pivot pin.

[0045] Although various embodiments of the nozzle assemblies of the present invention have been illustrated as being mounted to a flat insulating panel, it should be understood that other panel shapes can be used. For example, the nozzle assemblies of the present invention may be mounted within a curved insulating panel or a faceted insulation panel.

[0046] Although the various embodiments of the present invention have been described for use in the application of tanning solutions to a human subject, it should be understood that the present invention can also be applied to other cosmetic spray applications, as well as for the application of medicinal and decontaminant sprays, for example, antibiotics, antitoxins, disinfectants, sanitizers, etc. Further, although a preferred embodiment of the method and apparatus of the present invention has been illustrated in the accompanying Drawings and described in the foregoing Detailed Description, it is understood that the invention is not limited to the embodiment disclosed, but is capable of numerous rearrangements, modifications, and substitutions without departing from the invention as set forth and defined by the claims.

Claims

1. An electrostatic spray charging nozzie comprising:

a nozzle cap (110) having an outlet;
a nozzle body (60) having a first bore (70);
a fluid tip assembly (10) extending at least partially through the first bore (70), and having a liquid inlet adapted to be connected to a source of liquid, and a liquid outlet adapted to dispense the liquid through the outlet of the nozzle body (60); and
an adjustment mechanism 50 operable to move the fluid tip assembly (10) within the first bore (70) so as to adjust a longitudinal distance between the liquid outlet of the fluid tip assembly (10) and the outlet of the nozzle cap (110);
wherein the fluid tip assembly (10) comprises:

a liquid inlet connector (30) having a first end adapted to be coupled to a second side of the nozzle body (60), and a second end adapted to be connected to the source of liquid; and
a fluid tip having a liquid tip inlet adapted to be coupled to the first end of the liquid inlet connector (30), and a liquid tip outlet adapted to dispense the liquid through the outlet of the nozzle cap (110);
characterised in that:

the first end of the liquid inlet connector (30) includes adjustment threads (50) coupling the first

end of the liquid inlet connector (30) to the second side of the nozzle body (60), and
the adjustment threads (50) are adapted to adjust the longitudinal distance between the liquid outlet of the fluid tip and the outlet of the nozzle cap (110) by rotation of the liquid inlet connector (30).

2. The electrostatic spray charging nozzle of claim 1 wherein the nozzle body (60) includes a first side adapted to be coupled to the nozzle cap (110), and wherein the nozzle cap (110) is adapted for removable decoupling from nozzle first side of the nozzle body (60).

3. The electrostatic spray charging nozzle according to claim 1 or claim 2 further comprising:

an air cap (90) having a second bore aligned with the first bore (70), and positioned between the nozzle cap and the nozzle body (60) so that the liquid outlet is received within the second bore; and
wherein the nozzle cap (110) includes an aperture adapted to removably receive the air cap (90).

4. The electrostatic spray charging nozzle of claim 3, further comprising: a substantially non-conductive disc element (200) positioned between the nozzle cap (110) and the air cap (90), the substantially non-conductive element including a jet outlet hole (210).

5. The electrostatic spray charging nozzle of claim 4, wherein a diameter of the jet outlet hole (210) is greater than a diameter of the air cap (90) outlet.

6. The electrostatic spray charging nozzle of claim 3, wherein the air cap (90) is formed of a substantially non-conductive material.

7. The electrostatic spray charging nozzle of claim 4, wherein the air cap (90) is formed of a substantially conductive material, and comprises an electrode adapted to induce an electrostatic charge to the liquid.

8. The electrostatic spray charging nozzle of claim 3, wherein the air cap (90) is adapted for mounting within a ring cavity (190) of the nozzle body (60), and further comprising:

an electrode contactor recessed within the ring cavity (190), the electrode contactor having a contact pad (180) adapted to make electrical contact with a first surface of the air cap (90).

9. The electrostatic spray charging nozzle of claim 8, wherein the contact pad (180) comprises a spring-loaded contact pad (180).

10. The electrostatic spray charging nozzle of claim 1, wherein the nozzle body (60) includes an air inlet coupled to the first bore (70).

11. The electrostatic spray charging nozzle of claim 1, wherein the nozzle cap (110) comprises a hemispherical nozzle cap (110).

12. The electrostatic spray charging nozzle of claim 1, wherein the fluid tip comprises a dual fluid tip.

13. The electrostatic spray charging nozzle of claim 1, wherein the fluid tip is adapted for removal from the first side of the nozzle body (60).

14. The electrostatic spray charging nozzle of claim 1, wherein the fluid tip is adapted for removal from the second side of the nozzle body (60).

15. The electrostatic spray charging nozzle of claim 1, wherein
the first bore (70) comprises a central air channel bore and the fluid tip is adapted to be positioned into and held concentric with the central air channel bore of the nozzle body (60), and wherein
the fluid tip further includes at least one air channel along a length of the fluid tip, the at least one air channel adapted to allow air to flow along the length of the fluid tip within the central air channel bore.

16. The electrostatic spray charging nozzle of claim 1, wherein the adjustment mechanism 50 is adapted for adjustment of the longitudinal distance between the liquid outlet of the fluid tip and the outlet of the nozzle cap (110) within a predetermined range.

17. The electrostatic spray charging nozzle of claim 1, wherein the adjustment mechanism 50 is adapted for step-wise adjustment of the longitudinal distance between the liquid outlet of the fluid tip and the outlet of the nozzle cap (110).

18. An electrostatic spray charging nozzle system comprising:,

- an electrostatic spray charging nozzle according to claim 1; and
- an electrically insulating panel (360);

wherein the electrostatic spray charging nozzle is adapted to be mounted to the electrically insulating panel (360) positioned between the nozzle body (60) and the nozzle cap (110).

19. The electrostatic spray charging nozzle system of

claim 18, wherein the electrically insulating panel (360) comprises a nozzle mounting surface of a nozzle drum (410).

20. The electrostatic spray charging nozzle system of claim 19, wherein the nozzle drum (410) is adapted for oscillatory movement about a pivot axis.

21. An electrostatic spray charging nozzle system comprising:

- an electrostatic spray charging nozzle according to claim 1; and
- an electrically insulating panel (360);

wherein the nozzle body (60) is pivotally mounted to the electrically insulating panel (360).

Patentansprüche

1. Ein Düse zum elektrostatischen Aufladen eines Sprays, die Folgendes beinhaltet:

eine Düsenkappe (110) mit einem Auslass;
einen Düsenkörper (60) mit einer ersten Bohrung (70);
eine Fluidspitzenanordnung (10), die sich mindestens teilweise durch die erste Bohrung (70) erstreckt und die einen Flüssigkeitseinlass, der angepasst ist, um mit einer Quelle für eine Flüssigkeit verbunden zu werden, und einen Flüssigkeitsauslass, der angepasst ist, um die Flüssigkeit durch den Auslass des Düsenkörpers (60) auszugeben, aufweist; und
einen Einstellungsmechanismus 50, der betriebsfähig ist, um die Fluidspitzenanordnung (10) innerhalb der ersten Bohrung (70) zu bewegen, um einen longitudinalen Abstand zwischen dem Flüssigkeitsauslass der Fluidspitzenanordnung (10) und dem Auslass der Düsenkappe (110) einzustellen;
wobei die Fluidspitzenanordnung (10) Folgendes beinhaltet:

einen Flüssigkeitseinlassverbinder (30), der ein erste Ende, das angepasst ist, um mit einer zweiten Seite des Düsenkörpers (60) verkoppelt zu werden, und ein zweites Ende, das angepasst ist, um mit der Quelle für die Flüssigkeit verbunden zu werden, aufweist; und
eine Fluidspitze, die einen Flüssigkeitsspitzeneinlass, der angepasst ist, um mit dem ersten Ende des Flüssigkeitseinlassverbinders (30) verkoppelt zu werden, und
einen Flüssigkeitsspitzenauslass, der angepasst ist, um die Flüssigkeit durch den Auslass der Düsenkappe (110) auszugeben, aufweist;
dadurch gekennzeichnet, dass:

das erste Ende des Flüssigkeitseinlassverbinders (30) Einstellungsgewinde (50) umfasst, die das erste Ende des Flüssigkeitseinlassverbinders (30) mit der zweiten Seite des Düsenkörpers (60) verkoppeln, und
die Einstellungsgewinde (50) angepasst sind, um den longitudinalen Abstand zwischen dem Flüssigkeitsauslass der Fluidspitze und dem Auslass der Düsenkappe (110) durch die Drehung des Flüssigkeitseinlassverbinders (30) einzustellen.

2. Düse zum elektrostatischen Aufladen eines Sprays gemäß Anspruch 1, wobei der Düsenkörper (60) eine erste Seite umfasst, die angepasst ist, um mit der Düsenkappe (110) verkoppelt zu werden, und wobei die Düsenkappe (110) zum abnehmbaren Entkoppeln von einer erste Seite der Düse des Düsenkörpers (60) angepasst ist.

3. Düse zum elektrostatischen Aufladen eines Sprays gemäß Anspruch 1 oder Anspruch 2, die ferner Folgendes beinhaltet:

eine Luftkappe (90), die eine zweite Bohrung, welche nach der ersten Bohrung (70) ausgerichtet ist, aufweist und zwischen der Düsenkappe und dem Düsenkörper (60) positioniert ist, so dass der Flüssigkeitsauslass innerhalb der zweiten Bohrung aufgenommen wird; und
wobei die Düsenkappe (110) eine Öffnung umfasst, die angepasst ist, um die Luftkappe (90) abnehmbar aufzunehmen.

4. Düse zum elektrostatischen Aufladen eines Sprays gemäß Anspruch 3, die ferner Folgendes beinhaltet: ein im Wesentlichen nicht leitendes Scheibenelement (200), das zwischen der Düsenkappe (110) und der Luftkappe (90) positioniert ist, wobei das im Wesentlichen nicht leitende Element ein Strahlauslassloch (210) umfasst.

5. Düse zum elektrostatischen Aufladen eines Sprays gemäß Anspruch 4, wobei ein Durchmesser des Strahlauslasslochs (210) größer als ein Durchmesser des Auslasses der Luftkappe (90) ist.

6. Düse zum elektrostatischen Aufladen eines Sprays gemäß Anspruch 3, wobei die Luftkappe (90) aus einem im Wesentlichen nicht leitenden Material gebildet ist.

7. Düse zum elektrostatischen Aufladen eines Sprays gemäß Anspruch 4, wobei die Luftkappe (90) aus einem im Wesentlichen leitenden Material gebildet ist und eine Elektrode beinhaltet, die angepasst ist, um in der Flüssigkeit eine elektrostatische Ladung zu induzieren.

8. Düse zum elektrostatischen Aufladen eines Sprays gemäß Anspruch 3, wobei die Luftkappe (90) angepasst ist, um innerhalb eines Ringhohlraums (190) des Düsenkörpers (60) befestigt zu werden, und ferner Folgendes beinhaltet:

einen Elektrodenschütz, der innerhalb des Ringhohlraums (190) zurückgesetzt ist,
wobei der Elektrodenschütz einen Kontaktfleck (180) aufweist, der angepasst ist,
um mit einer ersten Oberfläche der Luftkappe (90) einen elektrischen Kontakt herzustellen.

9. Düse zum elektrostatischen Aufladen eines Sprays gemäß Anspruch 8, wobei der Kontaktfleck (180) einen gefederten Kontaktfleck (180) beinhaltet.

10. Düse zum elektrostatischen Aufladen eines Sprays gemäß Anspruch 1, wobei der Düsenkörper (60) einen mit der ersten Bohrung (70) verkoppelten Lufteinlass umfasst.

11. Düse zum elektrostatischen Aufladen eines Sprays gemäß Anspruch 1, wobei die Düsenkappe (110) eine halbkugelförmige Düsenkappe (110) beinhaltet.

12. Düse zum elektrostatischen Aufladen eines Sprays gemäß Anspruch 1, wobei die Fluidspitze eine doppelte Fluidspitze beinhaltet.

13. Düse zum elektrostatischen Aufladen eines Sprays gemäß Anspruch 1, wobei die Fluidspitze zur Abnahme von der ersten Seite des Düsenkörpers (60) angepasst ist.

14. Düse zum elektrostatischen Aufladen eines Sprays gemäß Anspruch 1, wobei die Fluidspitze zur Abnahme von der zweiten Seite des Düsenkörpers (60) angepasst ist.

15. Düse zum elektrostatischen Aufladen eines Sprays gemäß Anspruch 1, wobei die erste Bohrung (70) eine mittlere Luftkanalbohrung beinhaltet und die Fluidspitze angepasst ist, um in der mittleren Luftkanalbohrung des Düsenkörpers (60) positioniert und zu ihr konzentrisch gehalten zu werden, und wobei die Fluidspitze ferner mindestens einen Luftkanal entlang einer Länge der Fluidspitze umfasst, wobei der mindestens eine Luftkanal angepasst ist, um zu ermöglichen, dass Luft innerhalb der mittleren Luftkanalbohrung entlang der Länge der Fluidspitze strömt.

16. Düse zum elektrostatischen Aufladen eines Sprays gemäß Anspruch 1, wobei der Einstellungsmechanismus 50 angepasst ist, um den longitudinalen Abstand zwischen dem Flüssigkeitsauslass der Fluidspitze und dem Auslass der Düsenkappe (110) innerhalb eines vorgegebenen Bereichs einzustellen.

17. Düse zum elektrostatischen Aufladen eines Sprays gemäß Anspruch 1, wobei der Einstellungsmechanismus 50 angepasst ist, um den longitudinalen Abstand zwischen dem Flüssigkeitsauslass der Fluidspitze und dem Auslass der Düsenkappe (110) schrittweise einzustellen.

18. Ein Düsensystem zum elektrostatischen Aufladen eines Sprays, das Folgendes beinhaltet:

- eine Düse zum elektrostatischen Aufladen eines Sprays gemäß Anspruch 1 und
- eine elektrisch isolierende Platte (360);

wobei die Düse zum elektrostatischen Aufladen eines Sprays angepasst ist, um an der elektrisch isolierenden Platte (360), die zwischen dem Düsenkörper (60) und der Düsenkappe (110) positioniert ist, befestigt zu werden.

19. Düsensystem zum elektrostatischen Aufladen eines Sprays gemäß Anspruch 18, wobei die elektrisch isolierende Platte (360) eine Düsenbefestigungsoberfläche einer Düsentrommel (410) beinhaltet.

20. Düsensystem zum elektrostatischen Aufladen eines Sprays gemäß Anspruch 19, wobei die Düsentrommel (410) zur oszillierenden Bewegung um eine Schwenkachse angepasst ist.

21. Ein Düsensystem zum elektrostatischen Aufladen eines Sprays, das Folgendes beinhaltet:

- eine Düse zum elektrostatischen Aufladen eines Sprays gemäß Anspruch 1 und
- eine elektrisch isolierende Platte (360);

wobei der Düsenkörper (60) schwenkbar an der elektrisch isolierenden Platte (360) befestigt ist.

Revendications

1. Une buse de chargement de pulvérisation électrostatique comprenant :

un capuchon de buse (110) présentant une sortie ;

un corps de buse (60) présentant un premier alésage (70) ;
un assemblage de bout pour fluide (10) s'étendant au moins en partie à travers le premier alésage (70), et présentant une entrée de liquide adaptée pour être raccordée à une source de liquide, et une sortie de liquide adaptée pour distribuer le liquide par la sortie du corps de buse (60) ; et
un mécanisme de réglage 50 pouvant fonctionner pour déplacer l'assemblage de bout pour fluide (10) au sein du premier alésage (70) de façon à régler une distance longitudinale entre la sortie de liquide de l'assemblage de bout pour fluide (10) et la sortie du capuchon de buse (110) ;
où l'assemblage de bout pour fluide (10) comprend :

un raccord d'entrée de liquide (30) présentant une première extrémité adaptée pour être couplée à un deuxième côté du corps de buse (60), et une deuxième extrémité adaptée pour être raccordée à la source de liquide ; et
un bout pour fluide présentant une entrée de bout pour liquide adaptée pour être couplée à la première extrémité du raccord d'entrée de liquide (30), et une sortie de bout pour liquide adaptée pour distribuer le liquide par la sortie du capuchon de buse (110) ;
caractérisée en ce que :

la première extrémité du raccord d'entrée de liquide (30) comporte des filets de réglage (50) couplant la première extrémité du raccord d'entrée de liquide (30) au deuxième côté du corps de buse (60), et
les filets de réglage (50) sont adaptés pour régler la distance longitudinale entre la sortie de liquide du bout pour fluide et la sortie du capuchon de buse (110) en faisant tourner le raccord d'entrée de liquide (30).

2. La buse de chargement de pulvérisation électrostatique de la revendication 1 où le corps de buse (60) comporte un premier côté adapté pour être couplé au capuchon de buse (110), et où le capuchon de buse (110) est adapté pour être découplé de façon amovible du premier côté de buse du corps de buse (60).

3. La buse de chargement de pulvérisation électrostatique selon la revendication 1 ou la revendication 2 comprenant en outre :

un capuchon d'air (90) présentant un deuxième alésage aligné avec le premier alésage (70), et positionné entre le capuchon de buse et le corps de buse (60) de façon à ce que la sortie de liquide soit reçue au sein du deuxième alésage ; et
où le capuchon de buse (110) comporte une ouverture adaptée pour recevoir de façon amovible le capuchon d'air (90).

4. La buse de chargement de pulvérisation électrostatique de la revendication 3, comprenant en outre :
un élément en disque substantiellement non conducteur (200) positionné entre le capuchon de buse (110) et le capuchon d'air (90), l'élément substantiellement non conducteur comportant un trou de sortie de jet (210).

5. La buse de chargement de pulvérisation électrostatique de la revendication 4, où un diamètre du trou de sortie de jet (210) est plus grand qu'un diamètre de la sortie du capuchon d'air (90).

6. La buse de chargement de pulvérisation électrostatique de la revendication 3, où le capuchon d'air (90) est formé en un matériau substantiellement non conducteur.

7. La buse de chargement de pulvérisation électrostatique de la revendication 4, où le capuchon d'air (90) est formé en un matériau substantiellement conducteur, et comprend une électrode adaptée pour provoquer une charge électrostatique dans le liquide.

8. La buse de chargement de pulvérisation électrostatique de la revendication 3, où le capuchon d'air (90) est adapté pour être monté au sein d'une cavité en anneau (190) du corps de buse (60), et comprenant en outre :

un contacteur d'électrode situé en renfoncement au sein de la cavité en anneau (190), le contacteur d'électrode présentant un plot de contact (180) adapté pour faire contact électrique avec une première surface du capuchon d'air (90).

9. La buse de chargement de pulvérisation électrostatique de la revendication 8, où le plot de contact (180) comprend un plot de contact à ressort (180).

10. La buse de chargement de pulvérisation électrostatique de la revendication 1, où le corps de buse (60) comporte une entrée d'air couplée au premier alésage (70).

11. La buse de chargement de pulvérisation électrostatique de la revendication 1, où le capuchon de buse (110) comprend un capuchon de buse hémisphéri-

que (110).

12. La buse de chargement de pulvérisation électrostatique de la revendication 1, où le bout pour fluide comprend un bout pour fluide double.

13. La buse de chargement de pulvérisation électrostatique de la revendication 1, où le bout pour fluide est adapté pour être retiré du premier côté du corps de buse (60).

14. La buse de chargement de pulvérisation électrostatique de la revendication 1, où le bout pour fluide est adapté pour être retiré du deuxième côté du corps de buse (60).

15. La buse de chargement de pulvérisation électrostatique de la revendication 1, où le premier alésage (70) comprend un alésage de canal d'air central et le bout pour fluide est adapté pour être positionné dans l'alésage de canal d'air central, et être maintenu concentrique avec celui-ci, du corps de buse (60), et où le bout pour fluide comporte en outre au moins un canal d'air sur une longueur du bout pour fluide, le au moins un canal d'air étant adapté pour permettre à de l'air de s'écouler sur la longueur du bout pour fluide au sein de l'alésage de canal d'air central.

16. La buse de chargement de pulvérisation électrostatique de la revendication 1, où le mécanisme de réglage 50 est adapté pour régler la distance longitudinale entre la sortie de liquide du bout pour fluide et la sortie du capuchon de buse (110) au sein d'une gamme prédéterminée.

17. La buse de chargement de pulvérisation électrostatique de la revendication 1, où le mécanisme de réglage 50 est adapté pour régler par degrés la distance longitudinale entre la sortie de liquide du bout pour fluide et la sortie du capuchon de buse (110).

18. Un système de buse de chargement de pulvérisation électrostatique comprenant :

- une buse de chargement de pulvérisation électrostatique selon la revendication 1 ; et
- un panneau électro-isolant (360) ;

où la buse de chargement de pulvérisation électrostatique est adaptée pour être montée sur le panneau électro-isolant (360) positionné entre le corps de buse (60) et le capuchon de buse (110).

19. Le système de buse de chargement de pulvérisation électrostatique de la revendication 18, où le panneau électro-isolant (360) comprend une surface de montage de buse d'un tambour de buse (410).

20. Le système de buse de chargement de pulvérisation électrostatique de la revendication 19, où le tambour de buse (410) est adapté pour se déplacer en oscillant autour d'un axe pivot.

21. Un système de buse de chargement de pulvérisation électrostatique comprenant :

- une buse de chargement de pulvérisation électrostatique selon la revendication 1 ; et
- un panneau électro-isolant (360) ;

où le corps de buse (60) est monté de façon à pivoter sur le panneau électro-isolant (360).

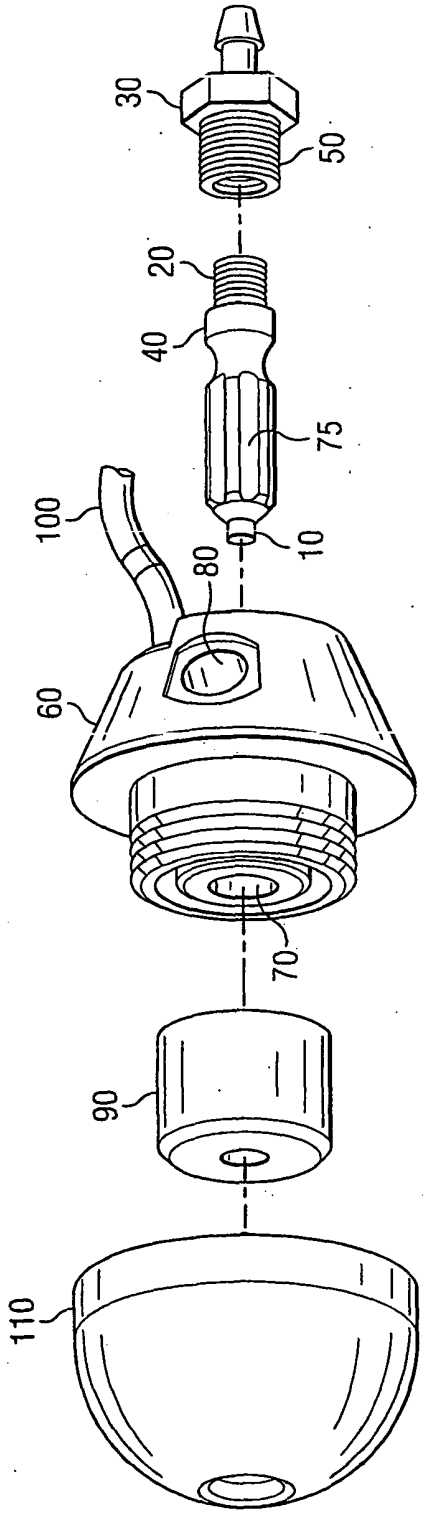


FIG. 1

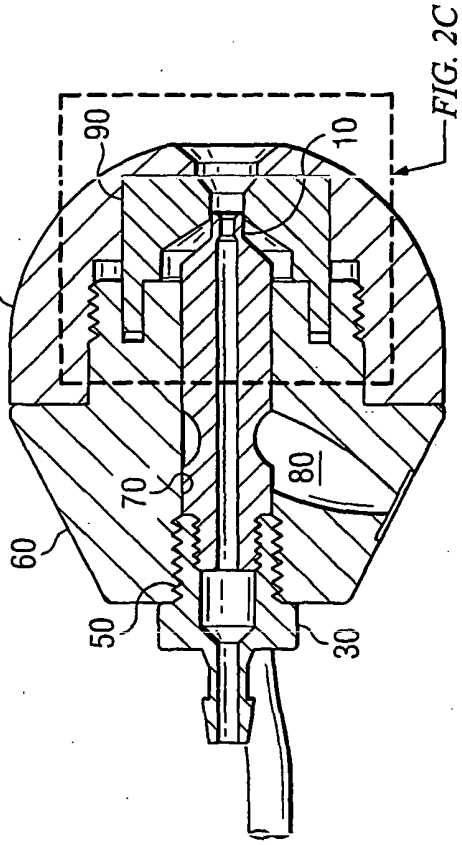


FIG. 2B

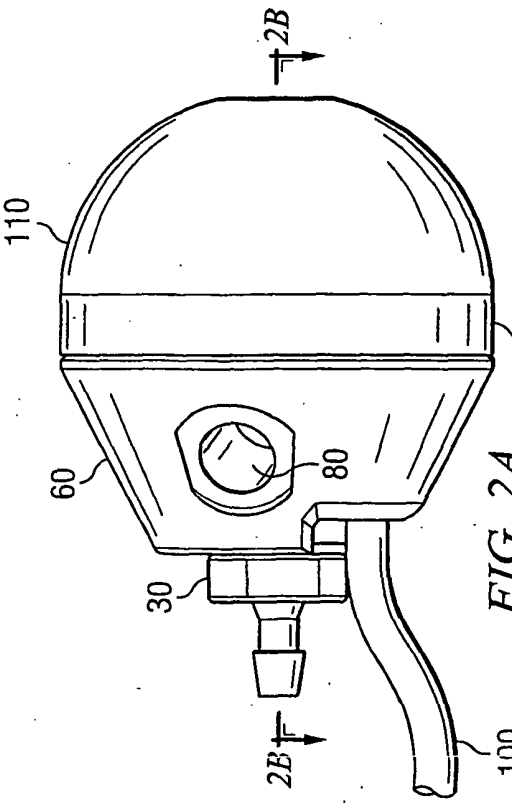


FIG. 2A

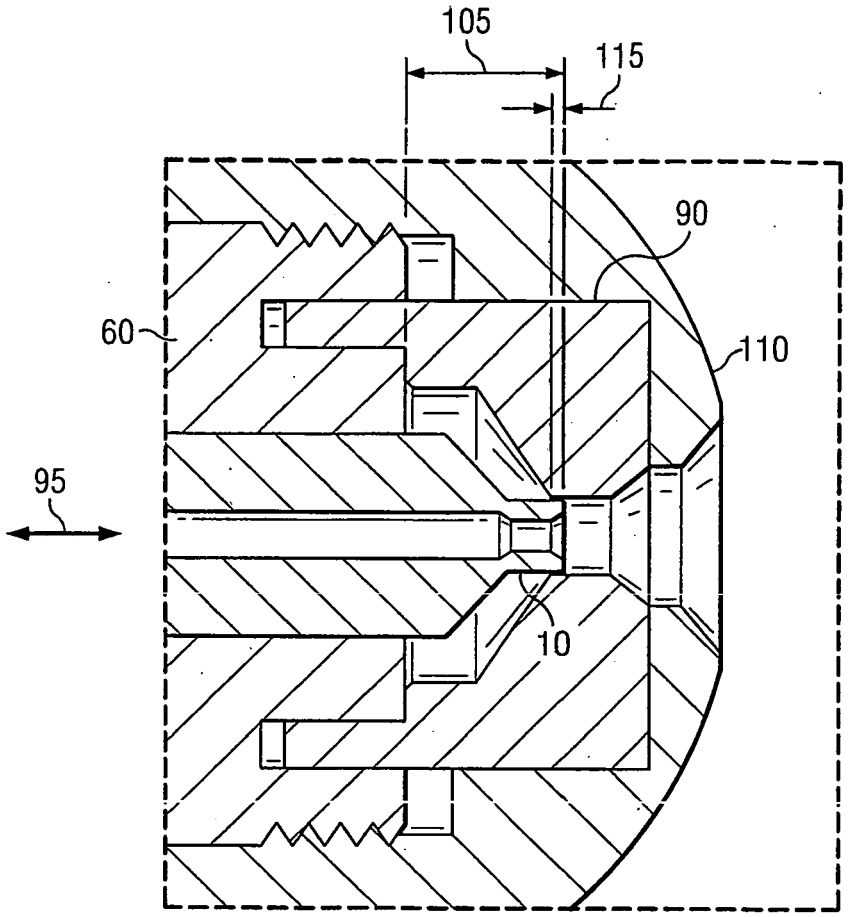


FIG. 2C

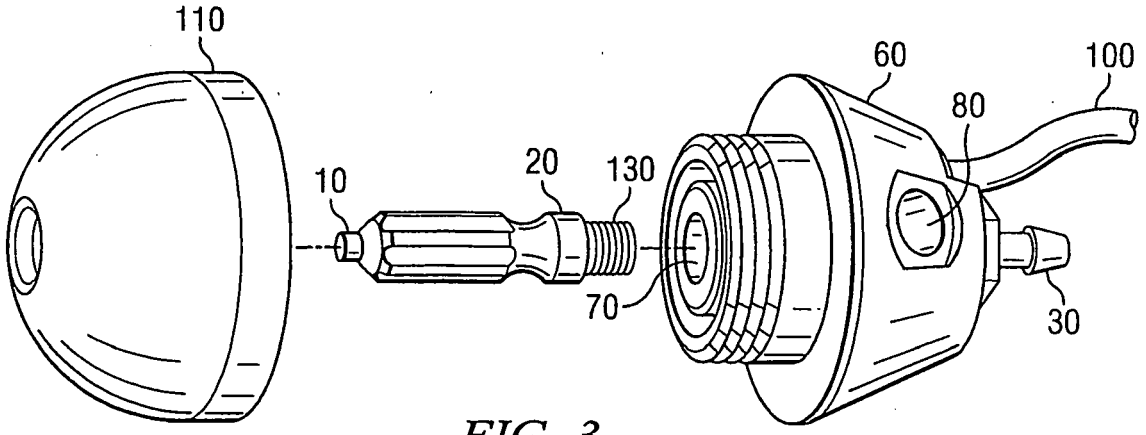


FIG. 3

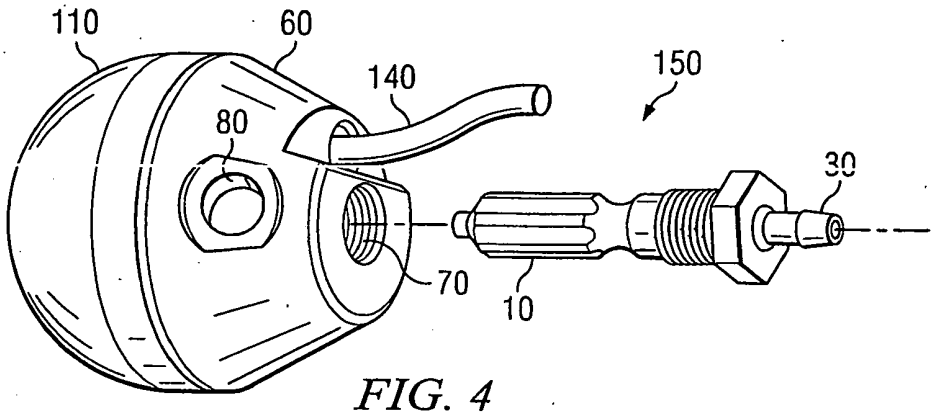


FIG. 4

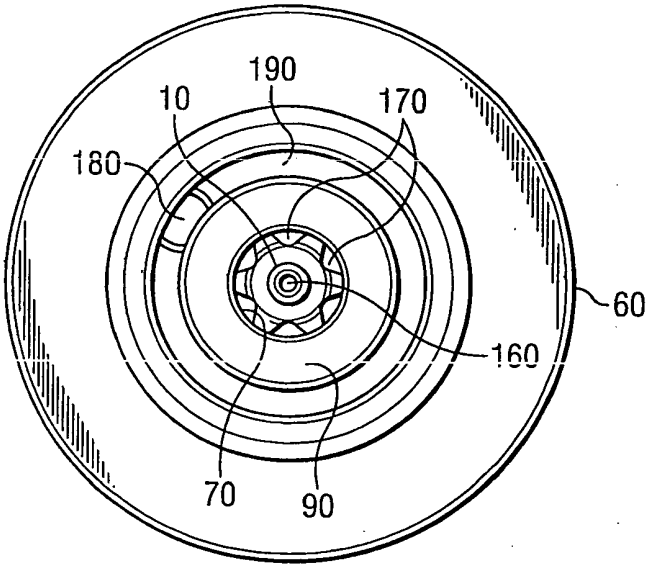


FIG. 5

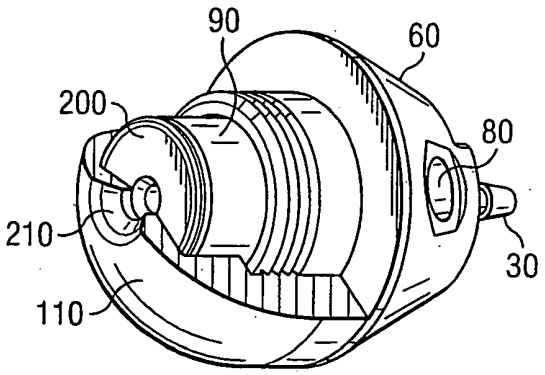


FIG. 6

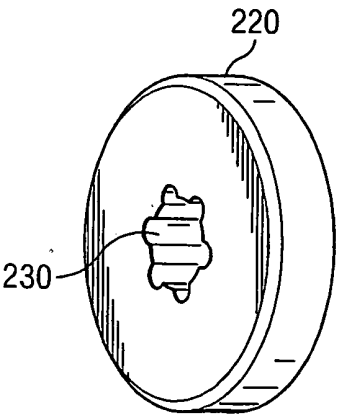


FIG. 7

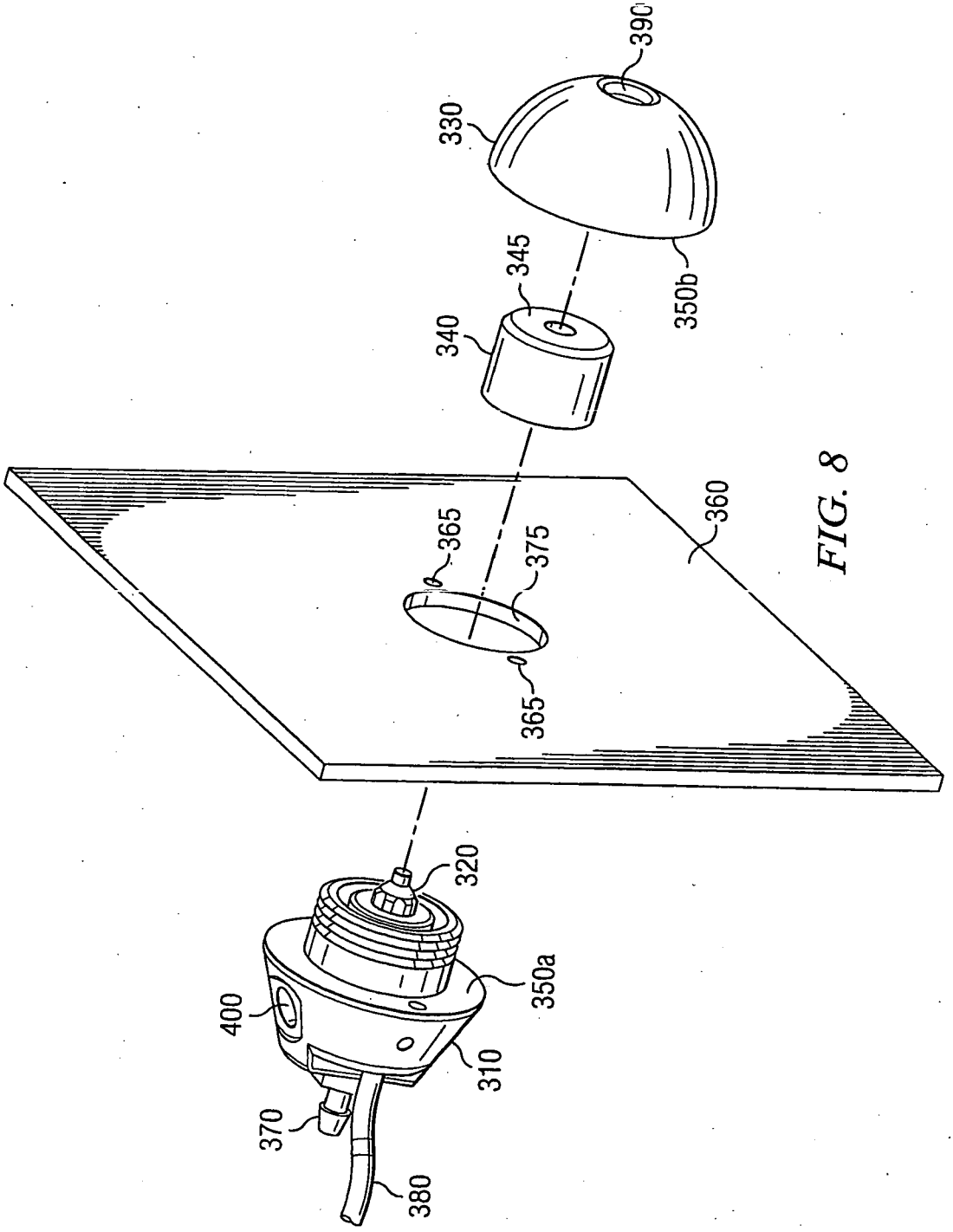


FIG. 8

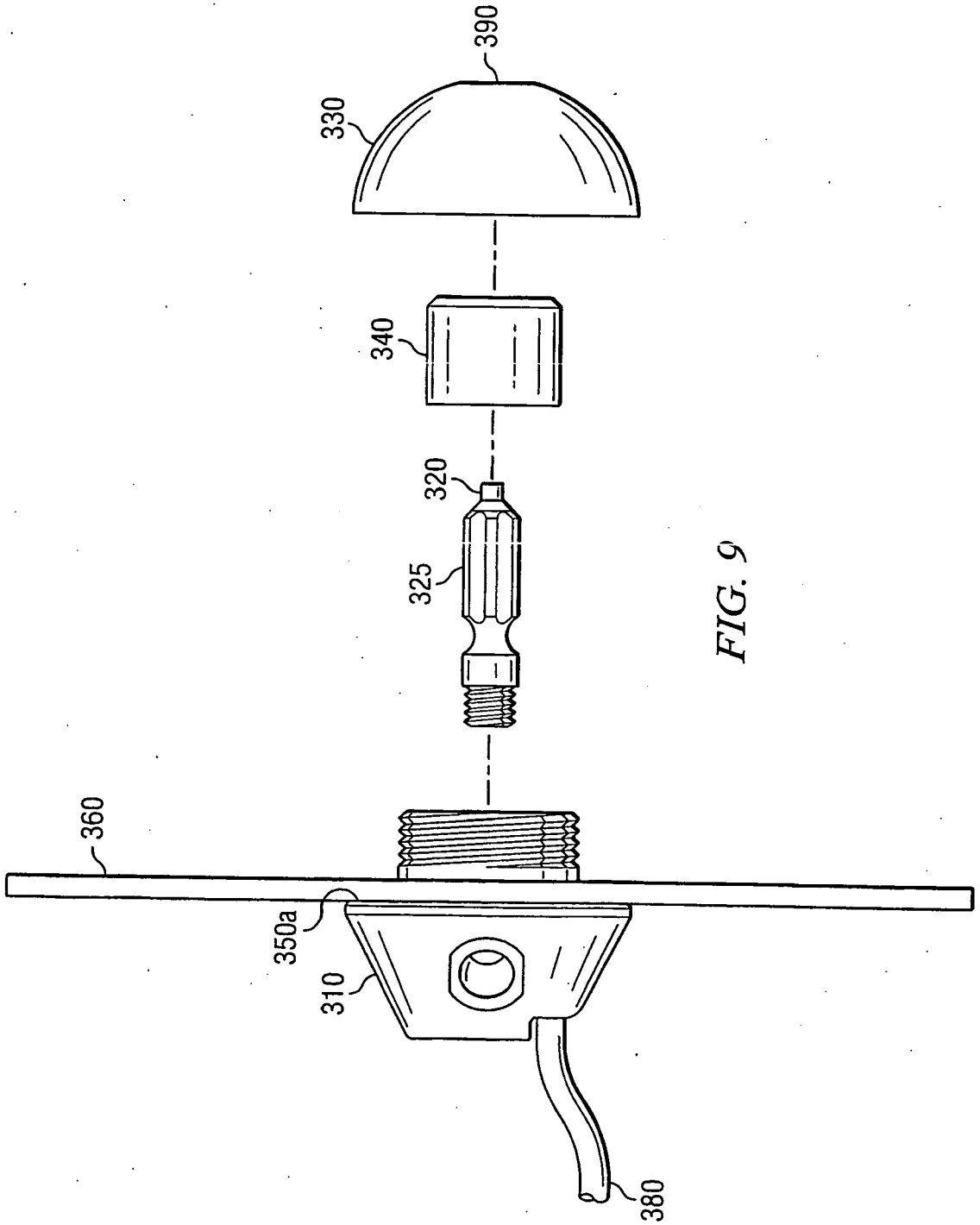


FIG. 9

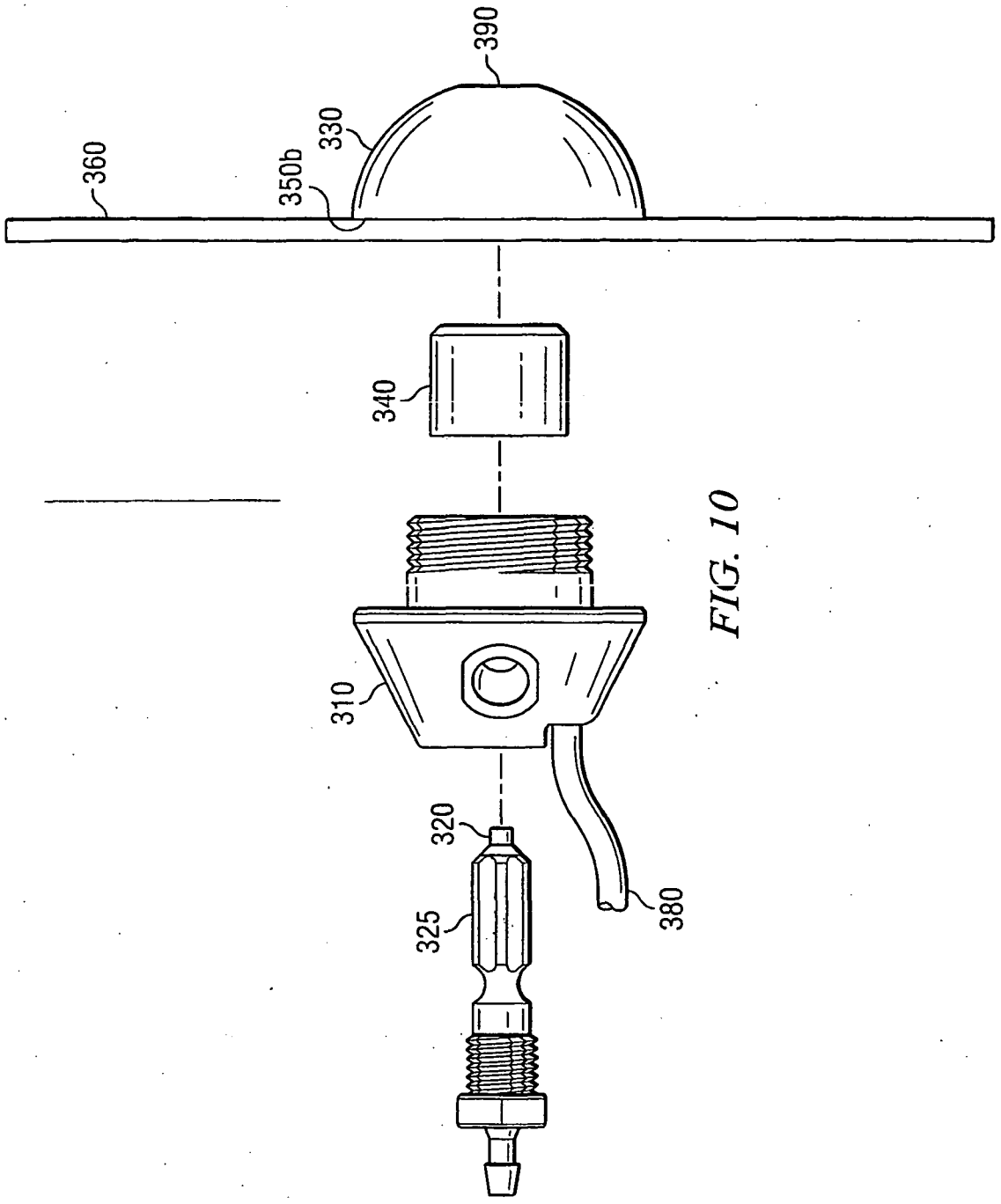


FIG. 10

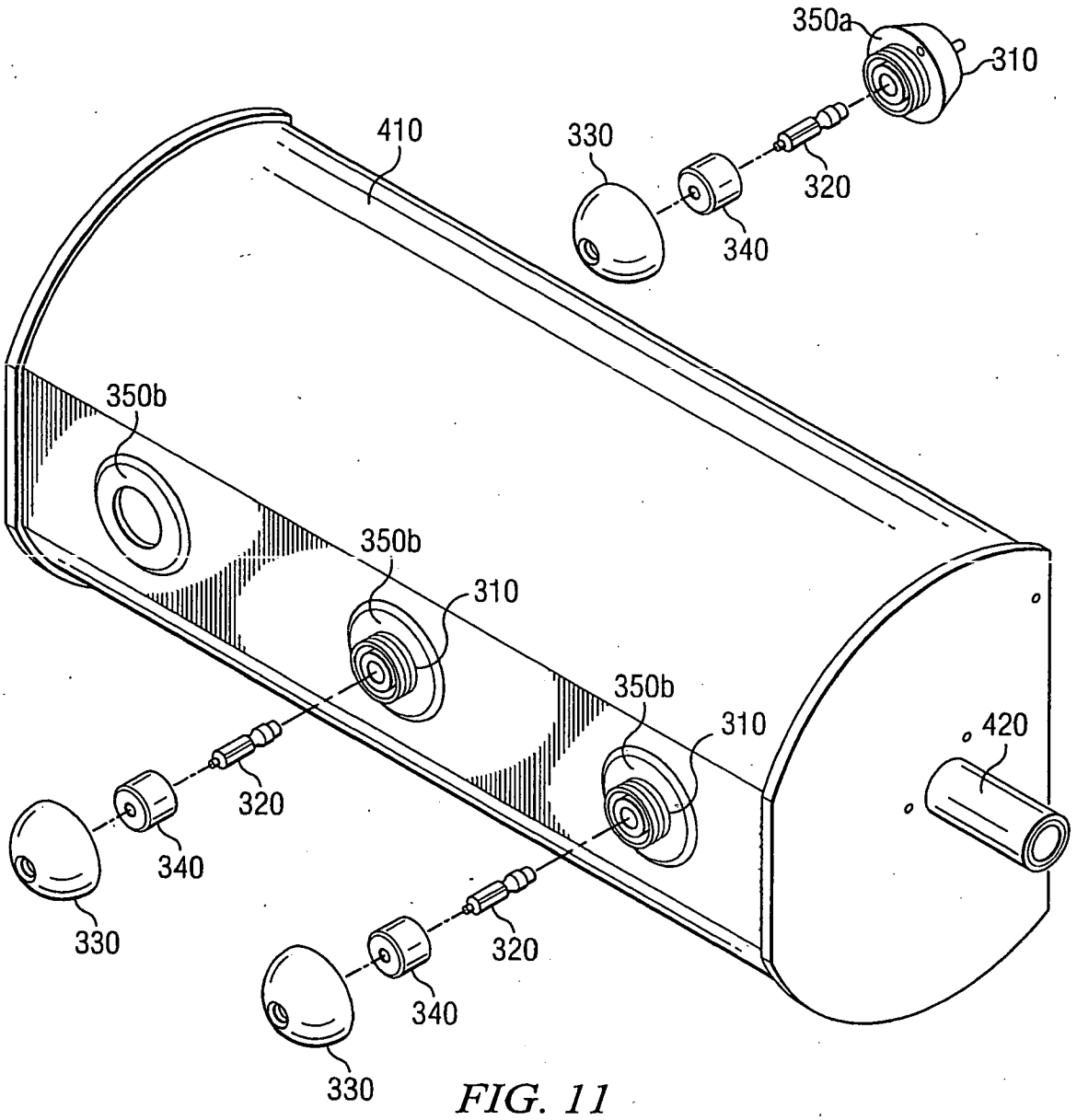

350a
310
410
330
320
340
350b
350b
310
350b
310
420
320
340
330
320
340
330

FIG. 11

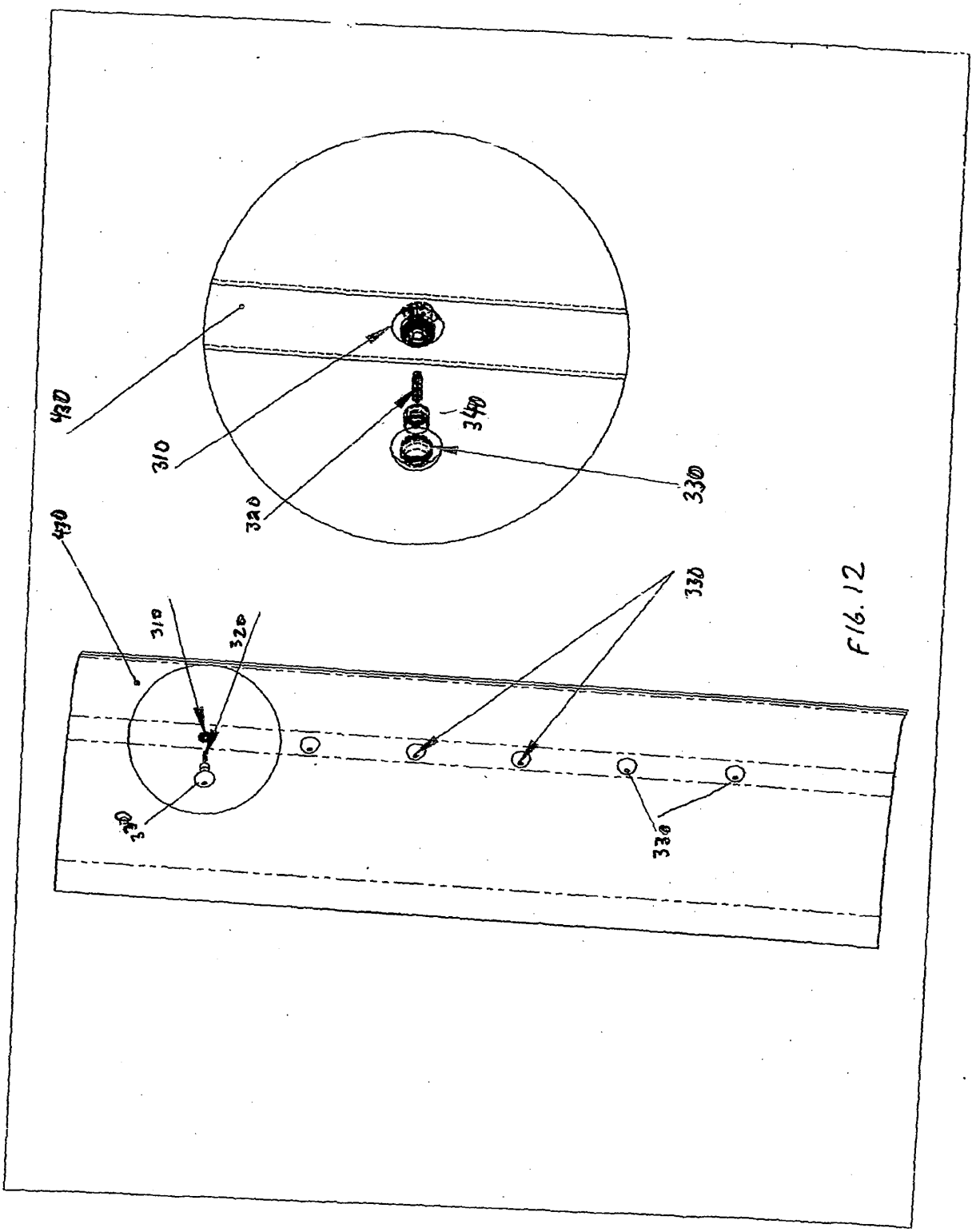


FIG. 12

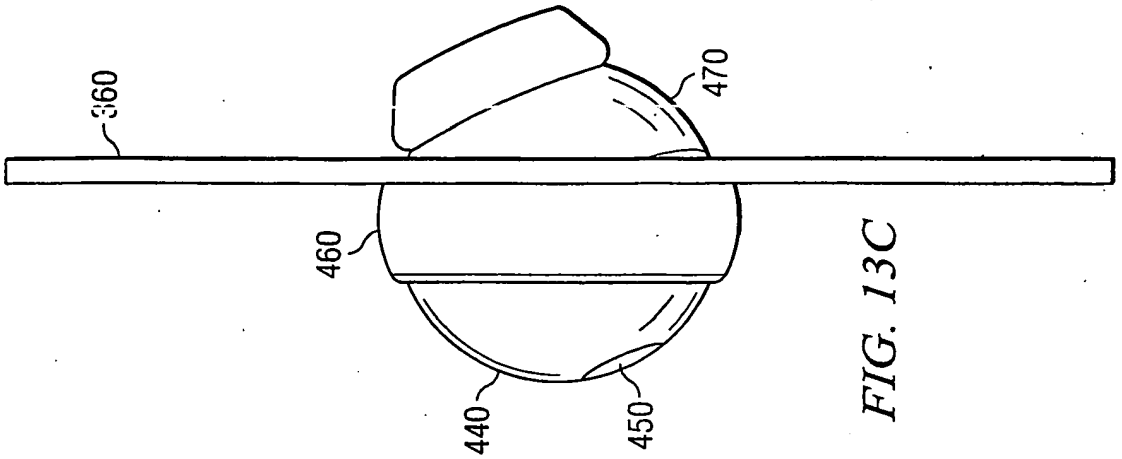


FIG. 13C

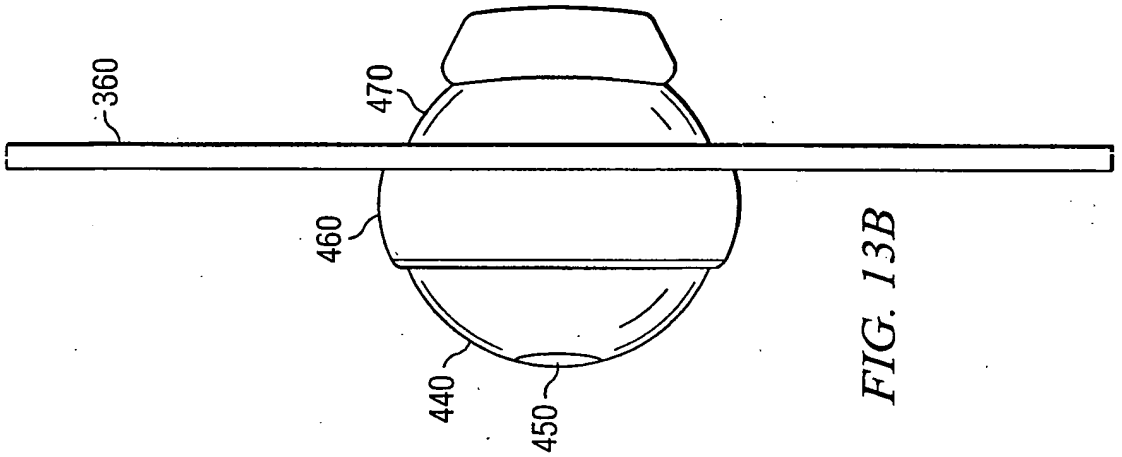


FIG. 13B

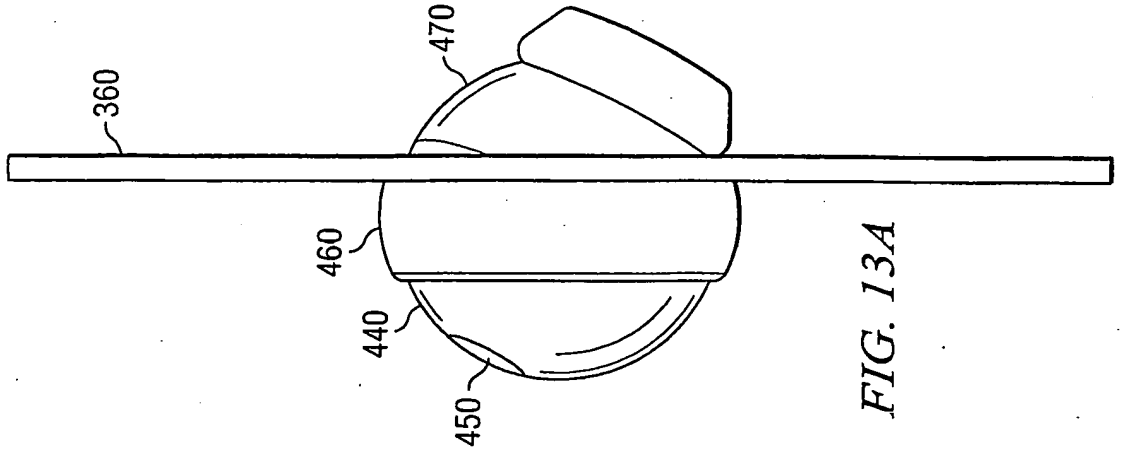


FIG. 13A

REFERENCES CITED IN THE DESCRIPTION

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