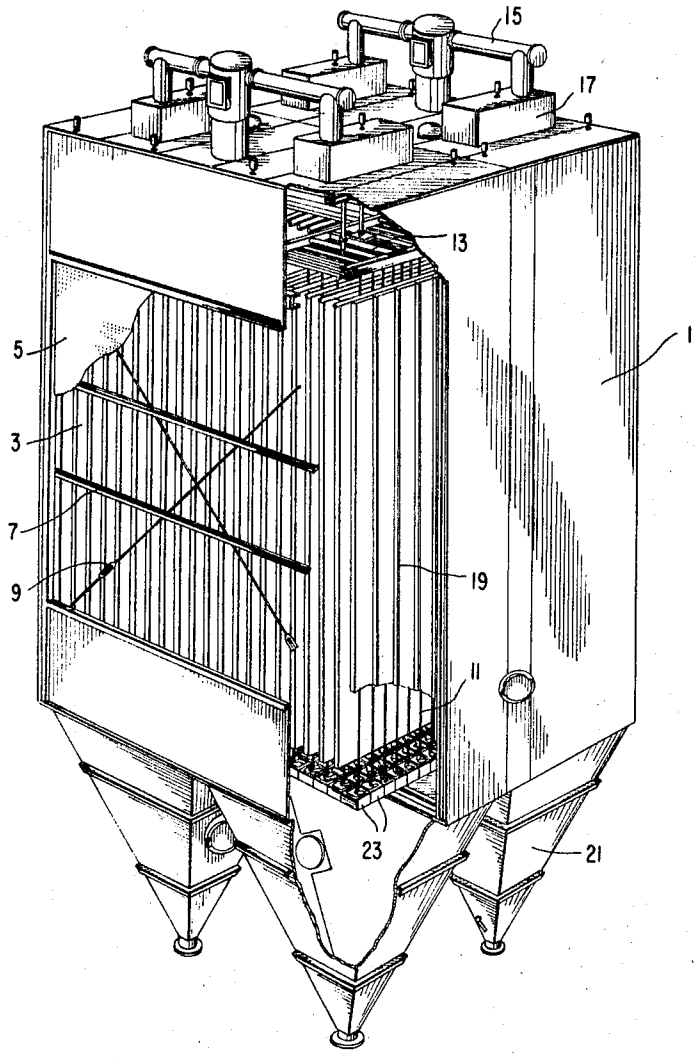
Feb. 4, 1969 B. RAGLAND 3,425,190

ELECTROSTATIC PRECIPITATOR WITH ELECTRODE TENSIONING MEANS

Filed March 18, 1968 Sheet 1 of 2

FIG. 1



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ELECTROSTATIC PRECIPITATOR WITH ELECTRODE TENSIONING MEANS

Filed March 18, 1968 Sheet 2 of 2

FIG. 2

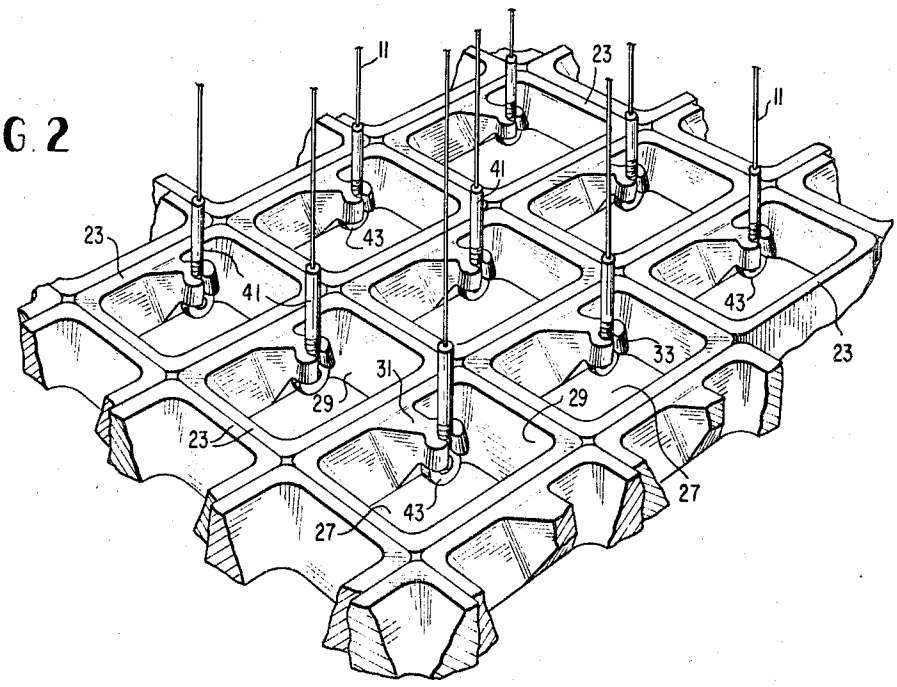
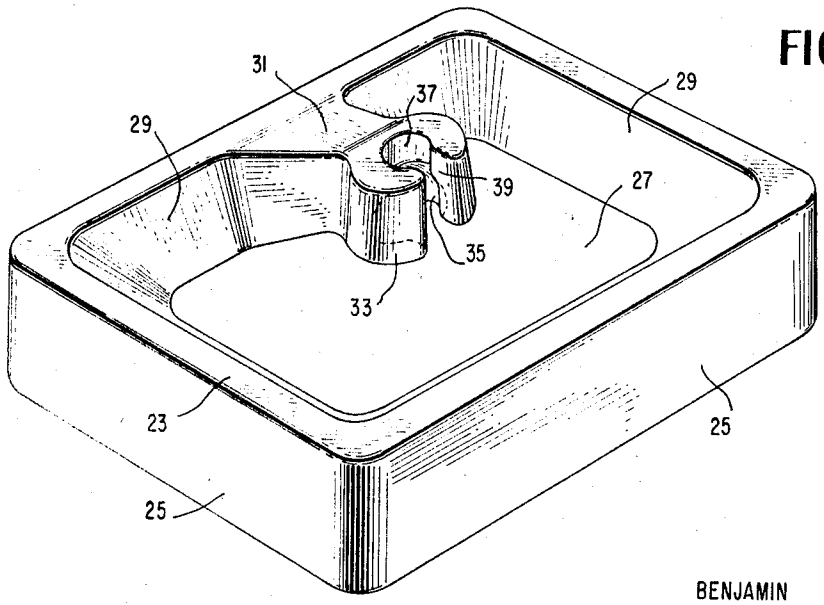


FIG. 3



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ELECTROSTATIC PRECIPITATOR WITH ELECTRODE TENSIONING MEANS

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ABSTRACT OF THE DISCLOSURE

An electrostatic precipitator which has vertical corona discharge wires that are tensioned by weights at their lower ends. The weights are polygonal and rub vertically against each other so that their rubbing friction damps the tendency of the body of wires to swing or to vibrate individually. The weights have upright sides and central openings and are suspended detachably from the wires by arms that extend from one side of the weight across the central portion, the center of gravity of the weight being below the point of attachment of the weight to the corona discharge wires.

The present invention relates to electrostatic precipitators of the type that are useful for the large scale removal of finely divided material from gases associated with industrial processes and operations.

In precipitators of this type, the laden gas is passed in a stream through the electrostatic field of force produced by maintaining an electrostatic potential or high voltage corona discharge between suitable electrodes. In the present invention, one set of electrodes, preferably the corona discharge electrodes, are elongated flexible vertically disposed members which will hereinafter be referred to as wires. The other set of electrodes, which are in the form of plates and are preferably the collectors at positive or ground potential, are of extended surface and may be in the form of pipes or flat plates. For purposes of illustration in the present application, the collector electrodes will be described and illustrated as flat plates.

Again for purposes of illustration of the present invention, a precipitator will be referred to which is of the parallel-plate type, in which rows of corona discharge wires are disposed in planes parallel to and alternating with the plates, in multilayer sandwich fashion. In such a precipitator, the parallel plates provide between them ducts in the direction of gas flow. The gas to be cleaned enters through a perforated plate or the like designed to provide uniform gas distribution through the precipitator chamber. Collector plates may for example be 4.5 to 6 feet deep in the direction of gas flow and 30 feet high, with a spacing of 9 or 10 inches between them. Several such collecting plates will be aligned with each other horizontally, so that a gas passageway perhaps 18 to 20 feet long is provided. The corona discharge wires may for example be about 1/10 inch in diameter and 30 feet long and supported by frames resting on insulators at the top of the precipitator chamber.

It is a common practice in devices of this type to provide weights for holding the wires taut and in position. In the past, it has been conventional to locate these weights in a pocket or slot of a grid at the bottom of the precipitator chamber just above the hoppers in which the dust is collected. This grid is suspended by rods or the like from the high tension frame atop the precipitator chamber. The corona discharge wires are those held straight and taut, and in their proper geometric relationship parallel to the collecting plates, and are connected to a source of high voltage direct current. The wires are usually negatively charged, in industrial type precipitators,

with the collecting plates and surrounding structure of the precipitator chamber at positive or ground potential.

Precipitators of this type are plagued by the fact that the wires cannot be held stationary. They tend to swing to and fro as a group or vibrate individually, relative to the collecting electrodes or plates, causing the gap between the plates and the wires to vary. This variance is often referred to in this art as the "swinging field effect." It may be caused by the impact of the gas flowing through the precipitator, or the electromagnetic or electrostatic forces that exist in the electrostatic precipitator. In any event, the swinging is undesirable, because not only do the electrostatic and electromagnetic field characteristics vary, but also there may be a positive arcing across between the wires and the plates with consequent damage to either or both, and a marked decrease in the efficiency of operation.

Other disadvantages have attended the prior art constructions. For instance, when as sometimes happens a wire breaks, its associated weight has a tendency to fall into the hopper and plug the hopper.

Moreover, the structures which have heretofore been used in this connection have been wasteful of height and space in the precipitator, with the result either that the effective length of the wires is reduced or the effective hopper capacity is reduced.

Furthermore, the wires have a tendency to stretch: and the weight systems heretofore used have not properly accommodated to this phenomenon, with the result that the tension in the wires has tended to vary from wire to wire.

Furthermore, the structures heretofore used have provided surfaces which were productive of high voltage discharge which was largely wasted in terms of useful electrostatic precipitator.

Accordingly, it is an object of the present invention to provide an electrostatic precipitator which reduces swinging of the electrodes.

Another object of the present invention is the provision of an electrostatic precipitator in which power losses through misdirected corona discharge are at a minimum.

Still another object of the present invention is the provision of an electrostatic precipitator in which weights that fall into the hopper do not block the hopper.

It is also an object of the present invention to provide an electrostatic precipitator of which the structure is greatly simplified.

The invention also contemplates an electrostatic precipitator in which the useful space is greatly increased, thereby providing more room for electrode structure and/or increased hopper capacity.

Yet another object of the present invention is the provision of an electrostatic precipitator having suspended wire electrodes in which the tension in the wires is substantially uniform.

It is also an object of the present invention to provide an electrostatic precipitator in which additional paths of electrical conduction for high voltage currents are provided in the plane of the weights at the lower ends of the corona discharge wires.

Finally, it is an object of the present invention to provide an electrostatic precipitator which will be relatively simple and inexpensive to manufacture, easy to install, operate, maintain and repair, and rugged and durable in use.

Other objects and advantages of the present invention will become apparent from a consideration of the following disclosure, taken in connection with the accompanying drawings, in which:

FIGURE 1 is a perspective view, with parts broken away, of an electrostatic precipitator according to the present invention;

FIGURE 2 is an enlarged fragmentary perspective view of the lower ends of a group of corona discharge wires, showing the novel structure of the present invention; and

FIGURE 3 is a perspective view of a single weight for the lower end of a corona discharge wire, according to the present invention.

Referring now to the drawings in greater detail, and first to FIG. 1, there is shown an electrostatic precipitator comprising a casing **1** having the usual side walls and a roof, and a relatively large gas inlet **3** for gases which are laden with particulate material to be separated electrostatically. A clean gas outlet (not shown) is provided on the opposite side of casing **1**, for the exit of gases from which the particulates have been removed. A perforated diffuser plate **5** is normally located over the gas inlet only, so as to ensure proper distribution of the gas over the entire series of gas passageways through the precipitator. Casing **1** is reinforced by the usual struts **7** and sway braces **9**, which lend rigidity to the sheet metal construction of this rather large type of installation.

A multiplicity of ionizer or corona discharge wires **11** are suspended from an ionizer assembly **13** located in the upper portion of casing **1**. Wires **11** are arranged in a plurality of parallel vertical planes that are perpendicular to diffuser plate **5**, and that accordingly extend lengthwise of the path of gas through the precipitator. Electric power is provided from a high voltage source (not shown) through appropriate conductors (not shown) that pass through the usual power supply ducts **15** and through penthouse assemblies **17** to the ionizer assembly **13**, which as usual is supported on insulating material so as to be insulated from casing **1**.

A plurality of vertical collector plates **19** are provided, which are parallel to each other and to the planes in which wires **11** are disposed. The groups or files of ionizer wires **11** and the collector plates **19** are disposed in alternation to each other, so that a file of wires **11** will be disposed between an adjacent pair of spaced parallel plates **19**, and so on. As is usual, the distances between the planes of the plates **19** and the files of wires **11** are all equal to each other. The plates **19** thus define a plurality of passageways through the precipitator, which are quite extensive vertically and in a direction parallel to gas flow, but which are quite narrow in the horizontal direction transverse to gas flow. As is also usual, the collector plates are grounded to casing **1**, the wires **11** being negatively charged and the plates **19** accordingly being relatively positively charged.

The bottom of casing **1** is comprised by a plurality of hoppers **21** having the usual downwardly inclined sides, for the collection of dust and other particulate materials that fall from plates **19**. As is also conventional, the plates **19** are provided with the usual rappers (not shown) for jarring the plates to cause the collected material to fall from the plates into the hoppers **21**.

Thus far, the construction of the precipitator can be entirely conventional. The novel structure of the present invention is as follows:

By the lower end of each wire **11** is suspended a tensioning weight **23** whose mass may be, say, **15** to **25** pounds. The assembly of weights **23** is shown in fragmentary perspective toward the bottom of FIG. 1, but is better shown in FIG. 2. An individual weight **23** is shown in perspective in FIG. 3.

Each weight **23** is polygonal and preferably rectangular. Weights **23** can also be hexagonal. Rectangular shape is preferred, however, so that less care need be taken how the weights are oriented relative to each other. Each weight has a plurality of sides **25** each of which is disposed in a vertical plane. Preferably, the sides **25** are at right angles to each other.

Each weight **23** is in the form of an open frame, the sides of the frame being bounded by the sides **25**. Each weight **23** thus has a central opening **27**, which is bounded by inclined sides **29** disposed on the inner sides of the sides of the open frame. Thus, the upper surfaces of weights **23** on which dust may settle and collect are relatively small in area; while the under sides of the weights are larger in area. In this way, adequate strength and mass are impaired to the weight, without providing much space on which dust or other collected particulate material can lodge.

Each weight **23** has an arm **31** that extends from at least one of the lateral sides of the weight inwardly over the central opening **27**, and upwardly. Thus, each arm **31** terminates in an inner end **33** which is disposed above the level of the sides **25**. On its under side, the end **33** of arm **31** has a downwardly opening recess **35** of generally semicylindrical configuration, which opens through the upper side of end **33** in a central opening **37** that is in the very center of weight **23** as seen from above. A slot **39** provides communication between recess **35** and opening **37**, at the side of end **33** which is opposite the arm **31**.

Each wire **11** terminates downwardly in a vertical rigid rod **41** that is larger in diameter than the wire and acts as a corona shield. The rods **41** are screw-threaded at their lower ends for the reception of cylindrical enlargements **43**. The screw-threaded end of rod **41** is screw-threadedly received through one of the cylindrical side walls of enlargement **43** perpendicular to the axis of enlargement **43**, so that in assembled form as seen in FIG. 2, the enlargement **43** resembles a wafer or disc or annulus disposed in a vertical plane. There are numerous possible ways of attaching the weights to the wires. The above is a description of the one way shown in FIGS. 1, 2 and 3.

The enlargement **43** is complementary to and is received in the downwardly opening recess **35**, while rod **41** extends through opening **37**. The purpose of slot **39** is to permit assembly of weight **23** to its associated wire **11**, by passing the wire **11** through slot **39**, and then lowering the weight on the wire until the rod **41** passes up through the recess **35** and then through the opening **37**, until finally the enlargement **43** seats in the recess **35**. The rod **41** is of a diameter greater than the width of slot **39**, so that weight **23** cannot be laterally dislodged from its associated wire **11**.

In this assembled relationship, the center of gravity of weight **23** is in line with wire **11** and rod **41**. At the same time, the center of gravity is below the recess **35**, so that the rest position of the assembled and suspended weight **23** is quite stable.

In grouped relationship, the weights **23** are all disposed at the same level, with their sides **25** substantially in contact with each other. By "substantially" is meant that they do not necessarily have to be flat in contact with each other at all times: a slight clearance is permissible; although ordinarily, they will be grouped together and restrained laterally by each other.

The weights **23** can be quite cheaply constructed: they can be cast iron, or if the greater cost is unobjectionable, cast steel. They may also be of a variety of other materials of sufficient density, preferably electrically conductive. The tendency of these weights to slide vertically relative to each other will ensure that they do not corrode together. Similarly, the tendency of these weights to slide vertically relative to each other will ensure that they do not become blocked or wedged together by encrustations or accumulations of collected particles that fall on and between them. In other words, the movement of the weights relative to each other makes them self-cleaning.

It will now be apparent why the principal advantage of the present invention is achieved: any tendency of the wires to sway, swing, or vibrate, and any pendulum effect of the weights will be damped by the sliding of the weights on each other. The surfaces **25** will be in frictional contact with each other, and the work of friction quickly consumes the pendulum forces of the weights so that the mass of weights and wires will not in practice swing. They are free to swing, of course, but the swinging energy is quickly absorbed by the friction. Therefore, it will be apparent that there is no need at all to machine

or finely finish the sides of the weights; indeed, a rough, unfinished construction is in certain circumstances very advantageous for increasing the friction between the weights and hence their ability to resist swinging.

It will also be evident that the assembly and disassembly of the weights to and from the wires **11** can be very quick and easy. No tool is required. The enlargement **43** may be screwed and unscrewed by hand and the weights similarly applied and removed.

Moreover, if a wire **11** breaks and its weight **23** plunges to the bottom of the hopper **21**, it will not block the hopper outlet, because it is in effect a relatively large openwork frame which cannot plug the opening of the hopper. Instead, it lodges above the opening and permits the collected dust to pass it in leaving the hopper.

It will also be noticed that it is no longer necessary to provide the elaborate suspension systems for the frames within which the weights previously used were lodged. Indeed, it is not necessary to provide such frames at all. Therefore, there is more room for electrode structure and/or more hopper capacity. The elimination of these cumbersome prior art frames and supports also eliminates their function as sources of power loss, because their wasted corona discharge is eliminated. Furthermore, the equipment is correspondingly less expensive.

The ability of the weights to move individually vertically also ensures that their full weight will be borne at all times by their associated wire **11**. Therefore, the tension in all the wires **11** is the same.

With all the weights **23** at the same level, and these weights rather flat in a horizontal plane, the height of the precipitator that is occupied by the weights is very small. In this way, too, more room for electrodes and/or more hopper capacity is provided.

Finally, the weights in contact with each other provide additional paths of electrical conduction for high voltage current in the plane of the weights, in addition to the paths for electrical conduction at the level of the ionizer assembly **13**. There need be no current loss across gas gaps between weights.

In view of the foregoing disclosure, therefore, it will be apparent that all the initially recited objects of the present invention have been achieved.

Having described my invention, I claim:

1. An electrostatic precipitator having a plurality of elongated flexible vertically disposed discharge electrodes attached at their upper ends to a frame means for supporting said electrodes; and tensioning means for said electrodes comprising a plurality of weights suspended from the lower ends of the electrodes; each of said weights being disposed in substantially the same horizontal plane; each of said weights having others of said plurality of weights disposed adjacent to, substantially in contact with, and in substantially surrounding relationship to said each of said weights respectively; each of said weights being free to slide vertically with respect to each other for damping the pendulum effect of the weights and any tendency of the electrodes to sway, swing, and vibrate.

2. An electrostatic precipitator as claimed in claim **1**,

each weight having a plurality of vertically disposed sides substantially in contact with and vertically slidable relative to the sides of other said weights.

3. An electrostatic precipitator as claimed in claim **2**, each said weight being in the form of a centrally open polygonal frame.

4. An electrostatic precipitator as claimed in claim **3**, and means for releasably interconecting the weights to the lower ends of the electrodes, comprising an arm on the weight that extends from at least one side of said polygonal frame over said central opening.

5. An electrosatic precipitator as claimed in claim **4**, said arm terminating over said central opening.

6. An electrosatic precipitator as claimed in claim **5**, said arm extending above the level of said polygonal frame.

7. An electrostatic precipitator as claimed in claim **3**, said polygonal frame being rectangular.

8. An electrosatic precipitator as claimed in claim **1**, there being a said weight individual to each said electrode.

9. An electrostatic precipitator as claimed in claim **8**, the center of gravity of each said weight being in line with the electrode from which it depends.

10. An electrostatic precipitator as claimed in claim **1**, each weight being in the form of a centrally open rectangular frame having a plurality of vertically disposed sides substantially in contact with and vertically slidable relative to the sides of other said weights, and means for releasably interconnecting the lower ends of the electrodes with the weights, comprising an arm on the weight that extends from one side of the rectangular frame over said central opening above the level of said polygonal frame, there being a said weight individual to each said electrode, and the center of gravity of each said weight being in line with the electrode from which it depends and being located below the connection between the weight and the electrode from which it depends.

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U.S. Cl. X.R.

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