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ELECTROSTATIC PRECIPITATORS

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FIG. 1

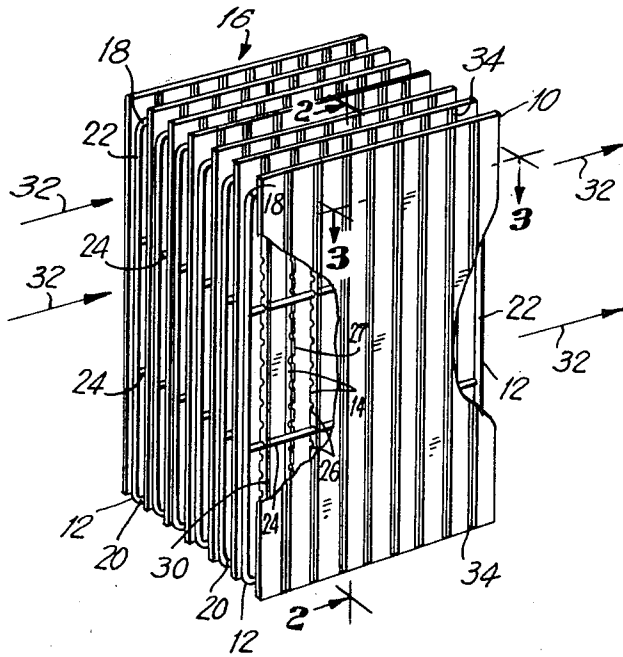


FIG. 2

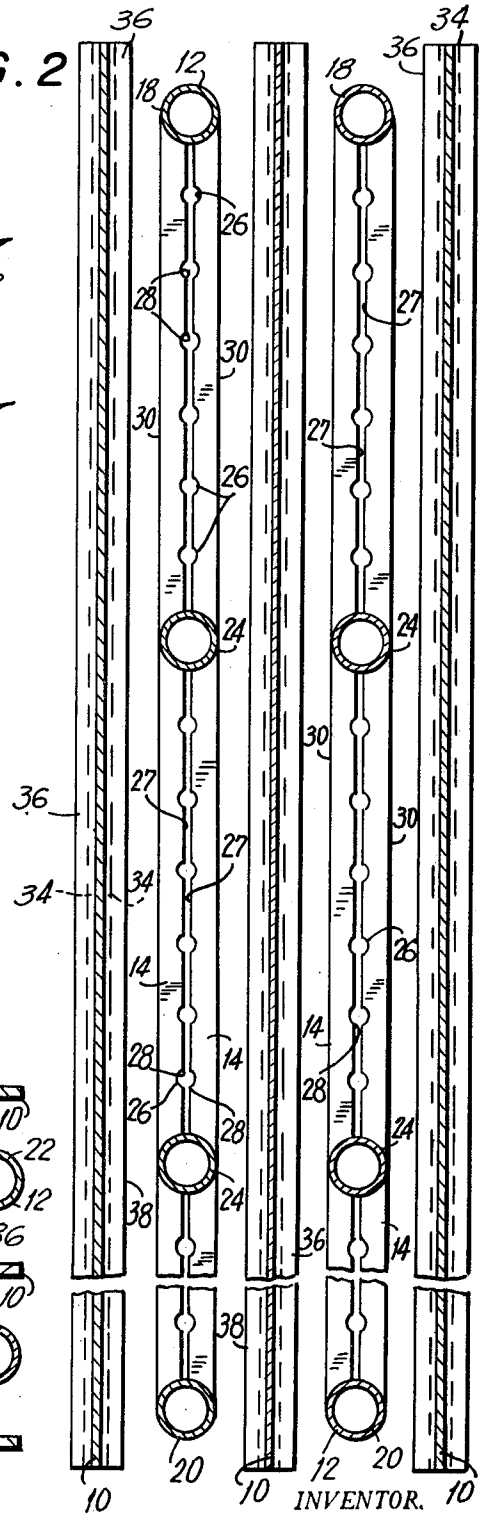
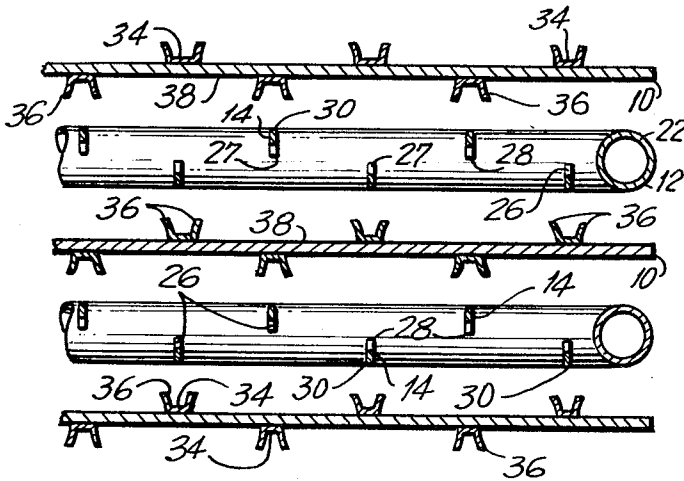


FIG. 3



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ELECTROSTATIC PRECIPITATORS

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4 Claims

ABSTRACT OF THE DISCLOSURE

An electrostatic precipitator having a plurality of spaced discharge electrodes interposed between a plurality of spaced collection plates, a first portion of the discharge electrodes between adjacent collection plates being eccentrically spaced closer to one of said adjacent collection plates, a second portion of said discharge electrodes being eccentrically spaced closer to the other, said discharge electrodes being adapted to produce a substantially unidirectional electrostatic field on the side thereof facing the more distant of said adjacent collection plates.

BACKGROUND OF THE INVENTION

This invention relates generally to electrostatic precipitators of the type used for air pollution control, gas cleaning, separation and selective particle removal. In the art, electrostatic precipitators are generally formed with discharge electrodes centrally disposed between spaced collection plates. These conventional discharge electrodes consist of small diameter wire conductors, wires with points or barbs spaced thereon or thin conductors having sharp edges (star wire). The sharp edges, points and barbs serve to enhance the corona effect.

While an increase in the voltage applied to the discharge electrodes increases precipitation, practical voltage levels are limited by the corona which extends toward the collection plates with the increase of voltage until the point is reached where the corona causes sparking from the discharge electrode to the collecting plate, which in turn stops precipitation. Spark over is a function of the applied potential and the square of the distance between the two closest points on the discharge electrode and adjacent collection plate respectively. Accordingly, while the points or barbs extending from the conventional wire discharge electrodes enhance the corona effect, they also reduce the effective spacing between the discharge electrodes and the collection plates and, therefore, the potential which can be applied to said discharge electrodes. By eccentrically spacing some of the discharge electrodes closer to one of the adjacent collection plates, eccentrically spacing the balance of said discharge electrodes closer to the other, and forming said discharge electrodes so that they produce a substantially unidirectional electrostatic field on the side thereof facing the more distant of said adjacent collection plates, higher operating voltages can be applied, permitting a wide range of voltage control without the danger of sparking while, at the same time, increasing precipitation efficiency.

The conventional wire discharge electrodes as described above are generally supported by tubular frames or stabilized over their entire length by weights secured to the bottom thereof. Since they are thin and subject to the same stresses as the entire supporting structure, they frequently rupture, short circuiting the entire field. This is one of the most common causes of failure in electrostatic precipitators. By forming discharge electrodes from a longitudinally extending bar having spaced notches in one side thereof, the edges defining the other side thereof being substantially curved, a discharge electrode having im-

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proved operating characteristics is provided while the foregoing structural weakness is avoided.

SUMMARY OF THE INVENTION

5 Generally speaking, in accordance with the invention, an electrostatic precipitator is provided which includes a plurality of spaced collection plates and a plurality of spaced discharge electrodes interposed between said collection plates, a first portion of the discharge electrodes between adjacent collection plates being eccentrically spaced closer to one of said adjacent collection plates, a second portion of said discharge electrodes being eccentrically spaced closer to the other, said discharge electrodes being adapted to produce a substantially unidirectional electrostatic field on the side thereof facing the more distant of said adjacent collection plates. The discharge electrodes are preferably formed from longitudinally extending bars having spaced notches in the side thereof facing the more distant of said adjacent collection plates, the side thereof facing the nearer of said adjacent collection plates being substantially free of sharp edges or points. When disposed within the electrostatic precipitators, the discharge electrode sides facing the more distant of the adjacent collection plates are uniformly spaced therefrom at a distance greater than one-half the distance between said adjacent collection plates.

A plurality of frames for supporting the discharge electrodes are preferably provided, said frames being centrally disposed between the collection plates so that the central plane of each of said frames is substantially parallel to the adjacent collection plates. The discharge electrodes are arranged on the frame so that the side thereof facing the more distant collection plate is spaced from and facing the frame center plane, a portion of said discharge electrodes being mounted on one side of said frame, the balance of said discharge electrodes being mounted on the other side thereof. The frame is preferably formed from a plurality of lengths of pipe and is substantially free from sharp edges and points.

Accordingly, it is an object of this invention to provide an electrostatic precipitator in which the discharge electrodes are eccentrically spaced from the adjacent collection plates.

Another object of the invention is to provide an electrostatic precipitator which will operate at higher than normal voltages, thereby offering a wide range of voltage control without sparking due to corona effect, while at the same time, increasing precipitation efficiency.

A further object of the invention is to provide an electrostatic precipitator wherein the eccentrically spaced discharge electrodes produce a substantially unidirectional field on the side thereof facing the more distant collection plate.

Still another object of the invention is to provide an electrostatic precipitator wherein the discharge electrodes are stronger and more readily cleaned than the conventional wire type.

Another object of the invention is to provide an electrostatic precipitator wherein the discharge electrodes provide a more effective corona action than conventional electrodes, thereby resulting in better ionization and cleaning.

Still other objects and advantages of the invention will in part be obvious and will in part be apparent from the specification.

The invention accordingly comprises the features of construction, combination of elements, and arrangement of parts which will be exemplified in the constructions hereinafter set forth and the scope of the invention will be indicated in the claims.

BRIEF DESCRIPTION OF THE DRAWING

For a fuller understanding of the invention, reference is had to the following description taken in connection with the accompanying drawing, in which:

FIG. 1 is a perspective view of a stack of alternating collection plates and frames carrying discharge electrodes according to the invention with portions broken away;

FIG. 2 is a partial enlarged sectional view taken along lines 2—2 of FIG. 1; and

FIG. 3 is a partial enlarged sectional view taken along lines 3—3 of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawing, the alternating stack of collection plates 10 and frames 12 carrying discharge electrodes 14 of an electrostatic precipitator is shown generally at 16. The collection plates 10 are substantially parallel to each other and preferably uniformly spaced. Interleaved between the collection plates 10 are frames 12. The frames are preferably centrally disposed between the adjacent collection plates and substantially parallel thereto. Each frame is preferably rectangular and consists of a top section 18, bottom section 20, side sections 22 and two internal support sections 24 extending between side sections 22 and substantially parallel to top and bottom sections 18 and 20. The sections are formed from lengths of metal pipe secured together as by welding. This arrangement provides a strong, rigid support for the discharge electrode 14.

Discharge electrodes 14 are formed from longitudinally extending rods having a plurality of spaced substantially arcuate notches 26 formed in side 27 thereof. Each arcuate notch defines two edges 28 at which the corona effect occurs. The opposed side 30 of discharge electrode 14 is substantially free from sharp edges or points so as to provide less opportunity for the generation of corona. By the foregoing construction, the discharge electrode is adapted to generate a substantially unidirectional electrostatic field extending from side 27.

A voltage is applied to each of the frames 12 by means not shown, the discharge electrodes 14 and the various sections 18, 20, 22 and 24 of the frame being conductively joined. The collection plates are grounded and a corona is produced at edges 28. The fluid, generally a gas, from which material is to be precipitated, is forced through the precipitation in the direction of arrows 32. Due to the action of the corona and electrostatic field, the precipitated material is attracted to and accumulates at collection plates 10. If desired, the fluid can be forced through more than one stage of electrostatic precipitators, each stage being similar to stack 16.

Collection plates 10 are preferably formed with channel shaped members 34 secured thereto in spaced relation. Members 34 extend substantially parallel to discharge electrodes 14 and the outwardly curved sidewalls 36 of the members 34 extend into the space between the collection plates and define, between the spaced members 34, a plurality of substantially turbulence free sections 38. This arrangement permits the precipitated material to collect within sections 38 without being re-entrained into the stream of fluid by the force of the fluid passing the collection plates. Members 34 are placed so that side 27 of each discharge electrode 14 faces one of said turbulence free sections 38 as shown in FIG. 3.

Each discharge electrode is secured at its ends to frame 12, as by welding, both ends being arcuate and adapted to mate with the correspondingly shaped pipes making up the frame. In the embodiment shown in the drawings, discharge electrodes 14 extend horizontally in substantially parallel lines, each line being formed from three separate electrodes, the first extending between top sections 18 and the upper of internal supports 24, the second extending between the two internal supports 24 and the third

extending between the lower of internal supports 24 and bottom section 20.

As best shown in FIGS. 2 and 3, the discharge electrodes are mounted on the sides of the frame so that a portion of the discharge electrodes between adjacent collection plates are eccentrically spaced closer to one of the adjacent collection plates while the balance of the discharge electrodes are eccentrically spaced closer to the other of said adjacent collection plates. Each discharge electrode is disposed so that side 27 thereof faces and is parallel to the more distant of the adjacent collection plates 10. As mentioned above, the frame 12 is centrally disposed between the collection plates and parallel thereto. Sides 27 of discharge electrodes 14 all face and are spaced from the central plane of frame 12, said frame central plane bisecting the space between adjacent collection plates and extending substantially parallel to said collection plates. Discharge electrode edges 28, at which corona is produced, are thus uniformly spaced from the respective facing collection plates at a distance greater than one-half the distance between the adjacent collection plates. Since side 30 of discharge electrode 14 is substantially free of sharp edges or points, substantially no corona is produced at that side even though it is closer to one of the adjacent collection plates than side 27 is to the other. Accordingly, a substantially unidirectional electrostatic field is produced at the sharp edges 28 of side 27, said field extending substantially in the direction of the more distant of the adjacent collection plates 10.

Due to the eccentric placement of the discharge electrodes and the unique design thereof, higher voltages may be applied to the frame and discharge electrodes than would be permitted if a conventional discharge electrode arrangement were utilized. It should be noted that the eccentric placement of a conventional wire discharge electrode actually decreases the allowable voltage. Corona is generated at the side of such electrodes which is brought closer to one of the collection plates, and the proximity of this corona to the collection plate will cause sparkover at voltages which would be permissible had the wire discharge electrodes been centrally disposed.

In the embodiment shown in the drawings, the lines of discharge electrodes are arranged so that those spaced closer to one of the collection plates alternates with those spaced closer to the other. This arrangement is shown merely by way of example and not by way of limitation, the arrangement of discharge electrodes in electrostatic precipitators according to the invention not being limited to a specific pattern. Thus, the lines of discharge electrodes could alternate repetitively in groups of two or more, or could be arranged so that the first half of the lines of discharge electrodes are spaced closer to one of the adjacent collection plates while the other half are spaced closer to the other of the adjacent collection plates.

Discharge electrodes utilized in electrostatic precipitators according to the invention need not be formed precisely as described above but should be adapted to produce a substantially unidirectional electrostatic field on the side thereof facing the more distant of the adjacent collection plates. Thus, side 27 of discharge electrode 14 need not be formed with arcuate notches but could be formed with square or V-shaped notches or with sharp points or ridges extending therefrom which are capable of producing a substantially unidirectional electrostatic field. On the other hand, regardless of the design of side 27 of discharge electrode 14, side 30 thereof should be substantially free of sharp edges or points so that substantially no corona is produced at that side. Thus, where the discharge electrode is formed from a substantially rectangular bar or a sheet of metal, the edges defining side 30 would be rounded off to increase the radius of curvature thereof. The discharge electrode could also be formed from a longitudinally extending sheet of metal in which case sides 27 and 30 would correspond to op-

posed edges of the sheet and would be formed as described above.

In addition to the advantages derived from the increased operating voltage possible with the electrostatic precipitator according to the invention, the foregoing arrangement also offers further structural and operational advantages over the known arrangements. Since the discharge electrodes are in the form of longitudinally extending rods or sheets supported at both ends on the frame of pipes, they can be subjected to greater stresses than the conventional wire discharge electrodes without rupture. Since rupturing of the wire electrodes, resulting in the short circuiting of the entire field is one of the most common causes of failure in electrostatic precipitators, this feature of the discharge electrode according to the invention is of great practical advantage.

Further, not only are discharge electrodes 14 less subject to rupture than conventional wire discharge electrodes, but their dimensional stability when mounted on frame 12 permits the system to be operated at higher potential without danger of breakdown due to sparkover.

One frequently used method of cleaning the electrostatic precipitator is a rapping system which periodically raps the collecting plates and the supports for the discharge electrodes to dislodge the precipitated material into hoppers. Frame 12, and discharge electrodes 14 secured thereto, are particularly adapted to be subjected to this stress due to the inherent strength of the arrangement according to the invention. In addition, the discharge electrodes according to the invention vibrate faster and harder than conventional wire discharge electrodes which usually extend the height of the collection plates. The relatively shorter length of the discharge electrodes 14 give them a higher frequency of vibration than the relatively long wire while their shape causes the amplitude and inertia of the vibrations to be greater than those of the wire. Accordingly, the discharge electrodes according to the invention are kept cleaner than the conventional wire discharge electrodes and are therefore more efficient. The discharge electrodes 14 also present a low aspect ratio to the fluid being cleaned and therefore are not subject to the extremes of stress to which long wire discharge electrodes are subjected.

Still a further advantage of discharge electrode 14 is the unique geometry of side 27. It has been found that the formation of sharp edges by means of a plurality of spaced notches produces a corona action which is more effective than that of the conventional electrodes. The discharge electrodes according to the invention produce improved ionization and cleaning without the inherent disadvantage of the frequently used pointed electrodes which generate a stronger "electric wind" to the collection plates which knocks precipitated dust loose and re-entrains it into the gas stream.

It will thus be seen that the objects set forth above, and those made apparent from the preceding description, are efficiently attained and, since certain changes may be made in the above construction without departing from the spirit and scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein described, and all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween.

What is claimed is:

1. An electrostatic precipitator comprising a plurality of spaced, substantially parallel collection plates; a plurality of tubular frame members, one of said frame members

being disposed between each adjacent pair of collection plates in a plane substantially parallel to said collection plates; and a plurality of discharge electrode plates each having a first edge formed with spaced notches therein for defining a plurality of spaced sharp edges or points in said first edge and a second edge opposed to said first edge substantially free of sharp edges and points, said discharge electrode plates being mounted on each of said frame members in planes extending substantially normally to said collection plates with the first edges thereof extending substantially parallel to said collection plates, and with a portion of said first edges eccentrically spaced closer to each of the collection plates adjacent thereto and facing the other, more distant of said adjacent collection plates, said frame member including first and second pairs of tubular edge sections, said discharge electrode plates extending between said second pair of edge sections, said discharge electrode plates being formed with arcuate recesses in the regions of said second pair of edge sections and engaging with the corresponding curved surfaces thereof.

2. An electrostatic precipitator as recited in claim 1, wherein the discharge electrode plates are mounted on each frame member with at least one of said discharge electrode plates having its first edge facing one of the adjacent collection plates alternating repetitively with at least one of said discharge electrode plates having its first edge facing the other of said collection plates.

3. An electrostatic precipitator as recited in claim 1, wherein said frame member includes at least one internal tubular section extending between said first pair of edge sections intermediate said second pair of edge sections, said discharge electrode plates extending between said second pair of edge sections and said intermediate section of said frame, said discharge electrode plates being formed with arcuate recesses in the regions of said internal sections and engaging with the corresponding curved surfaces thereof.

4. An electrostatic precipitator as recited in claim 1, including a plurality of substantially U-shaped partition members each having a base portion and a pair of wall portions extending from said base portion in generally diverging directions, said partition members being secured at their respective bases to said collection plates along lines extending substantially parallel to said discharge electrode plates and spaced relative to the facing first edges thereof, said partition member wall sections defining substantially turbulence free regions at said collection plates opposite said discharge electrode plate first edges.

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