Nov. 1, 1955 P. COOPERMAN 2,722,284

ELECTRICAL PRECIPITATOR

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Fig 2.

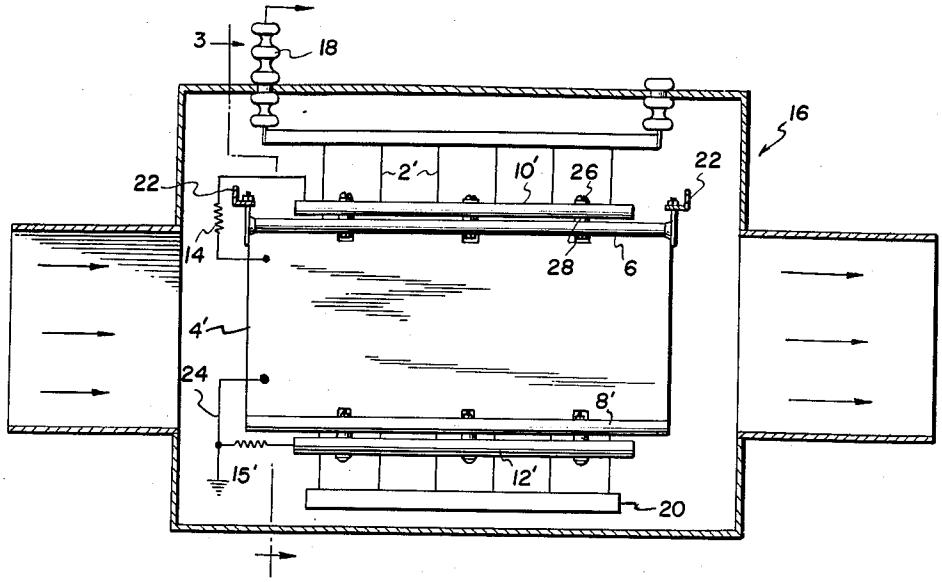


Fig 3.

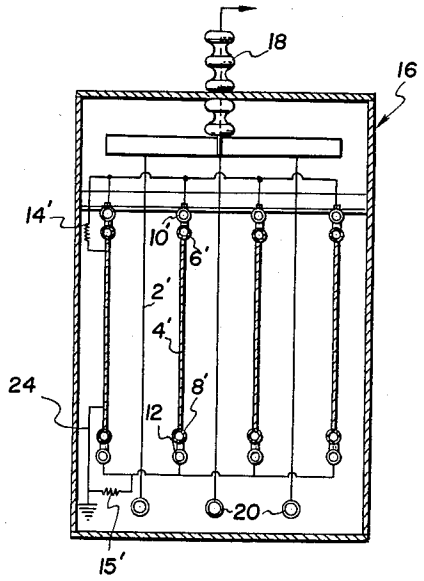
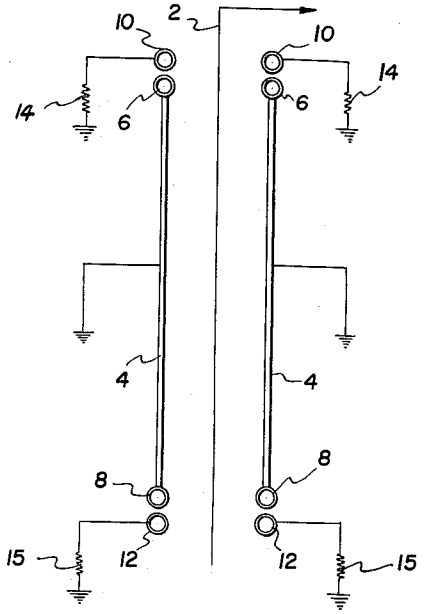


Fig 1.



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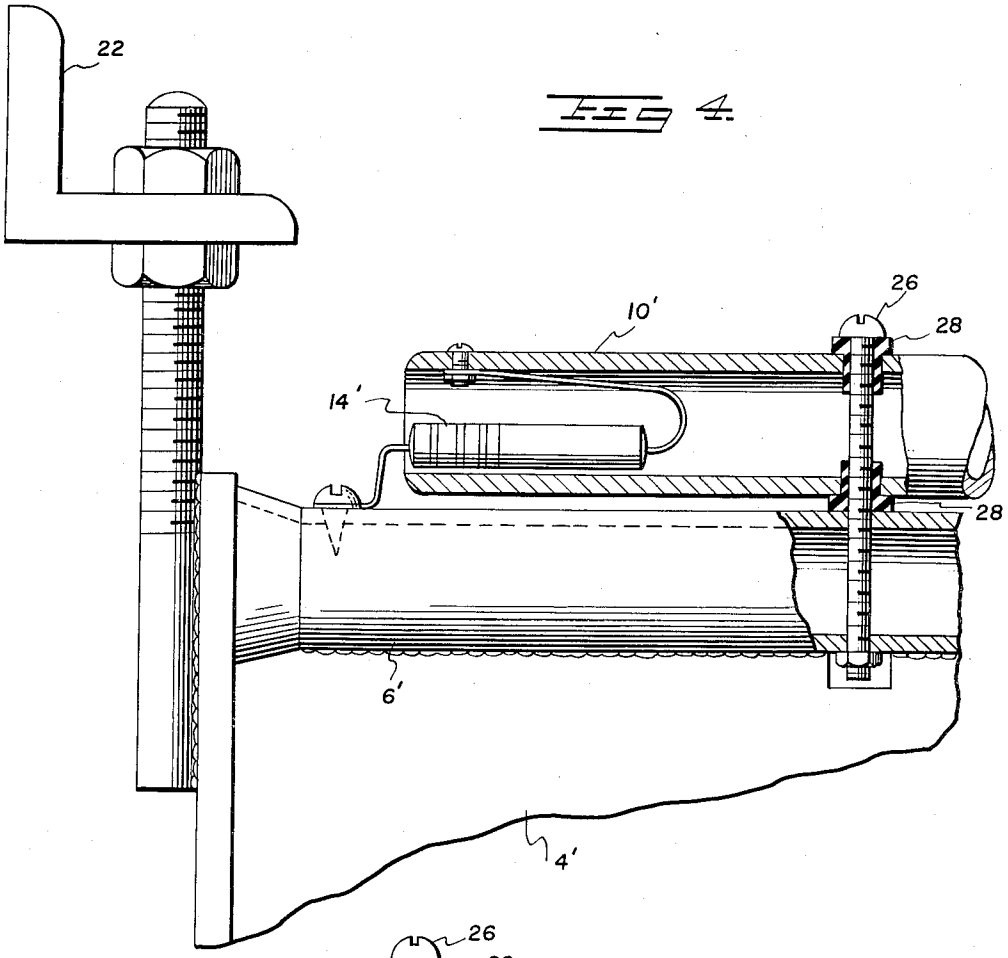


Fig 4.

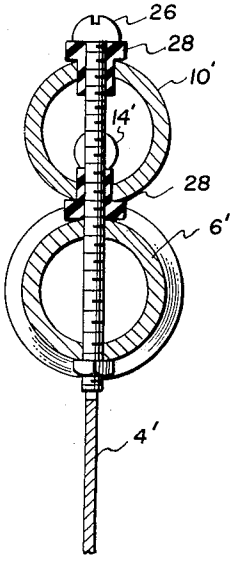


Fig 5.

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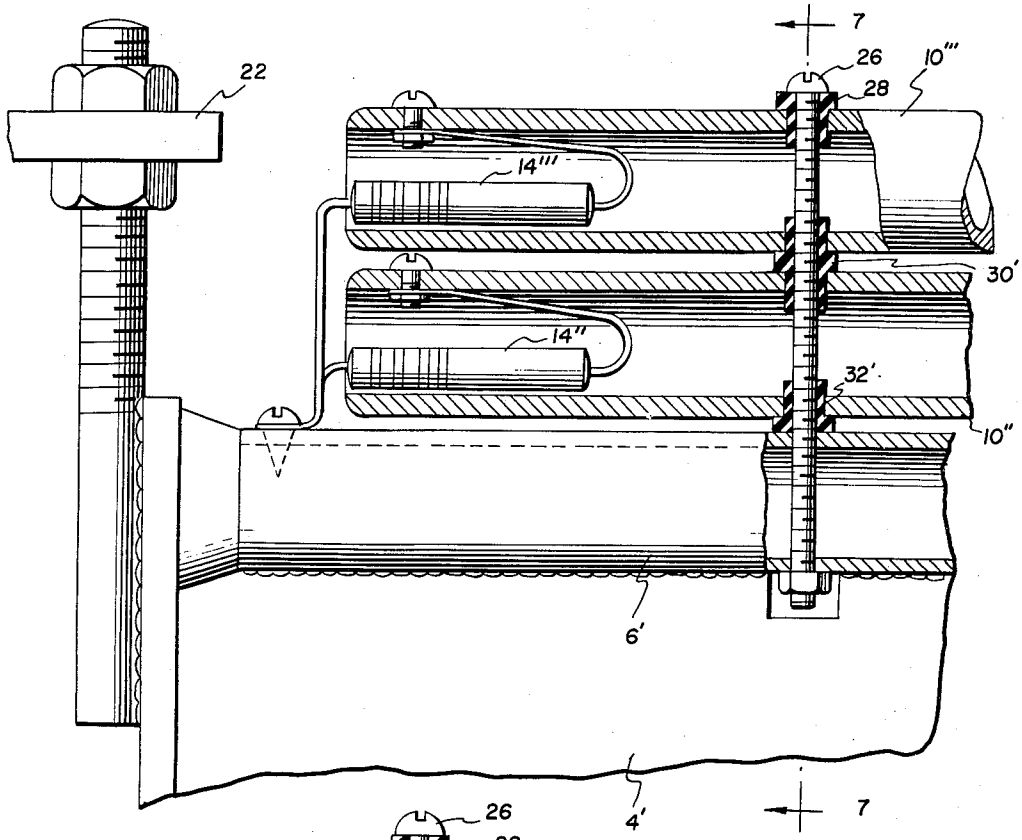
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ELECTRICAL PRECIPITATOR

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Fig 6.



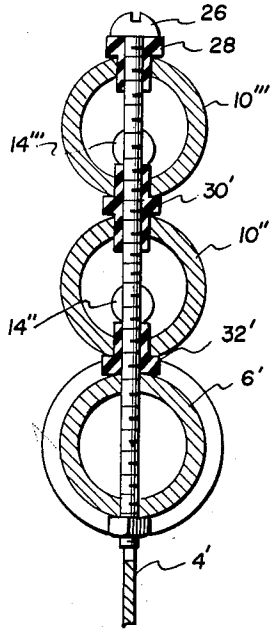


Fig 7.

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United States Patent Office 2,722,284 Patented Nov. 1, 1955

2,722,284

ELECTRICAL PRECIPITATOR

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Application January 26, 1954, Serial No. 406,288

8 Claims. (Cl. 183—7)

This invention relates to electrical precipitators and has for its primary object the reduction of deleterious sparking which limits the maximum useful precipitator voltage which may be applied to the electrodes of an electrical precipitator.

According to modern theory, sparking is caused by a chain of events, on a molecular scale, which start in the immediate vicinity of the positive electrode. This chain of events is triggered by electrons which have acquired a certain minimum amount of energy. Since electron energy is a function of the electric field strength, it is clear that sparking will start at the point or points of highest field strength. It is also evident that the maximum field at the surface of the electrode should be kept low in order to reduce sparking.

In an electrical precipitator, it is desirable to maintain a high average field at the surface of the collecting electrode, since the efficiency of particle collection increases with increasing field strength. The average field is, however, determined by the sparking voltage which, as shown above, is dependent on the maximum field at any point on the collecting plate. Thus, to improve the precipitator performance one must minimize the difference between maximum and average fields. This implies that the field at the collecting surface should be as uniform as possible.

Wherever the collecting electrode comes to an end, the lines of electric field strength tend to concentrate at the resulting edge. The effect may be thought of, in a manner of speaking, as due to the lines which would be present had the collecting electrode been infinitely large, going to the edge because there is no other place to go. Thus, the field strength at an edge may be enormously larger than at other points. In present practice, the field strength at the edges is reduced somewhat by attaching pipes to the edges of collecting plates so that the field lines have a larger area on which to terminate, thus reducing the crowding together of field lines.

It is known practice in precipitators using tubular electrodes, to flare the ends of the tubes away from the centrally disposed charging electrode. This accomplishes the purpose of reducing the concentration of field lines since the edge of the collector electrode is now brought further away from the discharge electrode than the main body of the collector electrode. However, where the precipitator is of the common form using a plurality of parallel plates for collector electrodes, with discharge electrodes between these plates, this expedient cannot be employed, since if the edge of the collecting plate is bent away from one electrode, it is thereby bent toward another electrode, which would make matters even worse.

The primary object of the invention is to provide a means for reducing the above edge-effect without altering the shape or dimensions of the collecting electrode, by simple and inexpensive means which are easily applied to precipitators of standard construction. A related object is to enable the voltage between electrodes to be raised without deleterious sparking and to thereby increase the efficiency of the precipitator.

Another object is to reduce sparking at the edges of a collector electrode having a substantial surface area terminating at an edge by adjusting the field strength at such edge so that the minimum crowding of field lines occurs.

The above objects are accomplished by placing biased conductors in proximity to such edges and maintaining these conductors at a suitable voltage with respect to the collector surface so as to procure the desired uniform distribution of field lines in the vicinity of the edge. Such voltage may be applied from an external source or may be more conveniently obtained by connecting the biased conductors to ground or to the collecting surface, through resistors to produce, in effect, a self-biased edge.

The specific nature of the invention as well as other objects and advantages thereof will clearly appear from a description of a preferred embodiment as shown in the accompanying drawing, in which:

Fig. 1 is a schematic diagram illustrating the principle of the invention;

Fig. 2 is a longitudinal diagrammatic view of a known type of parallel plate precipitator showing the invention embodied therein;

Fig. 3 is a view taken on line 3—3 of Fig. 2;

Fig. 4 is an enlarged view of a collector plate having an edge biased electrode according to the invention;

Fig. 5 is an enlarged detail view of a corner of the plate of Fig. 4 showing the manner of mounting the biased electrode;

Figs. 6 and 7 are views similar to Figs. 4 and 5 respectively, of a modified form of the invention employing two biased electrodes on each edge instead of one.

Referring to Fig. 1, the discharge electrode **2** of a precipitator is shown which may be in the form of a rod or a wire or a series of such rods or wires extending midway between two identical collector plates **4**, which are typically rectangular plates perpendicular to the plane of the drawing. The discharge electrode **2** is connected to a suitable source of high tension direct current (not shown), usually to the negative terminal of the source, while the positive side is connected to collector plates **4** and is generally grounded. It will be apparent that the edges of collector plates **4** which are parallel to the plane of the drawing may be extended sufficiently beyond discharge electrode **2** (or the outermost of such electrodes, if a series of them are used) so that there is no problem of edge-effect, since the distance from these edges to the nearest wire **2** may be made sufficiently great so that there is no undesirable concentration of field at these edges. However, the edges perpendicular to the plane of the drawing indicated at **6** and **8**, pass as close to the discharge electrode **2** as the rest of each collector electrode **4** and, therefore there will be an undesirable concentration of electric field intensity at these edges. It is customary, as previously explained, to round out these edges by terminating them in pipes **6** and **8** in order to provide a larger area at the edge than would otherwise be obtained. However, this expedient affords only partial relief, since if the pipe were made too large in diameter, it would approach so close to the discharge electrode tube as to defeat its purpose. According to the invention, a second pipe is placed parallel to and slightly spaced from each pipe **6**, and a suitable biasing voltage applied thereto. In practice, such a biasing voltage may be provided by means of a high resistance **14** connected at one end to each pipe **10** and grounded at the other end. Since pipe **10** is an area of extremely high voltage gradient, current will flow through resistor **14** to ground. The resulting voltage drop across resistor **14** therefore determines the bias of pipe **10** and may be so selected as to distribute the field intensity of the edge more uniformly than would be possible in the absence of this arrangement. In a typical

arrangement, at three inch spacing between wires 2 and plate 4, and without the biased conductors 10, the sparking voltage was 86 kv. After installing the biased conductors 10, and with a value of 20 megohms for resistors 14, the spacing between pipes 10 and 6 being of the order of ⅛ inch (and with a similar arrangement of pipes 8 and 12 and resistors 15) the sparking voltage was 96 kv. In other words, it was possible to maintain a much higher precipitator voltage without harmful sparking.

Figs. 2 and 3 show the invention applied to a typical parallel-plate precipitator contained in a gas duct section 16. A series of discharge electrodes 2' are supported midway between the adjacent parallel surfaces of collector plates 4' and are all connected in parallel through high tension bushing 18 to the usual source of high tension (not shown). A weighted rod 20 is provided for each longitudinally extending series of discharge electrodes in order to keep them straight and midway between the collector plates. Collector plates 4' are supported at their upper corners by structural iron members 22 which extend transversely across the duct and are fastened to the side walls thereof. This serves to ground the collector plates, as is indicated diagrammatically at 24. The construction described so far is conventional. Fixed to pipe 6' which terminates the top edge of each electrode plate 4' is a biased conductor 10', which may be a second pipe slightly shorter than 6' and may be fastened to pipe 6' by means of insulated screws 26 and insulating spacers 28. Resistor 14' may conveniently be disposed inside of pipe 10' and near one end as best shown in Fig. 4. This serves to protect the resistor both mechanically and electrically. A separate resistor 14' may be used with each pipe 10', similar to the arrangement shown in Fig. 4, or a single resistor of adequate capacity may be connected to all of the pipes 10' in parallel as shown in Figs. 2 and 3. A similar arrangement of pipes 12' with respect to lower pipes 8' is provided for the bottom edge of each collector electrode.

Figs. 6 and 7 show an arrangement using two biased conductors 10'' and 10''', respectively, to procure still finer control of the field distribution adjacent the edge of collector 4'. Resistor 14''' associated with second biased conductor 10''' is shown connected directly between its biased conductor and ground, but could be connected in series with resistor 14''. It will be apparent that the value of the resistances should be adjusted in each case in accordance with the value of the voltages used and with the geometry of the electrodes, to give a smoothly changing field distribution at the edges of collector electrodes 4'. A similar arrangement will, of course, be employed at the bottom edge of each electrode. Insulating bushings 30' electrically isolate biasing conductor 10''' from biased conductor 10''; and insulating bushing 32' similarly isolates biased conductor 10''' from edge-pipe 6' of collector electrode 4'.

Although the collector electrodes are shown as parallel plane electrodes, it will be apparent that the invention is not restricted to this configuration, but is equally applicable to other arrangements and configurations of electrodes, the essential feature being the reduction of edge concentrations of field intensity by means of biased conductors placed adjacent the electrode edges.

It will be apparent that the embodiments shown are only exemplary and that various modifications can be made in construction and arrangement within the scope of the invention as defined in the appended claims.

I claim:

1. Apparatus for the electrical precipitation of suspended particles from gas comprising a high tension discharge electrode, a grounded collector electrode spaced from said high tension discharge electrode for the passage of gas therebetween, said collector electrode having an extensive area, at least one edge of which terminates near said discharge electrode, an electrical conductor parallel to and spaced by a predetermined distance from said edge and at substantially the same distance from said discharge electrode as said edge, and means for applying a biasing potential to said conductor of a value intermediate the potential existing between said collecting electrode and said discharge electrode.

2. The invention according to claim 1, wherein said electrical conductor lies substantially in the extended surface of said area.

3. The invention according to claim 2, including a second conductor spaced from said first conductor, and means for applying a biasing potential to said second conductor of a value intermediate the potential between said first conductor and said discharge electrode.

4. The invention according to claim 2, said biasing means comprising an electrical resistance element connected between said electrical conductor and said collector electrode.

5. The invention according to claim 3, said second biasing means comprising a second electrical resistance element connected between second electrical conductor and collector electrode.

6. In combination with an electrical precipitator having a gas-conducting duct, a plurality of parallel spaced collector electrodes of extended surface area in said duct, a plurality of discharge electrodes spaced from and intermediate said collector electrodes, means for applying a high electrical potential between said discharge and collector electrodes, and edge-effect reducing means for said collector electrodes, said last means comprising a series of biased conductors respectively parallel to and spaced by a fixed distance from respective edges of said collector electrodes and at substantially the same distance from the discharge electrodes as the collector electrodes, and means for applying a biased potential to said biased conductors of a value intermediate the potential between said collector electrodes and said discharge electrodes.

7. The invention according to claim 6, said biasing means comprising electrical resistance means connected between said collector electrodes and said biasing electrodes.

8. The invention according to claim 7, including further biased electrode means spaced from said first biased electrode means, and further electrical resistance means connected between said further biased means and said collector electrodes.

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