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ELECTROSTATIC PRECIPITATOR

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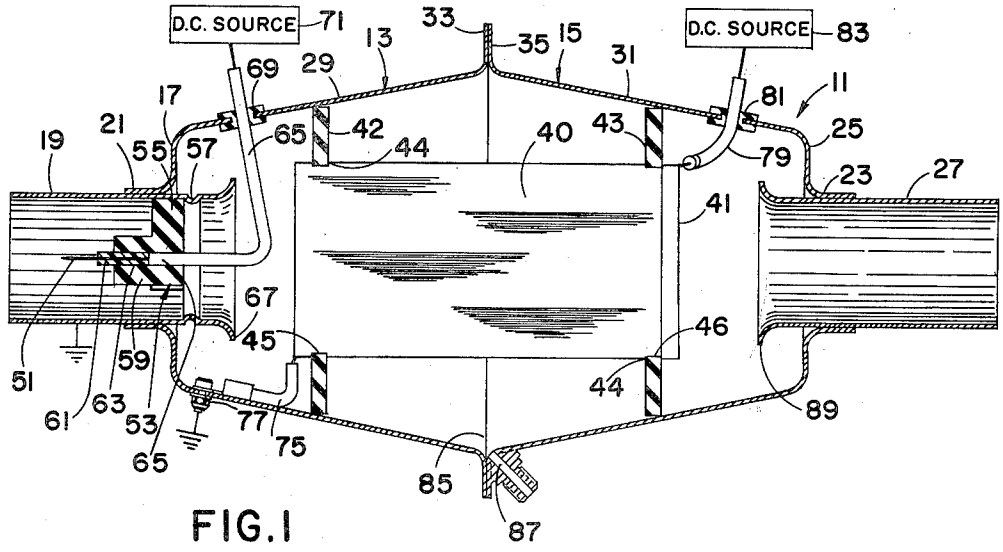


FIG. 1

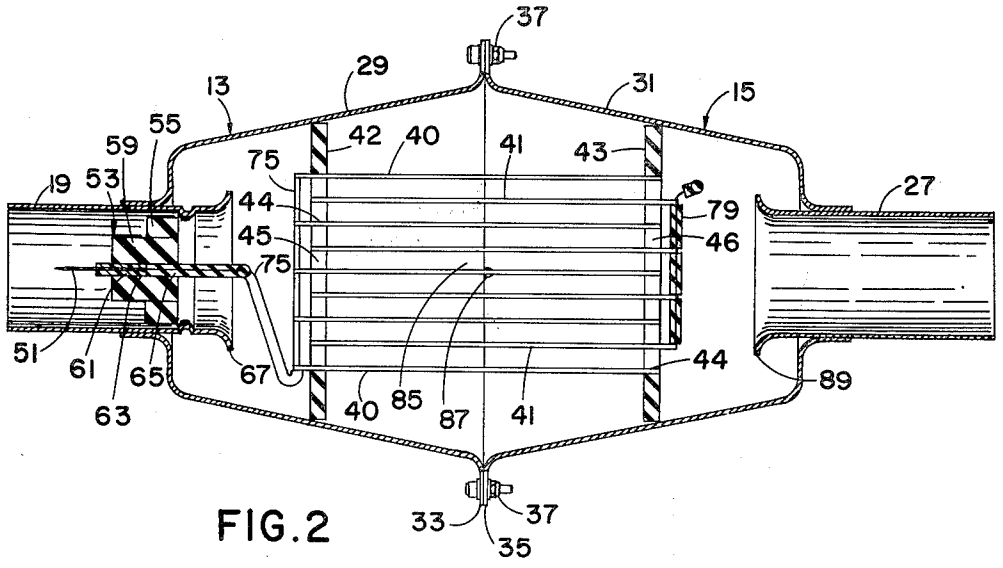


FIG. 2

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ELECTROSTATIC PRECIPITATOR

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This invention relates to electrostatic precipitators and more particularly concerns such precipitators which are adapted to separate oil particles from air.

An object of the present invention is to provide an improved electrostatic precipitator wherein the oil-bearing air is moved horizontally and the oil is precipitated and collected for recovery.

A further object is the provision of an electrostatic precipitator for oil-air separation which is compact and easily-fabricated due to an assembly of plates and support rings mounted in cup-like housing members.

Another object is to provide a horizontal-flow oil-air electrostatic precipitator wherein a stack of collector plates and a housing are so arranged that the entire flow of air with oil vapor passes through the passages between plates and the separated oil from the plates is centrally collected for removal.

An additional object is the provision of a horizontal-flow electrostatic precipitator in which an axially-centered ionizer in an inlet tube cooperates with vertically-arranged charged plates in a housing to separate and to collect oil vapor from air.

The realization of the above objects along with the features and advantages of the invention will be apparent from the following description and the accompanying drawing in which:

FIG. 1 is a cross-sectional side view of the embodiment of the invention and shows the axially-centered ionizing needle in the inlet tube, the horizontally-extending, vertically-arranged collector plates, and the oil outlet below the plates and

FIG. 2 is a partial cross-sectional top view including a showing of tops of the plates and shows the spacing of the collector plates, the transversely-centered oil outlet and the side parts of the insulating support rings for the plates.

Referring to FIGS. 1 and 2, the elongated housing 11 which is disposed on a horizontal axis includes two identical cup-like metal members 13 and 15 joined at their large ends to provide a collector chamber. The inlet member 13 at the left has an end wall 17 which has an inlet metal tube 19 received in an outwardly extending tubular projection 21. The outlet member also has a tubular projection 23 from its end wall 25 and a metal outlet tube 27 is mounted in tubular projection 23. The oppositely-oriented cup-like members 13 and 15 respectively have inclined conical side walls 29 and 31 which terminate centrally in flanged edges 33 and 35. A plurality of screws 37 connect the flanges 33 and 35 which are thus sealed in abutment. It is to be noted that inlet tube 19 and outlet tube 27 cooperate with passages within housing (to be described) to provide a continuous horizontal flow.

A previously-formed assembly of electrostatic metal plates 40 and 41 and two spacing and insulating plastic rings 42 and 43 is encased at each end by the two cup-like members 13 and 15. Plates 40 and 41 are alternately fitted and cemented into equi-spaced slots 44 formed in the top and bottom edges of the square openings 45 and 46 in the rings 42 and 43. Rings 42 and 43 extend radially inwardly from the intermediate parts of conical walls 29 and 31 to the inlet and outlet ends of plates 40 and 41. In FIG. 2, it is to be noted that the two side edges

of the openings 45 and 46 in rings 42 and 43 abut the sides of the two outer plates 41. Since the top and bottom parts of flat washer-like rings 42 and 43 block flow over the elongated plates 40 and 41 and since the side parts block flow around the sides of the plates, it is apparent that all of the flow through housing 11 passes through the passages between the plates 40 and 41. Rings 42 and 43 are respectively positioned with their circular edges against the inclined side walls 29 and 31 adjacent the midpoint thereof. The rings 42 and 43 space the plates away from the side walls 29 and 31 a greater distance than the spacing between plates. It is to be noted that, when the cup-like members 13 and 15 are connected and encase each end of the assembly, there will be a wedging action on the rings 42 and 43 so that the assembly of plates 40 and 41 and rings 42 and 43 are easily and firmly positioned.

For ionizing oil particles in the air flow entering the left end of inlet tube 19, a small pointed steel needle 51 is positioned on the center-line of tube 19 by means of a three-leg plastic spider 53. The three legs 55 are slidably received in inlet tube 19 and are positioned longitudinally by abutting the radially-inwardly projecting annular ridge or shoulder 57 formed in tube 19. In FIG. 2 the two thin inclined legs 55 are sectioned to indicate they are part of spider 53. The axially-positioned hub 59 of spider 53 has a tubular holder 61 mounted in the hub opening 63. Needle 51 is mounted in the heat-resistant, electrically-insulating ceramic holder 61 and is connected to the insulated wire 65 received in the inner part of axial hub opening 63. Wire 65 extends axially slightly beyond the flared discharge end 67 of inlet tube 19 and then extends upwardly through an insulating washer 69 in the inclined side wall 29 of the cup-like member 13. Wire 65 connects to a high voltage direct current source 71 (shown schematically) which provides a sixteen thousand volt supply so that oil particles in the air flowing by the needle 51 and grounded inlet tube 19 are positively charged. The flared discharge end 67 of the inlet tube 19 provides improved entry of flow into the passages between the plates 40 and 41.

In order that the plates 40 and 41 can be charged alternately negative and positive with maximum use of surfaces without arc-over, the five plates 40 to be grounded have their inlet ends extending or projecting beyond the inlet ring 42 while the four positive plates 41 have their outlet ends extending beyond the outlet ring 43 (see FIG. 2). With the alternate staggered relation of the equal-length plates, the respective opposite ends will be flush with the outer sides of the rings 42 and 43. Thus, the outlet ends of plates 40 will be flush with the outlet side of ring 43 and the inlet ends of plates 41 will be flush with the inlet side of ring 42. The five negative plates 40 are connected to ground by means of insulated wire 75 which is soldered to the bottom inlet corners of the negative plates 40. Wire 75 is grounded by the nut and bolt connection 77 through the side wall 29 in front of support ring 42 and under inlet tube 19. The four positive plates 41 are connected to wire 79 at the upper outlet corners by soldering. Since the inlet ends of positive plates 41 project beyond the adjacent ends of the negative plates a distance equal to the distance between plates, it is apparent that the diagonal distance from wire 79 to the negative plates 40 is sufficient to minimize arc-over. Wire 79 extends laterally in front of outlet tube 27 and through an insulating washer 81 in the top of side wall 31 of cup-like housing 15 and connects to a high voltage direct current source 83 (shown schematically) which provides a four thousand volt supply so that plates 41 are positively charged and grounded plates 40 are negatively charged.

With this arrangement, positively-charged oil particles are repelled by plates 41 and attracted to plates 40. Oil so deposited will drain rapidly from the vertically-arranged plates 40 and further, by gravity, will flow down the conical side walls 29 and 31 to the arcuate sump 85 formed at the bottom parts of the abutting ends of the cup-like members 13 and 15. The oil so collected is removed by oil outlet or fitting 87 connected onto the low point of sump 85 through side wall 31 adjacent flange 35. Oil outlet 87 will be connected to a reservoir arranged to receive oil without effect on the air flow through the precipitator. Air will leave the passages between the plates and will enter the flared end 39 of outlet tube 27 for continous horizontal flow.

In operation, the air with oil vapor or particles enters the unit through inlet tube 19. A high voltage electrostatic field for positively ionizing the oil particles is provided by the small pointed steel needle 51 and the grounded inlet tube 19. The needle 51 which is arranged concentrically inside the tube 19 is energized by the high voltage direct current source 71 so that it is positively charged. Electrons are thus removed from the oil in this ionizing section. The charged oil particles are carried out of the ionizer and are swept between the plates 40 and 41 by the air flow. It is to be noted that all air entering the precipitator passes between full length of the plates 40 and 41 before exhausting due to the arrangement of the baffle support rings 42 and 43. The flared end 67 of the inlet tube 19 facilitates the entry of the mixture to the inlet ends of the passages between the stack of parallel vertically-arranged plates 40 and 41. The plates 40 and 41 are respectively alternately charged positive and negative by the energizing of the high voltage direct current source 83. It is to be noted that arc-over in the plates 40 and 41 is minimized since an arc-over path which is shorter than the spacing between plates is avoided. As the positively-changed oil particles move through the passages between the plates 40 and 41 they are repelled by the positive plates 41 and attracted by and deposited on the negative plates 40. Since the plates are positioned vertically so that oil runs off quickly, the succeeding oil particles are more effectively attracted to the positively-charged plates 41. The oil drains by gravity from plates and along the inclined side walls to the arcuate bottom sump 85. The oil is then removed through oil outlet 87 connected to the low point of the sump 85 and is returned to a reservoir (not shown). The oil-free air leaves the passages at the outlet ends of the plates 40 and 41 and flows out of the unit through outlet tube 27. In this way, air is suitably-conditioned in respect to oil vapor for use in air conditioning on aircraft or similar uses. It is to be noted that the unit provides an axial flow, free of significant flow obstructions and with a negligible pressure drop. The unit further is compact and economically-manufactured and provides for efficient precipitation of charged oil particles and the collecting and removal of the oil due to the arrangement of plates and rings in facing cup-like housing members. The staggered end arrangement of the plates which prevents arc-over and provides for convenient electrical connections contributes to the reliability and compactness.

It is to be understood that persons skilled in the art can make changes in the described embodiment without departing from the invention as set forth in the following claims.

What is claimed is:

1. An electrostatic precipitator for air containing oil particles comprised of an assembly of a plurality of elongated plates having top and bottom edges and two insulating support rings having the same diameter, each of said rings having square openings with side, top and bottom edges, said plates being vertically arranged and equispaced in said openings of said rings to provide passages between said plates, said rings having slots in the top and bottom edges of said opening receiving the top and bottom edges of the end parts of said plates, each side edge of the openings abutting the adjacent side of the outer ones of said plates, a first horizontal cup-like member encasing one end of said assembly, a second horizontal cup-like member encasing the other end of said assembly, each of said cup-like members having a conical side wall terminating in a flanged larger end, said flanged ends being connected to provide an elongated horizontal housing, said housing positioning said assembly by having the intermediate part of the conical side walls respectively abutting the peripheral edges of said rings, said conical side walls of said housing providing an arcuate sump below the center parts of said plates, said rings serving to confine flow to the passages between said plates, inlet means including an ionizer connected to said first cup-like member for providing a horizontal flow of air having charged oil particles to the passages between said plates, means connected to said plates for electrically charging alternate plates to opposite polarity whereby the charged oil particles are precipitated and drain into said sump, a gravity-flow outlet connected to said sump adjacent the larger end of one of said conical walls, and said second cup-like member having an axial outlet whereby the flow from the plates moves horizontally for discharge from the precipitator.

2. An electrostatic precipitator for air containing oil particles comprised of an assembly of a plurality of elongated plates having top and bottom edges and two insulating support rings having the same diameter, each of said rings having square openings with side, top and bottom edges, said plates being vertically arranged and equispaced in said openings of said rings to provide passages between said plates, said rings having slots in the top and bottom edges of said opening receiving the top and bottom edges of the end parts of said plates, each side edge of the openings abutting the adjacent side of the outer ones of said plates, a first horizontal cup-like member encasing one end of said assembly, a second horizontal cup-like member encasing the other end of said assembly, each of said cup-like members having a conical side wall terminating in a flanged larger end, said flanged ends being connected to provide an elongated horizontal housing, said housing positioning said assembly by having the intermediate part of the conical side walls respectively abutting the peripheral edges of said rings, said conical side walls of said housing providing an arcuate sump below the center parts of said plates, said rings serving to confine flow to the passages between said plates, inlet means including an ionizer connected to said first cup-like member for providing a horizontal flow of air having charged oil particles to the passages between said plates, means connected to said plates for electrically charging alternate plates to opposite polarity whereby the charged oil particles are precipitated and drain into said sump, a gravity-flow outlet connected to said sump adjacent the larger end of one of said conical walls, outlet means connected to said second cup-like member providing an axial flow discharge path for air leaving the passages between said plates, the outlet ends of the alternate ones of said plates projecting beyond the side of the ring adjacent said outlet means, the outlet ends of the remaining plates being flush with the side of the ring adjacent said outlet means, the top corners of the projecting outlet ends of said plates being connected to said means for electrically charging, the inlet ends of said alternate and remaining plates being arranged oppositely to said outlet ends in relation to the side of the ring adjacent said inlet means, the bottom corners of the inlet ends of said remaining plates having a grounded conductor connected thereto.

3. An electrostatic precipitator for removing oil vapor from air comprised of an elongated housing arranged on a horizontal axis, said housing being formed by two identical cup-like metal members, each of said cup-like members having an end wall and conical side wall terminating with flanged connecting edge, said cup-like members being

oppositely-orientated with said flanged connecting edges in abutment so that one of said cup-like members provides an inlet member having an inlet end wall and the other of said cup-like members provides an outlet member having an outlet end wall, said inlet wall having an inlet opening, said outlet wall having an outlet opening, a plurality of equi-spaced rectangular metal plates arranged vertically and extending longitudinally in said housing and having inlet ends spaced from said inlet opening and outlet ends spaced from said outlet opening, two circular rings having square openings for said plates, said rings being positioned by said conical walls and extending radially inwardly respectively from the intermediate parts of said conical side walls of said cup-like members to the inlet and outlet ends of said plates to provide an inlet ring and an outlet ring, said rings having equi-spaced slots receiving the top and bottom edges of said plates and having side walls of said openings abutting the sides of the two outermost plates whereby flow is directed through the passages between said plates, said rings being formed from an electrical insulating plastic material so that said rings insulate said plates from said housing, alternate ones of said plates extending from the inlet side of said inlet ring and having ends projecting beyond the outlet ring to provide outlet plate ends, the remaining plates extending from the outlet side of said outlet ring and having ends projecting beyond the inlet ring to provide inlet plate ends, said cup-like members forming an oil-collecting arcuate sump at the juncture of the bottom parts of said inclined

walls below said plates a gravity-flow oil outlet through one of said inclined walls connected to the low part of said oil-collecting sump, ionizing means connected to said inlet opening for ionizing oil particles in an air flow, said ionizing means including a grounded inlet tube mounted in said inlet opening and an axially-centered ionizing needle, said inlet tube projecting into said housing to adjacent said plates and arranged to direct flow to the passages between said plates, a non-conductive spider positioned in said tube insulating and supporting said axially-centered ionizing needle, a source of direct current connected to the projecting outlet ends of said alternate plates, an electrical conductor connected between the projecting inlet ends of the remaining plates and a ground terminal in said inlet cup-like member, an outlet tube positioned in the end wall opening of said outlet cup-like member and projecting inwardly to adjacent said passages between said plates to provide horizontal discharge flow.

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