

Sept. 26, 1950

S. GILMAN

2,523,618

ELECTROSTATIC APPARATUS

Original Filed Feb. 9, 1945

Fig. 1.

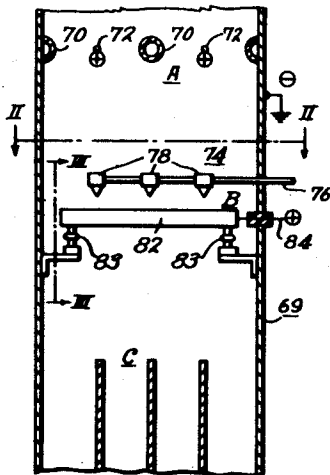


Fig. 4.

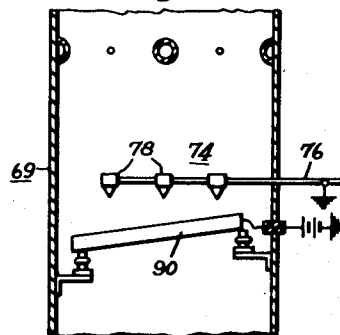


Fig. 2.

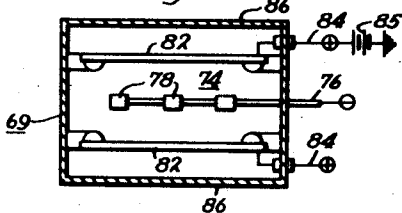


Fig. 5.

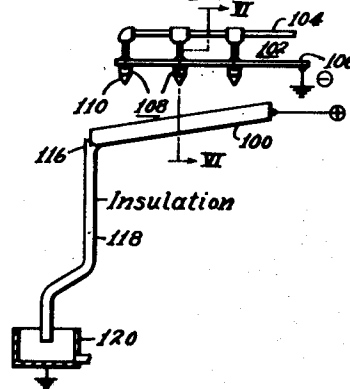


Fig. 3.

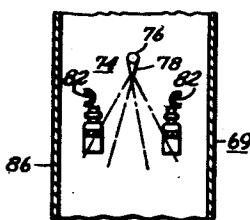
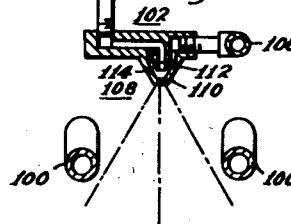


Fig. 6.



WITNESSES:

Edward Michaels
Nels L. Groove

INVENTOR

Samuel Gilman.

BY
B. I. Zangwill
ATTORNEY

UNITED STATES PATENT OFFICE

2,523,618

ELECTROSTATIC APPARATUS

Samuel Gilman, Maplewood, N. J., assignor to
Westinghouse Electric Corporation, East Pitts-
burgh, Pa., a corporation of Pennsylvania

Original application February 9, 1945, Serial No.
577,021. Divided and this application October
24, 1946, Serial No. 705,332

16 Claims. (Cl. 183—7)

1

This application is a division of my patent application, Serial No. 577,021, filed February 9, 1945.

My parent application is directed to apparatus for removing foreign particulate matter from a gas stream by means of equipment that produces an electrically charged liquid spray having a higher net electric charge than was previously obtainable with similar equipment such as disclosed, for example, in G. W. Penney Patent No. 2,357,354, dated September 5, 1944. Various embodiments are disclosed in the parent case. The instant application is limited to selected embodiments in which a charge is imparted to a liquid spray by the use of elongated electrodes.

Objects, features and innovations of my invention, in addition to those set forth in my aforesaid parent application, will be discernible from the following description which is to be taken in conjunction with the accompanying schematic drawing, in which:

Figure 1 is a vertical sectional view of an electrical dust-precipitator embodying a form of my invention;

Figs. 2 and 3 are sectional views, taken substantially along the lines II—II and III—III, respectively of Fig. 1;

Fig. 4 is a vertical sectional view of a further form of my invention;

Fig. 5 is a view showing another apparatus in accordance with my invention, for producing charged sprays; and

Fig. 6 is an enlarged sectional view, taken substantially on the line VI—VI of Fig. 5.

The apparatus shown in Figs. 1, 2 and 3 comprises a rectangular gas duct 69 in which is located a dust-charging or ionizing means A for charging gas-borne particulate matter, and a dust-precipitating means B on the downstream side of the dust-charging means, for removing the charged particles from the flowing gas stream. Field affecting means C comprising a plurality of spaced grounded plates may be provided on the downstream side of the dust-precipitating means B for preventing space discharges and for improving dust removal.

The dust-charging means A comprises a plurality of spaced grounded relatively large tubular electrodes 70, transverse to the gas stream, and between which relatively fine ionizing wires 72 are insulatedly supported. Such a dust-charging means, or ionizer element, is comparatively well known to the art.

The dust-precipitating means B comprises a means for producing a charged-spray, the last

2

means being indicated in its entirety by the reference numeral 74. The charged-spray-producing means 74 comprises any suitable equipment which emits a liquid spray, and is shown as a metallic pipe-member 76 provided with a plurality of metal nozzles 78 along its length. The tips of the nozzles are kept at ground potential by grounding the pipe-member 76 or conductively associating it with the gas duct 69 which is preferably of metal and also grounded. The spray from the nozzles 78 passes between a pair of spaced straight parallel semicylindrical electrodes 82 which are supported on insulators 83 and are given a relatively high potential through insulated conductors 84 connected to any suitable power source. Such a source is indicated schematically as a battery 85 having one terminal end grounded. The curved surfaces of the electrodes face the nozzles in the embodiment shown.

The potential-polarity of the ionizing wires 72 and the electrodes 82 is the same and is opposite to that of the electrodes 70 and the nozzles 78. The ionizing wires 72 produce charged matter in the space between them and the ground electrodes 70 so that gas-borne particles are charged. Liquid fed to the pipe-member 76 comes out of the nozzles 78 as a spray with its droplets charged because of the electrostatic field between the nozzles and the electrodes 82. Consequently, each nozzle-tip from which a spray emits is, in effect, an electrode that is charged oppositely from the electrodes 82. The spray droplets have electric charges of a sign or polarity which is opposite to that on the gas-borne particles so that the droplets and particles attract each other in the region where they intermingle, this region being generally somewhat below the electrodes 82. Preferably the charged spray spreads completely across a full transverse section of the gas duct, at the field affecting means C. The effectiveness with which the spray droplets are charged, and hence the efficiency of the dust-precipitator in the embodiments described, can be increased by preventing drops which collect on the electrodes 82 from continually discharging into the spray region or toward the nozzles 78, for reasons more fully described in my aforesaid parent application. To this end, in the embodiments disclosed in Figs. 1, 2 and 3, the liquid drops collecting on the electrodes 82 are caused to discharge toward the grounded gas duct 69 by arranging the apparatus so that a lengthwise side of each electrode 82 is sufficiently close to a parallel side 86 of the gas duct to make the field gradients at the electrode sufficient to electrically force the col-

lected drops on the electrodes to discharge toward the side 86 which functions as an electrode charged oppositely to the associated electrode 82. After a drop on an electrode 82 discharges and before it recharges, it will fall from the electrode if the drop has sufficient weight.

In Fig. 4, I show a further embodiment which is similar to that of Figs. 1-3 but in which the action of gravity is utilized to help remove drops from electrodes 90 that correspond to the electrodes 82 of Fig. 1. Electrodes 90 slope downwardly so as to cause drops thereon to tend to flow downwardly to the lowermost ends of the electrodes, away from the spray region so that they cannot discharge into the spray. Sloping the electrodes 90 permits the spacing between the electrodes and the parallel sides of the gas-duct to be greater than would be the case if the electrodes were not sloped.

Figs. 5 and 6 show a further form of my invention in which straight parallel cylindrical elongated relatively insulated electrodes 100 are provided between which a metallic spray-producing means 102 establishes a spray. In this embodiment, the spray-producing means has been shown as pneumatic and comprises a grounded liquid-supply pipe-member 104 and an air-supply pipe-member 106 connected to a plurality of spray nozzles 108 having outlet tips 110. Liquid flows centrally through each spraying nozzle via a passage 112. Air under pressure flows in a conical passage 114 which is around the passage 112 and is tapered to the outlet tip 110 for providing a spray which passes between the insulated electrodes 100.

The electrodes 100 are sloped as in the embodiment shown in Fig. 4. However, the lowermost end of each is provided with a small catch-basin 116 having a drain-opening to which a drain-pipe 118 is connected through which liquid collecting on the electrode may drain. The drain-pipe 118 is of a material providing a high resistance path along which the draining liquid flows into a grounded container 120.

In embodiments usually utilizing a high resistance drain, the liquid remaining on the insulated electrodes, such as the electrodes 100, loses electric charge by leakage so that the possibility of electrical discharge from distorted liquid drops on the electrodes is greatly minimized or entirely eliminated. In embodiments which do not use a drain, liquid on the electrodes can fall from them after they form large enough drops on which the pull of gravity is greater than the force exerted on them by the electrostatic field extending from the electrode to the spray-nozzles and to the point at which the charge of the spray may be considered to be concentrated.

I have found that the use of substantially straight electrodes, either cylindrical or semi-cylindrical or some other cross-section, in equipment for charging a spray, is a considerable improvement over the ring-type electrodes, particularly if used with a plurality of spray-nozzles of a pneumatic type along the lines shown, for example in Figs. 5 and 6.

Using a pneumatic nozzle, identified as type JPNF, set-up No. 12, described in a catalogue identified as "Spraying System Nozzles and Related Products," Catalogue No. 22 of the Spraying System Company, Chicago, Illinois, an improvement of as much as 200% and above in the charge given to the spray was obtained over that obtained in the specific non-pneumatic type of spray-nozzle and ring electrode, specifically de-

scribed in the aforesaid Penney patent. In one embodiment of the invention, the top surfaces of the straight electrodes were substantially on the same level as the extreme tip of a spray-discharge nozzle, being not more than $\frac{1}{4}$ " below it. The pair of electrodes were parallel and spaced about $\frac{1}{4}$ " apart, with a spray-tip mid-way between them. By sloping the electrodes about 20° to the horizontal, instead of keeping them horizontal, very effective draining of collected liquid was provided, permitting a much higher voltage between the spray-nozzle and the electrodes before objectionable drop discharges occurred.

The diameter of the straight electrodes and their spacing affect the size of the drops on the electrodes and the amount of charge that can be given to the spray. With a constant voltage across the tubular electrodes and the spray-discharge nozzle, increasing the separation of the electrodes affects the field-gradient at the nozzle tip and at the surface of the electrodes. The factors affecting the field-distribution are, however, so varied and complex that an exact analysis is hardly practical. Various grounded surfaces around the nozzle and the relatively insulated electrodes obviously will change the field lines. Even the character and angle of the spray have their effect. However, experiments indicated that for a particular apparatus there appears to be an optimum spacing for straight electrodes at which a maximum charge is imparted to the spray.

While I have described my invention in connection with several embodiments, it is obvious that its teachings have wide application and can be applied in other forms or uses.

I claim as my invention:

1. A device of a class described comprising, in combination, a duct-means for a gas-stream, charging-means for charging gas-borne particles, a liquid-spraying device on the downstream side of said charging-means, an insulated electrode-means in said duct-means spaced to permit the spray from said liquid-spraying device to pass in proximity thereto and then spread across the duct-means, and a high-resistance drain for draining off liquid collecting on said insulated electrode-means.

2. A device of a class described comprising, in combination, a duct-means for a gas-stream, charging-means for charging gas-borne particles, a liquid-spraying device on the downstream side of said charging-means, a sloped elongated electrode-means in said duct-means spaced and insulated from said liquid-spraying device, means for oppositely charging said liquid-spraying device and said electrode-means, and drain means from the lower end of said electrode-means.

3. Charging apparatus comprising a spraying-device having a plurality of spaced points from which a plurality of sprays can be emitted, a pair of spaced elongated parallel electrodes spaced from said points near outer opposite sides of the region for the sprays, said electrodes being relatively insulated from said points, and means for supporting said electrodes so as to substantially span the distance between said points, said electrodes being substantially straight, and sloping with respect to a line joining a pair of said points.

4. Charging apparatus comprising a spraying-device having a plurality of horizontally spaced points from which a plurality of pneumatic sprays can be emitted, a pair of spaced elongated metal electrodes spaced from said points near outer opposite sides of the region for the sprays, said elec-

5

trodes being relatively insulated from said points, and means for supporting said electrodes so as to substantially span the distance between said points, said electrodes being substantially straight and supported so as to slope downwardly, said points being spaced from a plane which joins the edges of said electrodes farthest from said points, the points being spaced from said plane in a direction opposite to the direction in which the sprays leave said points.

5. Apparatus for providing a charged liquid spray, comprising a spraying-device having a plurality of horizontally spaced pneumatic spray-producing nozzles having tips from which a plurality of sprays can be emitted, and a pair of spaced separate electrodes spaced from said tips and spanning the distance therebetween near outer opposite sides of a region occupiable by the sprays, said electrodes being relatively insulated from said nozzles, said nozzles pointing between said electrodes and having their tips spaced from said electrodes in the direction opposite to the spraying direction.

6. The invention of claim 5 characterized by said electrodes being substantially straight and sloping with respect to a line joining a pair of said points.

7. Apparatus for providing a charged liquid spray, comprising a spraying-device having a plurality of spaced pneumatic spray-producing nozzles from which a plurality of sprays can be emitted, said nozzles having tips, a pair of spaced substantially straight electrodes spaced from said tips both laterally and in the spraying direction and spanning the distance therebetween, said electrodes being transversely curved at faces located at outer opposite sides of a region occupiable by the sprays, said electrodes being relatively insulated from said nozzles, said nozzles pointing between said electrodes, additional electrode-means relatively insulated from said pair of electrodes, and arranged on a side thereof away from said region, and means for oppositely charging said electrodes with respect to said nozzles and said electrode-means, the spacing, configuration and charging-potentials of said electrodes, electrode-means, nozzles and charging means being such that the field gradient at said electrodes in a direction toward said region is less than the field gradient at a part of said electrodes facing in a direction away from said region.

8. A device of a class described comprising, in combination, a rectangular metallic duct-means for a gas-stream, charging-means for charging gas-borne particles, a liquid-spraying device on the downstream side of said charging-means, a pair of separate parallel insulated rod-like electrodes in said duct-means spaced to permit a spray from said liquid-spraying device to pass therebetween and then spread across the duct-means, said electrodes paralleling opposite sides of said duct-means, and potential-applying means for providing a spray-charging electric field between said liquid-spraying device and said electrodes and a drop-attracting electric field between said duct-means and said electrodes, the spacing, configuration and potentials being such that the tendency of the field gradient at said electrodes in a direction toward said liquid-spraying device to cause drops on said electrodes to be deformed and discharge toward said spray, is overcome.

9. An invention including that of claim 8 but characterized further by said electrodes slop-

6

ing with respect to the direction of gas-flow past said electrodes.

10. Means for producing a charged liquid-spray comprising spray means providing a plurality of spray-emitting points arranged substantially linearly, insulated electrode-means insulated and spaced from said points of said spray means, said electrode-means comprising substantially parallel spaced metal rod-like portions spanning the points, said portions being unconnected in the spanning distance, said spray-emitting points of said spray means being spaced from the plane nearest thereto which includes said metal portions of said electrode-means, a second electrode-means comprising sections insulated from said portions and located near a side thereof away from said points, and means for oppositely charging said insulated electrode-means and said spray means, and for oppositely charging said insulated electrode-means and said second electrode-means, the spacing, configuration and charging potentials being such that the tendency of the field gradient at said insulated electrode-means in a direction toward said spray means to cause liquid-drops on said insulated electrode-means to deform and discharge toward said space, is overbalanced.

11. Means for producing a charged spray comprising a pair of elongated parallel metal electrodes, spraying nozzle-means having a spraying nozzle-tip insulated from said electrodes, said nozzle-tip being near the plane nearest thereto which includes a part of each of said electrodes, but lying on a side of said plane directed away from said electrodes, said nozzle-tip being directed to provide a spray in the space between said electrodes which spray is chargeable by an electric field between said nozzle-tip and said electrodes, said electrodes extending lengthwise beyond the nearest point of said nozzle-means for a distance greater than the distance of said nearest point to either of said electrodes.

12. Charged-spray-producing means as defined in claim 11 but further characterized by said electrodes being sloped from the direction in which said nozzle-means emits said spray.

13. Charged-spray-producing means as defined in claim 11 but further characterized by additional electrode-means spaced from each of said electrodes on a side of each of said electrodes which faces away from said nozzle-tip, and voltage-applying means for oppositely charging said nozzle-tip and said electrodes and for oppositely charging said electrode and electrode-means, the spacing, configuration and charging-potentials being such that the field gradient at said electrodes facing in a direction toward said space is less than the field gradient at a part of said electrodes facing in a direction away from said space.

14. Charged-spray-producing means as defined in claim 13 but further characterized by said electrodes being sloped from the direction in which said nozzle-means emits said spray.

15. Means for producing a charged spray comprising a pair of elongated rod-like substantially parallel electrodes, a spray-nozzle-means having a spraying point insulated from said electrodes and providing a spray in the space between said electrodes, and chargeable by an electric field between said spraying point and said electrodes, said electrodes being lengthwise substantially straight and transversely curved on the sides facing said spraying point, said spraying point being near a plane nearest thereto that in-

7

cludes a part of each of said electrodes, said spraying point lying on a side of said plane facing away from said electrodes, said electrodes extending lengthwise beyond the nearest point of said spraying nozzle-means for a distance greater than the distance of said nearest point to either of said electrodes.

16. Charged-spray-producing means as defined in claim 15 but further characterized by pneumatic means associated with said nozzle-means to provide a spray at said spraying point.

SAMUEL GILMAN.

8

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,958,406	Dariah	May 15, 1934
2,207,576	Brown	July 9, 1940
2,357,354	Penney	Sept. 5, 1944