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W. J. COLEMAN ETAL

3,071,705

ELECTROSTATIC PROPULSION MEANS

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2 Sheets-Sheet 1

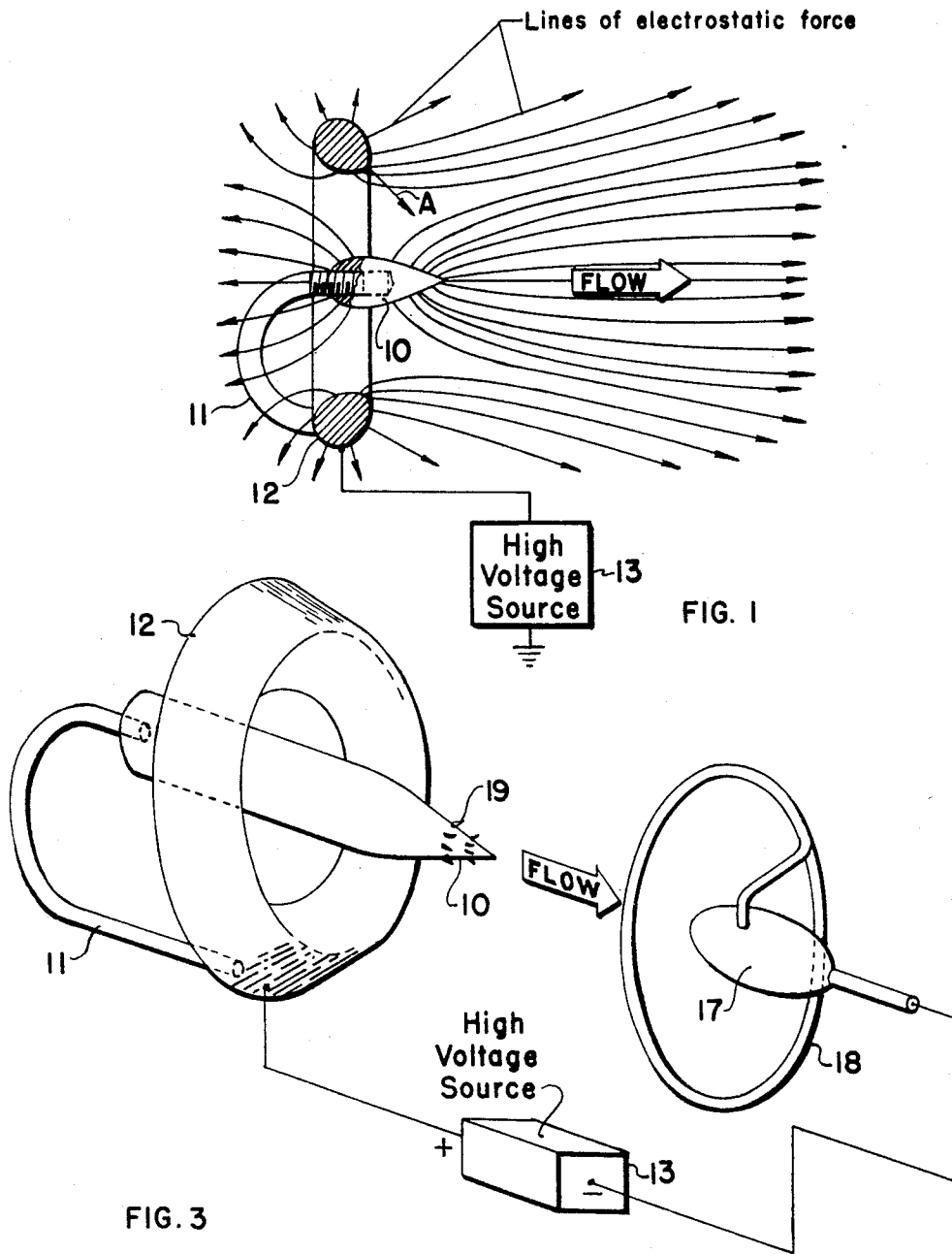


FIG. 1

FIG. 3

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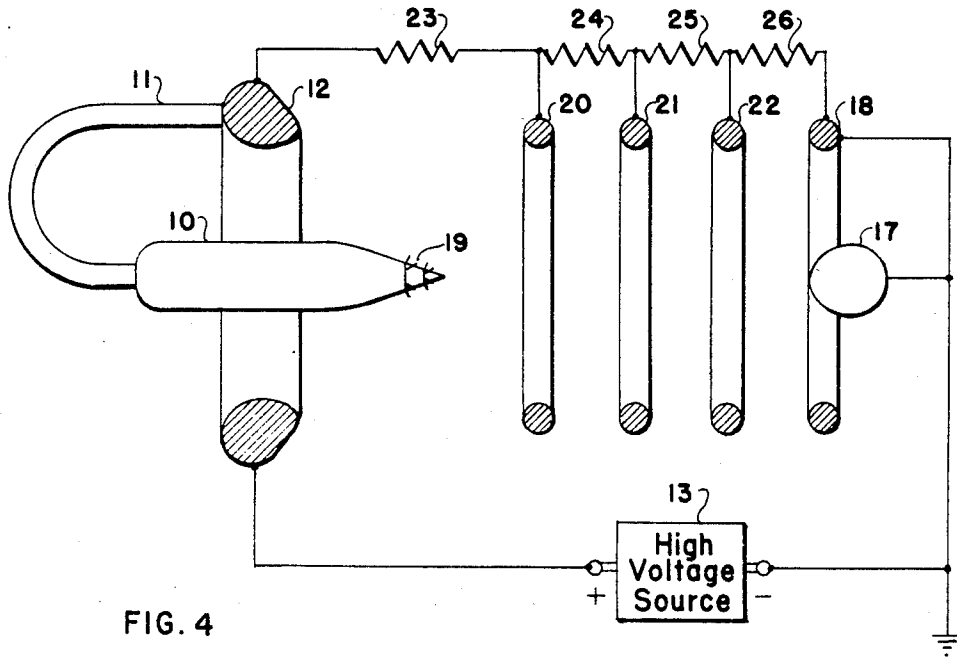


FIG. 4

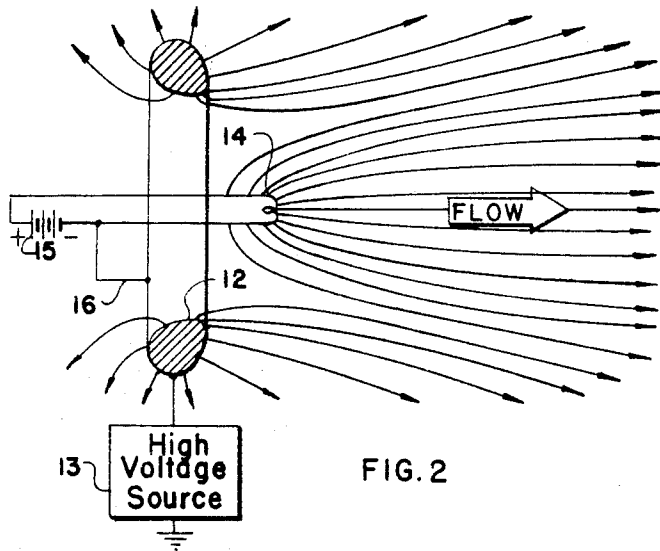


FIG. 2

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ELECTROSTATIC PROPULSION MEANS

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12 Claims. (Cl. 313-63)

This invention relates to electrostatic propulsion means, and more particularly to means for propelling air and other fluids by electrostatic forces acting upon such fluids and for propelling devices through air and other fluids by such forces.

It is well known that if an electrically-charged conducting surface has a relatively sharp point, a large part of the charge will concentrate in the neighborhood of the point, thus producing a high electrostatic stress in the air surrounding the point. Free electrons present in this region of air will be accelerated so strongly by the electrostatic force that by collision with neutral gas molecules they will strip or knock loose other electrons from those molecules. Thus, electron-positive ion pairs will be created and the cumulative collision process known as corona will result. Further, if the pointed conductor is positively charged, the positive ions present in the corona discharge will move away from the point because of mutual electrostatic repulsion, while the negative electrons will be attracted to the conductor. Neutral molecules will be struck by the repelled positive ions and momentum will be transferred from the ions to the air mass in the vicinity of the point, thereby generating a flow of air. This flow of air, or so-called "electric wind," will be in directions radially outward from the point of the positively charged conductor and therefore of little or no use as propulsion means. In order to provide a useful and efficient device, the flow of air must be concentrated in one direction.

Accordingly, it is the primary object of this invention to provide in the vicinity of the ionization point of a corona discharge device of other ionization means, an electrostatic field whose lines of force are concentrated along a desired flow axis originating at the ionization point whereby practically all of the ions produced, along with entrained neutral molecules, will flow in the desired direction. Further thereto, it is an object to provide in the vicinity of such ionization means, a conducting surface electrically energized and so shaped in cross-section as to produce an electrostatic field in the desired direction.

It is a further object to provide means downstream of the ionization point to further restrict the electrostatic field to a downstream direction. Further thereto, it is an object to provide a conducting surface or surfaces a variable distance downstream of the ionization point to establish an end point for the lines of force emanating from the electrically energized conducting surface and ionization point, thereby preventing the electrostatic field from diverging while allowing substantially unimpeded airflow.

It is a still further object to provide downstream of the ionization point, electrostatic field or fields having lines of force substantially parallel and in the downstream direction to confine the airflow in the desired downstream direction.

Other objects of the invention, as well as the advantages thereof will become apparent from the following description when read in conjunction with the accompanying drawings in which:

FIG. 1 is a cross-sectional view schematically illustrating one embodiment of the invention;

FIG. 2 is a cross-sectional view schematically illustrating another embodiment of the invention;

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FIG. 3 is a perspective view of still another embodiment; and

FIG. 4 is a cross-sectional view of the device of FIG. 3 provided with additional means for preventing the electrostatic field from diverging.

As shown in FIG. 1, the device of the present invention comprises an ionization head 10 threadedly mounted for longitudinal adjustment upon one end of a C-shaped bracket or connector 11, which in turn is fixedly attached to a toroid 12 whose axis coincides with that of the head 10. A suitable high voltage D.C. source 13 has one terminal connected to the toroid 12 and another terminal connected to ground.

It is characteristic of electrostatic lines of force that they concentrate in those places on the surface of a conductor where the radius of curvature is the least; that they are normal to the surface from which they emanate; and that such lines of force do not cross one another, but when influenced by such lines emanating from another body, will cause one another to bend and thereby change direction. With this in mind, it will be noted that the cross-section of the toroid 12 is such that the lines of force emanating therefrom upon the application of a positive charge from the voltage source 13 would be concentrated in the direction of the arrow A. However, because such lines of force and those emanating from the ionization head 10 will not cross one another, the lines of force emanating from the toroid are bent outwardly while the lines of force emanating from the ionization head 10 are bent inwardly or compressed to thereby take a desired downstream direction as shown by the arrows on the ends thereof. Since the positive ions in the vicinity of the positively charged ionization head 10 are repelled from the head and travel along the lines of force, and since momentum will be transferred from the ions to the air mass, a flow of air is generated in the direction of the "flow" arrow. The air, as it moves to the right, is replenished by an inflow of air through the toroid, thereby ensuring continuous operation of the device.

As previously indicated, the head 10 is mounted for longitudinal adjustment. Thus the head may be positioned with respect to the toroid 12 to vary the resulting airflow and to permit the optimum placement thereof to obtain the greatest airflow possible under different operating conditions.

As shown in FIG. 2, means for ionizing the air comprise a heating element 14 positioned on the axis of the toroid 12 and supplied with an electric current from a source 15. The high voltage D.C. source 13 is connected to the toroid 12, which in turn is connected by means of a conductor 16 to the negative side of the source 15. The operation of the device shown in FIG. 2 is similar to that of the FIG. 1 device and further explanation is therefore deemed unnecessary.

Referring now to FIG. 3, there is shown a device which utilizes an ionization head 10 and toroid 12 similar to those shown in FIG. 1, and provided with means downstream thereof to establish an end point for the lines of force emanating from the ionization head and the toroid. Such means comprise a streamline-shaped metal target 17 connected to and supporting a metal ring 18. As shown, the positive terminal of the high voltage source 13 is connected to the toroid 12, while the negative terminal thereof is connected to the target 17. The target 17 and ring 18 connected thereto thereby become sources of electrons which neutralize all of the ions striking the surfaces of the target and ring. Since substantially all of the ions repelled by the head 10 will strike either the target 17 or the ring 18, a closed circuit is thereby established which permits operation of the device with no appreciable net accumulation of charge.

The ionization head 10 is mounted upon the connector

11 for longitudinal adjustment as in FIG. 1, and is provided with a plurality of needle points 19 which are symmetrically spaced in rows around the head and which are given a positive charge from the source 13 so as to secure positive ion flow. The longitudinal adjustment of the ionization head permits the optimum placement of the head with respect to the toroid, as indicated hereinabove with reference to FIG. 1, while additional control means may comprise provision for varying the distance between the toroid and the downstream metal ring and target.

In the arrangement shown in FIG. 4, a series of metal rings 20-22, each charged to a D.C. potential, are positioned between the toroid 12 and the downstream ring 18. As shown, the rings 20-22 are connected through resistors 23-26 to each other and to the toroid 12 and the ring 18. The resistors are preferably so selected to provide a linear potential gradient between the toroid 12 and the grounded ring 18 whereby a constant strength electrostatic field between the toroid 12 and the ring 18 is obtained. The advantage in so selecting the resistors and thus obtaining such electrostatic field is that the repelled ions will fall through equal potential increments between collisions with molecules, regardless of their downstream position, and each ion will therefore gain equal increments of kinetic energy between collisions. Thus, the energy transfer from the ions to neutral molecules will be evenly spread over the entire volume between the ionization point and the ring 18 and target 17. A further and possibly greater advantage is that a constant strength electrostatic field consists of parallel electrostatic lines of force in the downstream direction, thereby providing further means for maintaining the ion flow in the desired downstream direction.

From the foregoing, it will be apparent that the invention provides highly effective apparatus for propelling fluid mediums such as air. By the ionization of molecules and the concentrating of electrostatic lines of force along and in the direction of a desired flow axis, the ions so produced are caused to move in the desired direction. Momentum is transferred from the moving ions to the fluid mass, thus creating the desired fluid flow.

Although shown and described in what is believed to be the most practical and preferred embodiments, it is apparent that departures therefrom will suggest themselves to those skilled in the art and may be made without departing from the spirit and scope of the invention. We therefore do not wish to restrict ourselves to the particular forms of construction illustrated and described, but desire to avail ourselves of all modifications that may fall within the scope of the appended claims.

Having thus described our invention, what we claim is:

1. An electrostatic propulsion device comprising means for ionizing a fluid, an electrically energized conducting surface positioned relative to said ionizing means and adapted to produce an electrostatic field whose lines of force concentrate along an axis substantially passing through said ionizing means, those lines of force emanating from said ionizing means, a plurality of conducting surfaces spaced from each other and downstream from said electrically energized conducting surface, a connector between said electrically energized conducting surface and that conducting surface of said plurality of conducting surfaces nearest thereto, connectors between adjacent conducting surfaces of said plurality of conducting surfaces, and a connection to ground from that conducting surface of said plurality of conducting surfaces most remote from said electrically energized conducting surface, said connectors including means to provide a linear potential gradient between said electrically energized conducting surface and said grounded conducting surface.

2. A device as set forth in claim 1 wherein said electrically energized conducting surface is a toroid having its axis coincident with that of said ionizing means.

3. A device as set forth in claim 1 wherein said plural-

ity of conducting surfaces comprise metal rings whose axes are coincident with that of said ionizing means.

4. An electrostatic propulsion device comprising means for ionizing a fluid in the vicinity of a point, a toroid upstream of said point and surrounding said means and having its axis coincident with that of said means, means for electrically energizing said toroid, said toroid being adapted to produce upon energization an electrostatic field whose lines of force concentrate about said axis and in the downstream direction thereof, those lines of force emanating from said ionizing means, a plurality of metal rings spaced from each other and downstream from said toroid and having their axes coincident with the axis of said toroid, a connector between said toroid and the ring nearest thereto, connectors between adjacent rings, and a connection to ground from that ring most remote from said toroid, said connectors including means to provide a linear potential gradient between said toroid and said grounded ring.

5. A device as set forth in claim 4 and including a grounded conducting surface positioned on the axis of and in the plane of the ring most remote from said toroid.

6. An electrostatic propulsion device comprising means for ionizing a fluid in the vicinity of a point, and conducting surface upstream of said point, a source of electric potential connected to said conducting surface, said conducting surface being adapted to produce an electrostatic field whose lines of force concentrate along an axis substantially passing through said ionizing means, those lines of force emanating from said ionizing means, target means spaced downstream from said conducting surface to establish an end point for said electrostatic lines of force, and means connecting said target means to the negative side of said source of electric potential.

7. An electrostatic propulsion device comprising means for ionizing a fluid in the vicinity of a point, a toroid upstream of said point and surrounding said means and having its axis coincident with that of said means, a source of electric potential connected to said toroid, said toroid being adapted to produce upon energization an electrostatic field whose lines of force concentrate about said axis and in the direction thereof those lines of force emanating from said ionizing means, target means spaced downstream from said toroid to establish an end point for said electrostatic lines of force, and means connecting said target means to the negative side of said source of electric potential.

8. An electrostatic propulsion device comprising means for ionizing a fluid in the vicinity of a point, a toroid upstream of said point and surrounding said means and having its axis coincident with that of said means, means for electrically energizing said toroid, said toroid producing upon energization an electrostatic field whose lines of force concentrate about said axis and in the direction thereof those lines of force emanating from said ionizing means, a plurality of metal rings spaced from each other and downstream from said toroid and having their axes coincident with the axis of said toroid, a connector between said toroid and the ring nearest thereto, connectors between adjacent rings, and means connecting that ring most remote from said toroid to the negative terminal of said electrical energizing means, said connectors including means to provide a potential gradient between said toroid and that ring connected to said negative terminal.

9. An electrostatic propulsion device comprising means for ionizing a fluid in the vicinity of a point, a toroid upstream of said point and surrounding said means and having its axis coinciding with that of said means, means for electrically energizing said toroid, said toroid being adapted to produce upon energization an electrostatic field whose lines of force concentrate about said axis and in the downstream direction thereof those lines of force emanating from said ionizing means, a plurality of metal rings spaced from each other and downstream from said toroid

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and having their axes coincident with that of said toroid, a connector between said toroid and the ring nearest thereto, and connectors between adjacent rings, said connectors including means to provide a linear potential gradient between said toroid and the ring most remote therefrom.

10 10. An electrostatic propulsion device comprising means for ionizing a fluid in the vicinity of a point, means positioned relative to said ionizing means for creating an electrostatic field whose lines of force concentrate about an axis those lines of force emanating from said ionizing means, a plurality of conducting surfaces spaced one from another and downstream from said ionizing means and said electrostatic field creating means, connectors between adjacent conducting surfaces, and means for electrically energizing said conducting surfaces, said connectors including means to provide a linear potential gradient between said conducting surfaces.

15 11. An electrostatic propulsion device comprising means for ionizing a fluid in the vicinity of a point, means positioned relative to said ionizing means for creating an electrostatic field whose lines of force concentrate about an axis those lines of force emanating from said ionizing means, a plurality of rings spaced from each other and

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downstream from said ionizing means and said electrostatic field creating means and having their axes coincident with that of said ionizing means, connectors between adjacent rings, and means for electrically energizing said rings, said connectors including means to provide a linear potential gradient between said rings when energized by said energizing means.

12. A device as set forth in claim 9 wherein the ring most remote from said toroid is connected to ground.

References Cited in the file of this patent

UNITED STATES PATENTS

1,357,466	Moller -----	Nov. 2, 1920
2,264,495	Wilner -----	Dec. 2, 1941
2,460,175	Hergenrother -----	Jan. 25, 1949
2,636,664	Hertzler -----	April 28, 1953
2,658,009	Ransburg -----	Nov. 3, 1953
2,765,975	Lindenblad -----	Oct. 9, 1956
20 2,809,314	Herb -----	Oct. 8, 1957

FOREIGN PATENTS

262,829	Great Britain -----	Feb. 16, 1928
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