Jan. 4, 1955

H. A. WINTERMUTE

2,698,669

ELECTRICAL PRECIPITATOR

Filed July 31, 1951

3 Sheets-Sheet 1

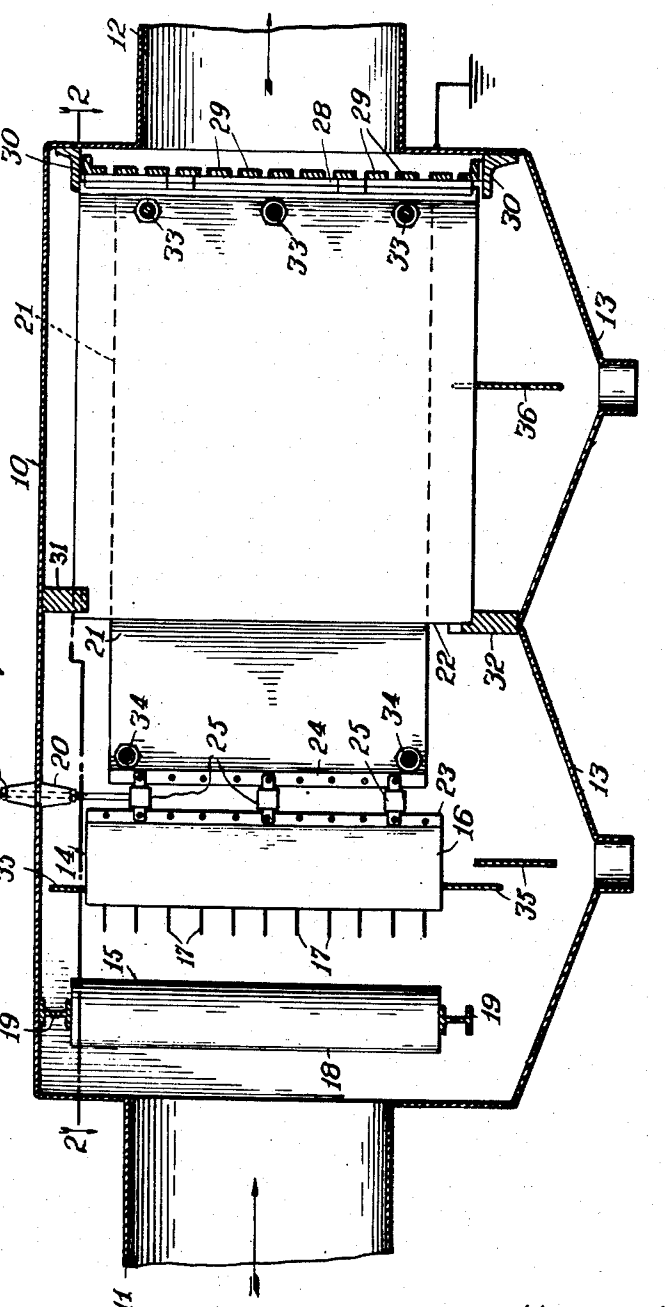

Fig. 1.

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Fig. 2.

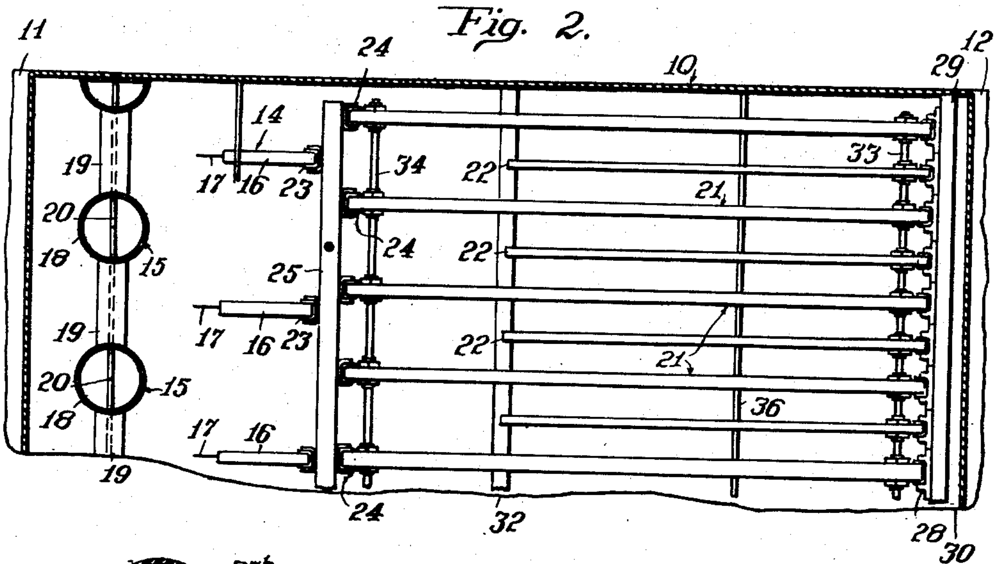


Fig. 3b

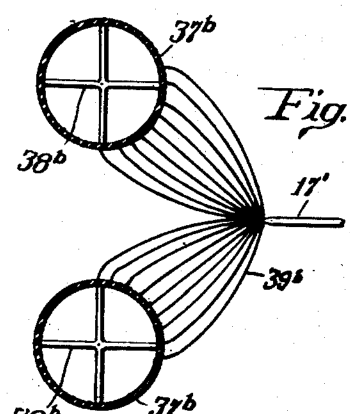


Fig. 3c

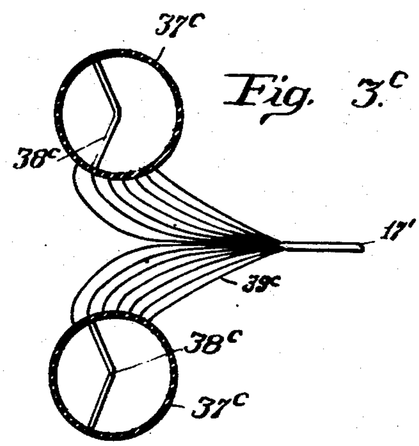
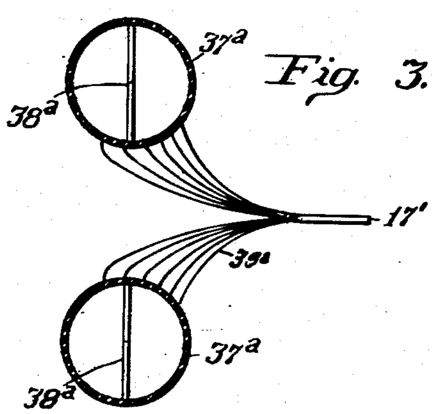


Fig. 3a



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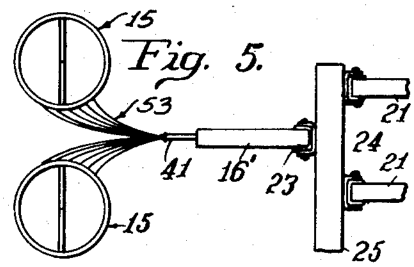


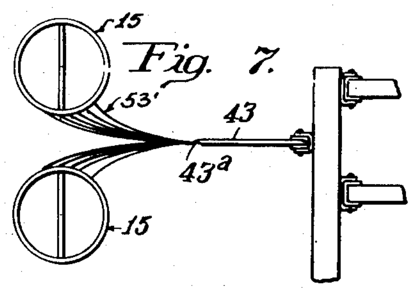


Fig. 4.

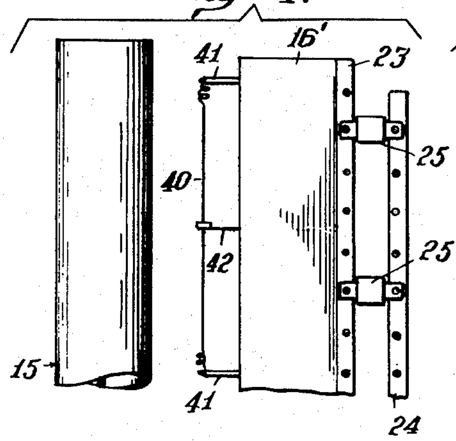


Fig. 6.

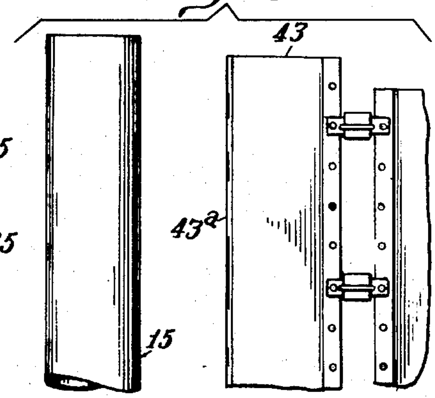
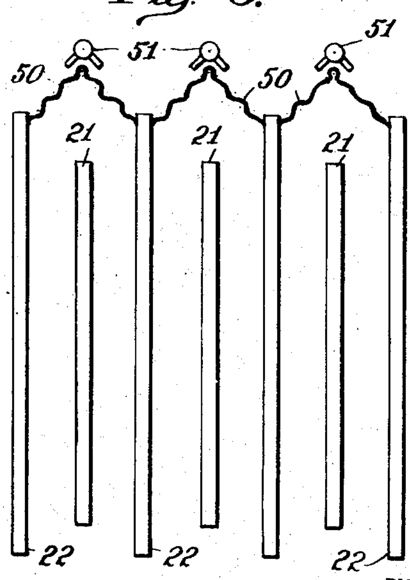


Fig. 8.



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ELECTRICAL PRECIPITATOR

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Application July 31, 1951, Serial No. 239,492

5 Claims. (Cl. 183—7)

This invention relates to an electrical precipitator and particularly to an electrical precipitator of the two-stage type for the cleaning of air.

Air cleaning precipitators of the two-stage type typically comprise a charging zone wherein particles suspended in the air are ionized by the action of electrical discharges in a high tension electrical field between opposed sets of electrodes at least one set being discharge electrodes, and a precipitating zone wherein the air is subjected to a high tension electrical field between opposed sets of substantially non-discharging electrodes.

It has been found that improved smoothness of operation and efficiency of collection, as well as other important advantages can be obtained by making at least one of the sets of electrodes in at least one of the stages of a semiconductive material of relatively high electrical resistance, such as Portland cement concrete, "Transite" board and the like.

Some of the advantages and improvements that are obtained by the construction of the invention are as follows:

When the electrodes of both the charging and precipitating sections are made entirely of metal or high conductance material, any electrical arc-over results in complete deenergization of the whole precipitator, and a ceasing of all precipitating action during the period of arc-over. Also, in the present commercial air cleaning units, the precipitating section is composed of closely spaced parallel plate electrodes. These constitute a condenser of considerable capacity which are charged from a high voltage condenser. On arc-over, both the plate electrodes and the condenser discharge with a loud report which is often as loud as the report from a .32-caliber pistol. Frequently, due to the acoustic properties of the air duct system, this noise is transmitted to the point of air discharge and often magnified in intensity. When part or all of the electrodes are made of high resistance or low conductance materials, an arc-over from a discharge electrode point has no appreciable effect on the flow of corona current from the remaining corona discharge points. In other words, the precipitation voltage and corona current remain substantially the same, and the charging of particles in the gas stream is not interrupted. On arc-overs in the precipitating section, a similar localizing action takes place when the plates are made of low conductance materials and there is no interruption of the precipitating action. Also, due to the limiting of the amount of energy released at the time of arc-overs, there are no loud reports when these occur.

Due to the limiting effect on current flow of the resistance of the low conductance materials, a temporary short circuit or heavy back corona discharge of the glow type from a corona point to the opposing electrode is controlled and has no noticeable effect on the applied precipitator voltage, and there is normal corona current flow from each of the other discharge electrode points. As the precipitator voltage and flow of corona current remains substantially normal, normal charging of the suspended particles continues and the efficiency of the precipitating section is not impaired.

A precipitator constructed of metal, used in collecting some types of dust may have a "back corona discharge" of the intense ionization glow type. This results in highly localized and irregularly spaced corona discharges and also a considerable reduction in the total number of corona discharge points. With such a condition of corona discharge, there is a noticeable reduction in precipitator efficiency. However, when the electrodes are made of semiconductive material, there is an equalizing and ballasting effect of the high resistance in series with each corona discharge point. Furthermore, due to this ballasting action, the corona current from each discharge point cannot become excessive and there is no reduction in the total number or distribution of the corona discharges. Due to the establishment of uniform corona discharges, the gases are uniformly ionized and the suspended particles charged and precipitated.

In cases where the air is cleaned for re-use, it is necessary to keep the ozone and nitrous oxide contents at a very low value. Tests have shown that a low ozone content is secured in commercial installations by using discharge electrodes made of very fine wire, usually about 5 to 7.5 mills in diameter. When wires of this size are used, the points of corona discharge are very small in size and the current flow from each point is very low. This combination of small corona points and low current flow, forms but little ozone, and with normal air flow, the ozone content will not exceed the permissible amount. With electrodes made of high resistant material, the corona current flow from each corona point is controlled and kept down to a current flow when the amount of ozone formed is very low. As the flow of current from each corona point can be maintained at a low value by the resistance effect of the resistant material, it is feasible to use discharge wires heavier than usual and still maintain a current flow from each point sufficiently low to insure an ozone formation which is well below the permissible content. The use of larger sized wire for the discharge electrode points is desirable as such wires have a greater mechanical strength.

The principles of the invention are illustrated in the accompanying drawings in which:

Fig. 1 is a vertical longitudinal section through an air-cleaning precipitator embodying the principles of the invention;

Fig. 2 is a horizontal section on line **2—2** of Fig. 1;

Figs. 3*a*, 3*b* and 3*c* are diagrammatic representations of several forms of charging section electrodes, indicating the distribution of lines of corona discharge;

Fig. 4 is a partial elevation and Fig. 5 is a plan view of charging section electrode forms;

Fig. 6 is a partial elevation and Fig. 7 is a plan view of another charging section electrode arrangement; and

Fig. 8 is a fragmentary showing of a modification of precipitating section electrode arrangement with electrode washing means.

In Figs. 1 and 2, **10** is the precipitator shell, provided with a gas inlet **11**, gas outlet **12** and hoppers **13** for precipitated material. The charging section comprises a plurality of discharge electrodes **14** and a plurality of opposed non-discharge electrodes **15**.

The discharge electrodes comprise vertical extending plates **16** of low conductivity such as "Transite" board, bearing on their upstream edges a plurality of projecting metal wires **17** providing discharge points.

The non-discharge electrodes comprise a plurality of semi-conductive pipe sections **18**, of "Transite", concrete or the like, vertically supported in the shell by I-beams **19** and provided with interior metallic members **20** to control the distribution of corona discharge as hereinafter described.

The precipitating section comprises two sets of alternating electrodes, one set comprising plates **21** of semi-conductive material being energized at high potential and the other set comprising plates **22** likewise of semi-conductive material being grounded.

The discharge electrode system of the charging section and the forward end of high potential plates **21** of the precipitating section are engaged by metallic U-strips **23** and **24** respectively which are carried by transverse bars **25**, the whole being supported by insulating bushing **26** through which the two sets of electrodes are energized by means of conductor **27**.

The downstream ends of plates **21** and **22** are engaged by U-strips **28** which are attached to slotted plate **29**. Plate **29**, which is carried by angle members **30**, not only serves as a support for the rear end of the precipitating electrode plates but also acts to maintain uniform gas flow across the cross-section of the precipitator. The forward ends of the plates **22** are supported and spaced by upper baffle and spacer member **31** and lower baffle and spacer member **32**.

Rods **33** carrying suitable spacers maintain plates **21** and **22** in spaced relation at their downstream or ground potential ends and rods **34** and associated spacers maintain plates **21** in spaced relation at their upstream or high potential ends.

Gas flowing through the precipitator is directed into the area between the electrodes by suitable baffles, including baffle members **31, 32** previously described, and transverse baffles **35** in the charging section and **36** in the precipitating section.

Figs. 3*a*, 3*b* and 3*c* show several different forms of the electrode members **15** of Figs. 1 and 2, the form of Fig. 3*a* corresponding to that indicated by way of example in Figs. 1 and 2. In these figures, the discharge electrodes are diagrammatically indicated at **17'**. In each figure the non-discharge electrodes comprise a tubular member **37***a, b, c,* of semi-conductive material, such as concrete or "Transite" and internal metallic members **38***a, b, c* serving to determine the distribution of corona discharge indicated diagrammatically at **39***a, b, c.* In Figs. 5 and 7 the distribution of corona discharge is indicated diagrammatically at **53** and **53'**.

In the charging section electrodes of Figs. 4 and 5, non-discharge electrodes **15** are similar to electrodes **15** of Figs. 1 and 2, the discharge electrodes comprise a fine metallic wire (5 to 7.5 mils) **40** supported at each end by arms **41** and in the center by guide **42**, mounted on the leading edge of semi-conductive plate **16'**.

Another form of discharge electrode is shown in Figs. 6 and 7 as a thin strip **43** having a fine edge **43***a* which may be serrated.

Fig. 8 shows an arrangement for washing and oiling the collecting plate electrodes **22** of the charging section. It comprises inverted V screens **50** sloping down from liquid outlets **51** into contact with the upper ends of plates **22**.

Although in the illustrative apparatus of Figs. 1 and 2 all of the electrodes of both sections of the precipitator are shown as being constructed of or including high resistance material, metal or other readily conducting material may be substituted for the high resistance material in some of the electrodes without departing from the principles of the invention or foregoing its advantages. For example:

In the ionizing or charging section, the discharge electrodes can be made entirely of metal or other high conductance material, and control of corona discharge secured by the use of resistant materials in the collecting electrodes; or, the discharge electrodes can be made in part of high resistant material and the collecting electrodes of metal or other high conductance materials.

In the collecting or precipitating section the plates **22** which are not connected to the discharge electrode system of the ionizing or charging section, can be made of a metal such as aluminum or other high conductance materials. The use of high conductance material for the plates **22** is the preferred construction in that a washing and oiling system, such as is shown in Fig. 8 can be used to clean these plates. Tests have shown that this is a practical method of cleaning, and observations made over a long period of time have shown that all the precipitate is collected on the surfaces of the plates that are of opposite polarity to that of the corona discharge, and that no precipitate collects on the surface of the plates of the same polarity as that of the corona discharge. Therefore, the only plates that will have to be cleaned are those of opposite polarity to the corona discharge, and which operate at ground potential. The cleaning system shown in Fig. 8 will function satisfactorily in that the screen not only carries all the liquid to the surfaces of the ground plates, but also acts as an umbrella and keeps all liquids from the high potential electrodes **21** formed of resistant material; or, if it is desired to collect the precipitate dry, the plates can be vibrated or rapped as they operate at ground potential.

I claim:

1. An electrical precipitator for separating suspended materials from a stream of gas including a charging section comprising a set of discharge electrodes and a set of opposed complementary non-discharge electrodes, said non-discharge electrodes comprising hollow cylindrical members of semi-conductive material and conductive members secured to and extending along the interior of said cylindrical members at selected points to control the distribution of corona discharge from said set of discharge electrodes throughout the gas stream, and a precipitating section comprising opposed sets of non-discharge electrodes, said discharge electrodes and at least one of the sets of non-discharge electrodes of the precipitating section being constructed at least in part of semi-conductive material whereby the discharge electrodes of the charging section and said one of the sets of non-discharge electrodes of the precipitating section are maintained at high potential with respect to the opposed electrodes.

2. An electrical precipitator as defined in claim 1 wherein said set of non-discharge electrodes being energized at high potential at the upstream end thereof and being electrically connected to the other set of non-discharge electrodes at the down-stream end thereof.

3. An electrical precipitator as defined in claim 1 wherein said set of non-discharge electrodes extending up-stream beyond the other set of non-discharge electrodes and being energized at high potential at the up-stream end thereof.

4. An electrical precipitator as defined in claim 1 wherein said set of non-discharge electrodes extending up-stream beyond the other set of non-discharge electrodes and being energized at high potential at the up-stream end thereof, and electrically connected to the other set of non-discharge electrodes at the down-stream end thereof.

5. An electrical precipitator as defined in claim 1 wherein said set of non-discharge electrodes and the discharge electrodes of the charging section being supported and energized by a common conductive support maintained at high potential.

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