# United States Patent [19]

**Volsy**

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[54] **ELECTROSTATIC PRECIPITATOR FOR THE COLLECTION OF PARTICLES CONTAINED IN A GAS**


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[51] **Int. Cl.** ..... **B03c 3/04**

[58] **Field of Search** ..... 55/146, 150, 151, 152, 55/128, 129, 120, 121, 270; 324/32, 33, 71 R, 71 CP; 73/23 R, 28; 310/8.1; 317/3, 4



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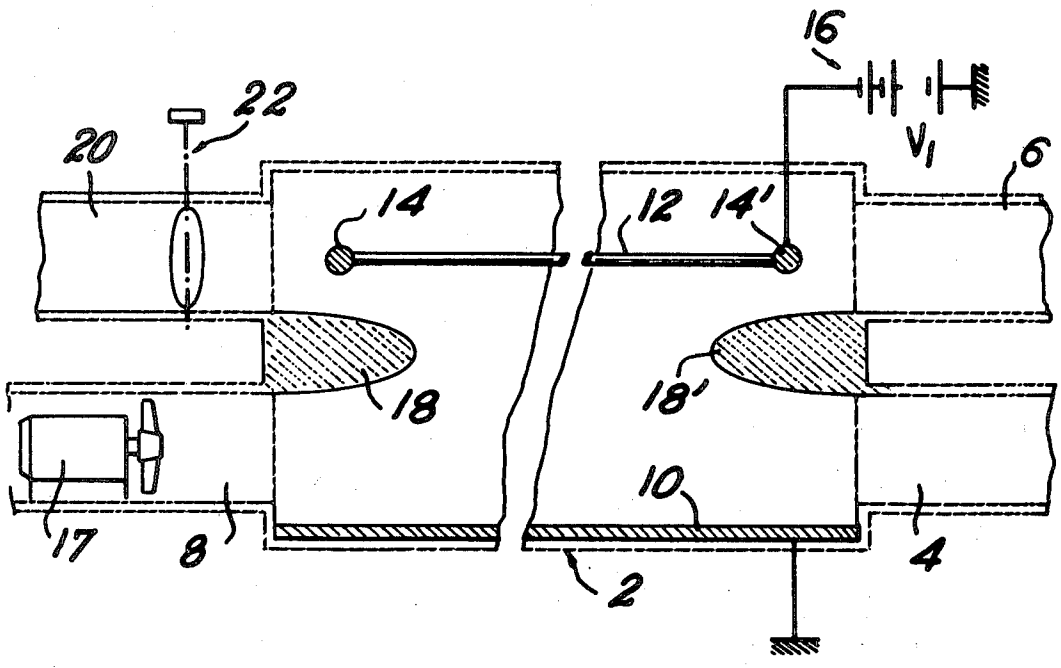
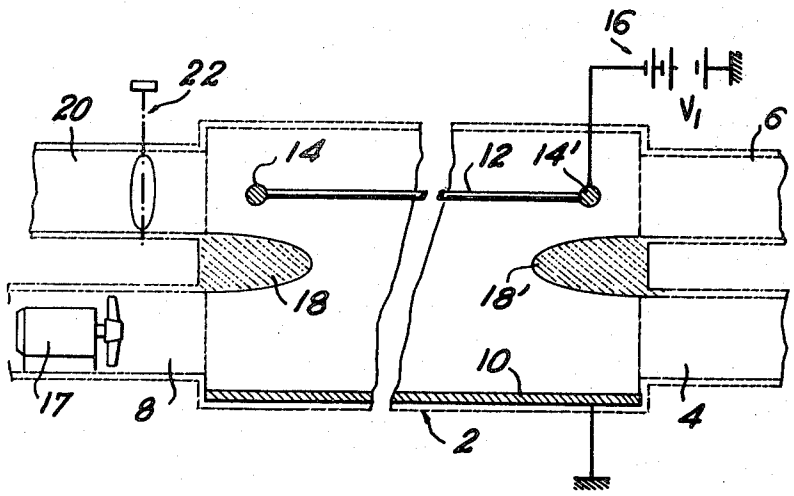
[57] **ABSTRACT**

Particles suspended in polluted gas or atmospheric air to be analyzed and purified are charged and precipitated in a single unit comprising a leak-tight chamber of substantial length, an admission duct for the gas to be analyzed and a "clean" gas supply duct which are parallel and open into one end of the chamber, at least one outlet duct being located opposite to the admission duct at the other end of the chamber. The chamber contains at least two electrodes, one of which is a conductive plate adjacent to the admission and outlet ducts, the other being at least one electrode such as a conductive wire which produces a corona discharge in the gas.


**8 Claims, 1 Drawing Figure**

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# ELECTROSTATIC PRECIPITATOR FOR THE COLLECTION OF PARTICLES CONTAINED IN A GAS

This invention relates to an electrostatic precipitator for the collection of particles in a gas such as air.

More precisely, the present invention is concerned with a device for the collection of polluting particles contained in a sample of atmospheric air. The device also permits the removal of dust from a gas and consequently the purification of this latter. By collecting the impurities contained in the atmosphere or in any other gas, it is possible to carry out both a qualitative and quantitative analysis of said impurities or in other words to determine the concentration of impurities and to perform a chemical analysis of said impurities.

Control of air pollution, especially in large urban areas, constitutes a problem of considerable importance. Many types of particle collection equipment are already in use and among these can be mentioned:

systems of filtration through porous fabrics; by means of these systems, the pores choke at a very high rate and the device rapidly becomes inoperative;

inertial systems based on gravity settling, particle impact or centrifugal force; the disadvantage of these systems lies in their low collection efficiency in the case of particles which have a small mass (for example particles smaller than 1 micron in diameter);

the thermal precipitation systems (bombardment of photons); on the contrary, these systems permit retention only of particles which have a very small mass;

electrostatic precipitation devices; as a rule, these devices consist of a pin or a wire which serves as an ion source and is placed along the axis of a cylinder of revolution, the particles being precipitated on the cylinder walls. Recovery of the deposits thus obtained is a difficult operation and the efficiency of this type of apparatus decreases very rapidly in time as the particle deposits are formed on the wire; moreover, the design concept of these devices precludes any automatic adaptation to the measurement of particle concentration.

The precise object of the present invention is to provide an electrostatic precipitator for the collection of particles contained in a gas which overcomes the disadvantages attached to the techniques of the prior art which were mentioned in the foregoing.

The electrostatic precipitator for the collection of particles contained in a gas essentially comprises:

a leak-tight chamber of substantial length, a first inlet duct for the admission of gas to be analyzed and a second inlet duct for the supply of "clean" gas which are located in parallel relation and have their openings at one end of said chamber, at least one outlet duct located opposite to the first inlet duct at the other end of said chamber, at least two electrodes having different functions being placed within the interior of said chamber, one electrode being a conductive plate located close to that wall of said chamber which is adjacent to the first and third ducts, the geometry of the other electrode or electrodes being such as to produce in conjunction with the conductive plate a corona discharge in the gas which is present within said chamber;

deflectors which provide a separation both at the inlet and at the outlet between the gas streams of the ducts while ensuring relative independence between the polluted gas stream which is admitted through the first duct and discharged through the third duct, and the "clean" gas stream which is admitted through the second duct;

a generator which serves to deliver direct or modulated current and applies a direct-current potential difference between the electrodes. The electrode which produces the corona discharge can be, for example, either a conductive wire which is parallel to said plate or a conductive pin which is located at right angles to said plate.

The gases are introduced through the first and second ducts. In a preferred embodiment, provision is made for a suction device within the third duct. In another preferred embodiment, the electrode which produces the corona discharge is placed in the line of extension of the second duct.

By means of the device in accordance with the invention, the same system formed by the electrodes therefore serves to carry out both the charging of the particles contained in the polluted gas to be analyzed and to cause precipitation of said particles.

Charging of the particles is produced by the ionized molecules of air resulting from corona discharge by applying a potential difference between the electrodes.

The particles which are thus ionized are received by the plate under the action of the electrostatic field applied between the plate and the electrode which produces the corona discharge. Vortices arising from the electric wind are eliminated while ensuring a flow of clean gas between the electrodes, which prevents any loss of aerosols on the walls of the collection chamber. This result is obtained under very good conditions by placing the corona discharge electrode in the axis of the clean gas supply duct or in an extreme position corresponding to the inlet of the two ducts for the admission of clean gas and polluted gas.

A clearer understanding of the invention will in any case be gained from the following description of one embodiment of the invention which is given by way of non-limitative example. Reference is made in the description to the single accompanying FIGURE in which the device according to the invention is shown in longitudinal cross-section.

The electrostatic device for collecting particles in a gas as shown in FIG. **1** essentially comprises a leak-tight chamber **2** of substantial length and having a parallelepipedal shape, for example, said chamber being connected at one end to the inlet ducts **4** and **6** and at the other end to the outlet duct **8.** The chamber **2** is provided internally with a conductive metallic plate **10** which is fixed on the bottom wall of said chamber **2** and electrically insulated from said wall. Provision is also made within the chamber **2** for a conductive wire **12** which is parallel to the axis of this latter and placed in the line of extension of the inlet duct **6.** Said wire is maintained in position by means of two insulating supports **14** and **14'**. An electric current generator **16** serves to apply between the conductive wire **12** and the plate **10** a direct-current potential difference $V_1$. In this example, the duct **8** is connected to a suction device **17** of known type. Within the chamber **2,** the gas streams corresponding to the inlet ducts **4** and **6** are partially separated by the deflectors **18** and **18'**. In this example, the chamber **2** is provided with an outlet duct **20** which is located in the line of extension of the inlet duct **6.**

In one alternative form of construction, the duct **20** is fitted with an adjustable closure system **22.**

In the precipitator shown in the FIGURE, the electric conductor which produces the corona discharge in conjunction with the conductive plate is a conductive wire **12** located parallel to the axis of the chamber **2** but, as has been stated earlier, the electric conductor can consist of a conductive pin placed at right angles to the conductive plate **10.**

The operation of the device is immediately apparent from the foregoing description. The polluted gas which is introduced into the chamber **2** through the inlet duct **4** is ionized by virtue of the assembly consisting of the conductive wire **12** and the plate **10.** The wire **12** behaves as a charge emitter since it is subjected to the corona effect and applies a potential difference $V_1$ between the wire **12** and the plate **10.** The gas is accordingly ionized and the ion space charge confers a charge on the particles in suspension in the gas. These charged particles are then attracted by the plate **10** which has the same effect as a collecting plate and thus collects the particles contained in the polluted gas. The gas which is introduced through the duct **6** and can be either a clean gas or the gas which is withdrawn from the duct **8** compensates for the electric wind produced by the corona discharge. This prevents any formation of vortices and any deposition of particles on the walls of the chamber **2** other than the plate **10.** The rate of flow of the gas injected into the duct **6** can advantageously represent 5 to 30 percent of the throughput of polluted gas.

By way of indication, the rate of flow of the gas within the chamber **2** under the action of the suction device **17** can advantageously be within the range of 10 to 400 cm/second; the direct-current potential difference $V_1$ applied between the plate **10** and the conductive wire **12** can be within the range of 2 to 40 kV whereas, in a preferred embodiment, the length of the chamber **2** can range from 3 to 30 cm according to the voltage applied, the rate of propagation of the gas and the percentage content of impurities.

In order to perform automatic measurement of the particle concentration of the polluted gas, the collecting plate **10** can be adapted to an automatic measuring device which can be constituted by an electrometer, by a piezo-electric strip or by a moving film and the quantity of polluted gas introduced into the apparatus can be measured by means of a flowmeter.

Should it be desired to remove dust from a gas, means can be provided for cleaning the plate **10** by scraping or sweeping said plate, for example.

Tests carried out with a device of this type on the basis of polluted and opaque gas of a smoke-producing charge have shown that the polluted air delivered at the discharge end was wholly transparent and undetectable by the naked eye. All the particles were precipitated solely on the plate **10.**

Further tests carried out by means of Dow-Latex beads 0.1 micron in diameter have shown that 90 percent of these beads were collected by the plate **10** in a mean time of traversal of the polluted gas within the precipitation chamber of 0.05 second and that, in the case of beads having a diameter of 0.8 micron, the collection efficiency was higher than 99 percent.

The device in accordance with the invention therefore provides a large number of advantages over other devices of the same type. It is of very simple constructional design, is therefore inexpensive to produce and also has very high reliability of operation; by virtue of the fact that the particles are collected on a single flat plate, removal of said particles for subsequent chemical analysis presents no difficulty.

It can readily be understood that the present invention is not limited to the example which has been more especially described with reference to the accompanying drawing; on the contrary, all variants are included within its scope, especially the alternative form of construction in which the bottom wall of the chamber **2** is replaced by the plate **10.**

What we claim is:

**1.** An electrostatic precipitator for the collection of particles contained in a gas, wherein said precipitator comprises:

a leak-tight chamber of substantial length, a first inlet duct for the admission of gas to be analyzed and a second inlet duct for the supply of "clean" gas which are located in parallel relation and have their openings at one end of said chamber, at least one outlet duct or third duct located opposite to said first inlet duct at the other end of said chamber, at least two electrodes having different functions being placed within the interior of said chamber, at least one other of said electrodes being a conductive plate located close to that wall of said chamber which is adjacent to the first and third ducts, the geometry of at least one other of said electrodes being such as to produce in conjunction with the conductive plate a corona discharge in the gas which is present within said chamber;

deflectors which provide a separation both at the inlet and at the outlet between the gas streams of the ducts while ensuring relative independence between the polluted gas stream which is admitted through the first duct and discharged through the third duct, and the "clean" gas stream which is admitted through the second duct;

a direct-current generator which applies a direct-current potential difference between the electrodes.

**2.** A precipitator according to claim **1,** wherein the corona-discharge electrode is located in the line of extension of the second duct.

**3.** A precipitator according to claim **1,** wherein the electrode which produces the corona discharge is a conductive wire in substantially parallel relation to the conductive plate.

**4.** A precipitator according to claim **1,** wherein the electrode which produces the corona discharge is a conductive pin located at right angles to the conductive plate.

**5.** A precipitator according to claim **1** wherein, the third duct includes a suction device.

**6.** A precipitator according to claim **1,** including a fourth duct opposite to the second duct and said fourth duct having a device for varying the opening of said duct.

**7.** A precipitator according to claim **1** wherein said conductive plate is connected to a measuring apparatus.

**8.** A precipitator according to claim **1** including a cleaning system for said conductive plate.

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