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H. A. WINTERMUTE
GAS FLOW CONTROL FOR ELECTRICAL
PRECIPITATORS AND THE LIKE

2,608,266

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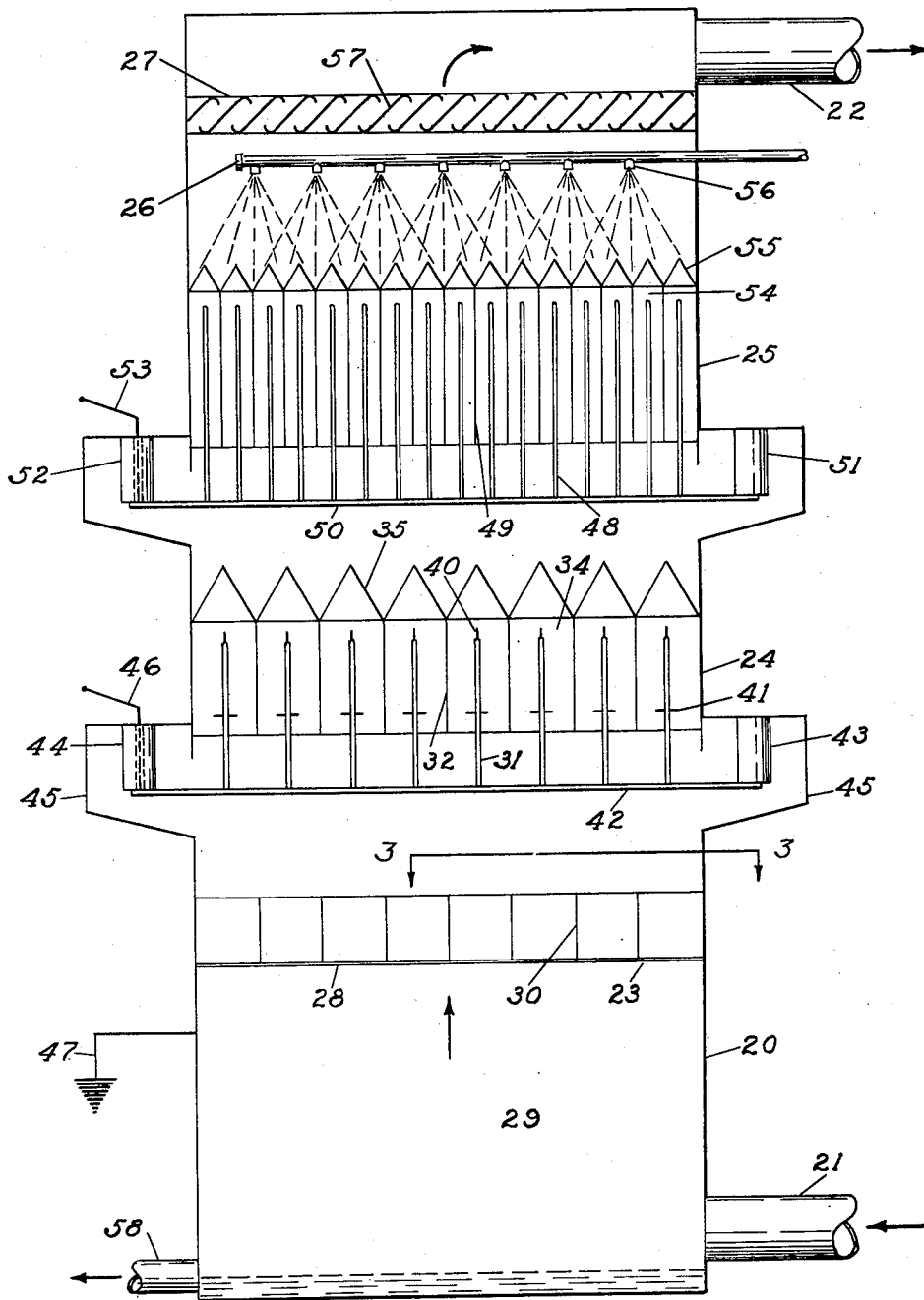


Fig. 1.

INVENTOR.
Harry A. Wintermute.
BY
Stowell & Evans
Attorneys

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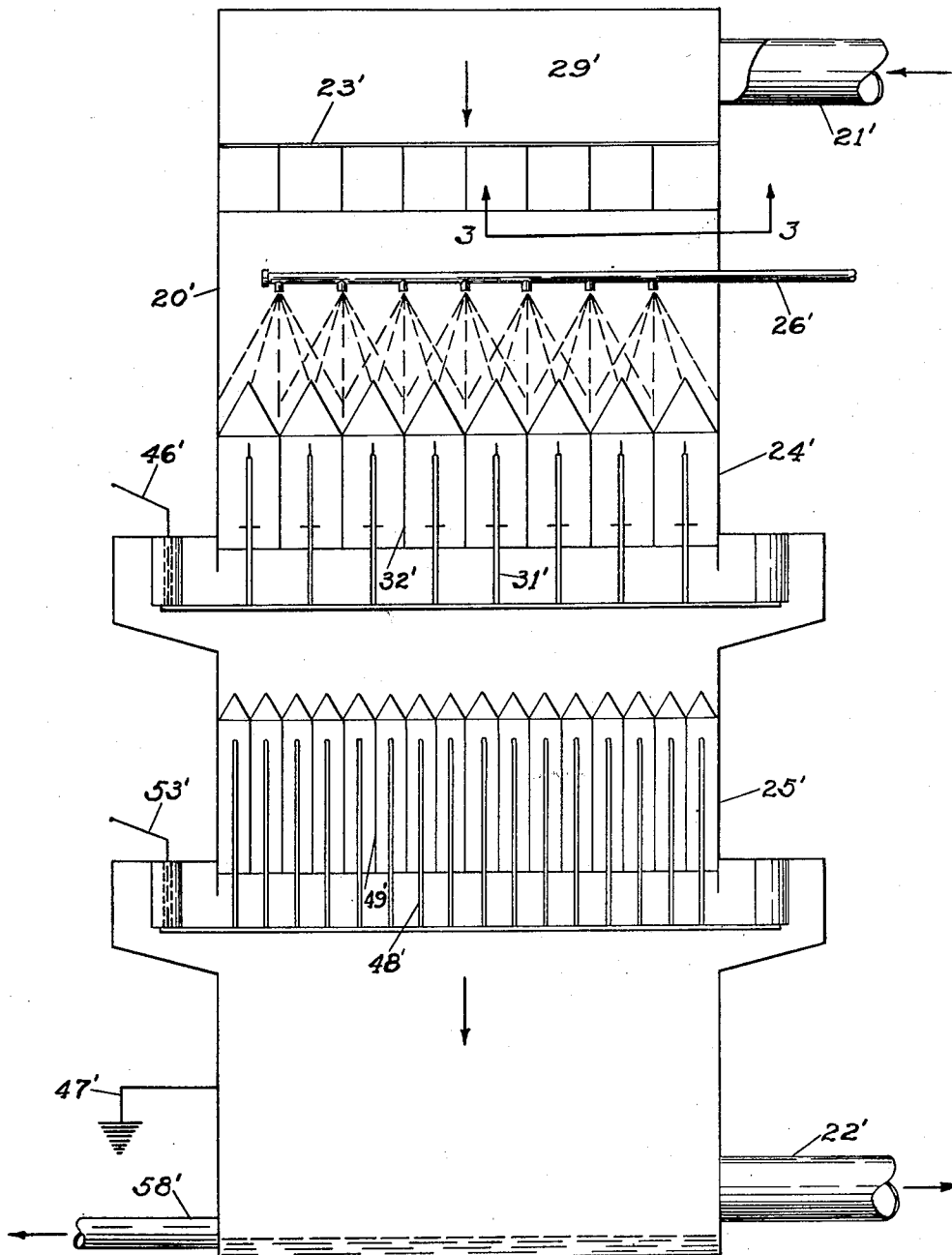


Fig. 2.

INVENTOR.
Harry A. Wintermute.
BY

Stowell & Evans
Attorneys

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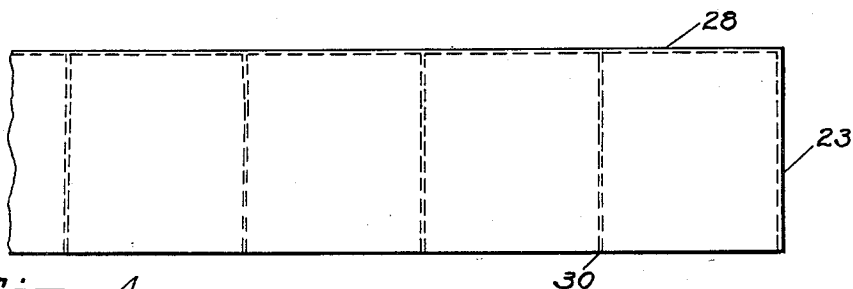


Fig. 4

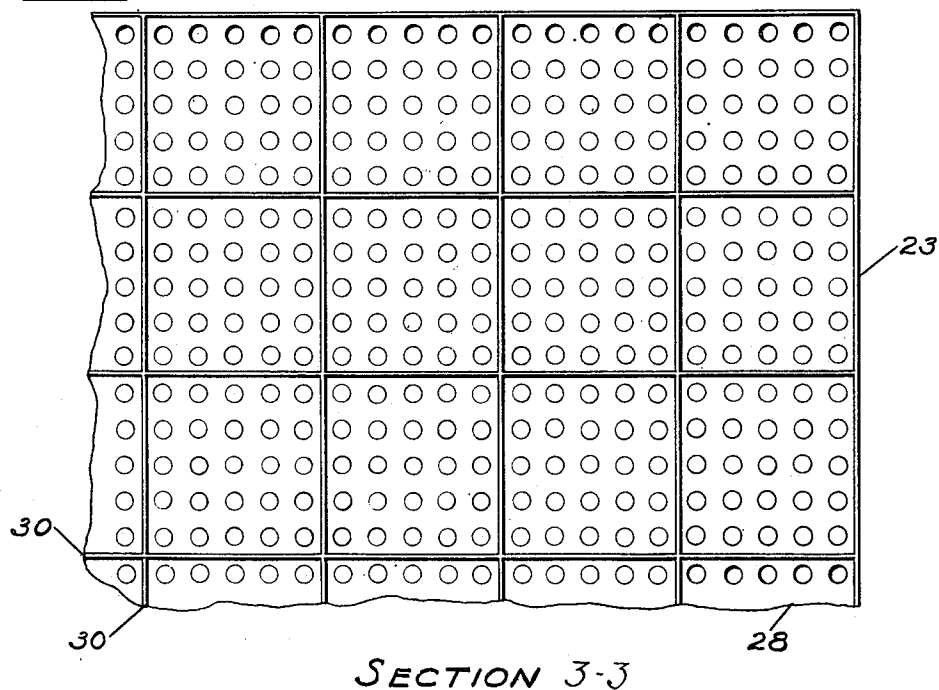


Fig. 3

INVENTOR.
Harry A. Wintermute.
BY
Stowell & Evans
Attorneys

UNITED STATES PATENT OFFICE

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GAS FLOW CONTROL FOR ELECTRICAL
PRECIPITATORS AND THE LIKE

Harry A. Wintermute, Plainfield, N. J., assignor
to Research Corporation, New York, N. Y., a
corporation of New York

Original application September 24, 1946, Serial
No. 698,978, now Patent No. 2,555,216, dated
May 29, 1951. Divided and this application
August 1, 1949, Serial No. 107,896

5 Claims. (Cl. 183-7)

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This invention relates to electrical precipitators and more particularly to electrical precipitators having means providing for uniform gas flow therethrough. The invention is particularly adapted to electrical precipitators having liquid-flushed collecting electrodes. The invention relates more particularly to gas flow distributors especially suitable for use in electrical precipitators.

An object of the invention is to provide an electrical precipitator that may be of the vertical-flow type wherein the extended surface electrodes extend in the vertical direction and that may include means for washing the extended surface electrodes with a liquid, wherein means is provided for establishing substantially uniform gas flow past the extended surface electrodes.

Another object is to provide an improved gas flow distributor for electrical precipitators.

Another object is to improve the efficiency of operation of electrical precipitators by providing for uniform gas flow through the precipitator whereby maintenance of high gas velocities is facilitated.

Typically, an electrical precipitator in accordance with the invention includes a casing, extended surface electrodes in the casing defining a plurality of gas passages, complementary precipitating electrodes in each of the gas passages, a plenum chamber in the casing on the upstream side of the gas passages, and gas inlet means opening into the plenum chamber. In such a precipitator, there is provided means for establishing substantially uniform gas flow through the gas passages comprising a perforate plate member extending transversely of the casing between the plenum chamber and the gas passages and a plurality of web members defining other gas passages extending from the perforate plate rectilinearly towards the first gas passages. The electrical precipitator may be of the vertical-flow type wherein the extended surface electrodes define vertically extending gas passages and means may be provided for flushing the electrodes with washing liquid.

The invention will be more particularly described and other of its aims, objects and advantages will be in part apparent and in part pointed out in the following detailed description taken in connection with the accompanying drawings in which:

Fig. 1 is a vertical sectional view taken through an up-draft vertical-flow precipitator embodying the principles of the invention;

Fig. 2 is a similar view of a down-draft elec-

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trical precipitator constructed in accordance with the invention;

Fig. 3 is a sectional view taken along the line 3-3 of Figs. 1 and 2 showing the gas flow distributing assembly; and

Fig. 4 is a side view of the assembly shown in Fig. 3.

Referring to the drawings, particularly to Fig. 1 thereof, the up-draft, vertical-flow, two-stage precipitator shown has a casing 20, a gas inlet conduit 21 at the bottom, and a gas outlet conduit 22 at the top. Gas initially bearing suspended solid or liquid particulate matter, such as dust, smoke, mist and the like, is passed through the precipitator by a fan or other suitable means (not shown) in the directional sense of the arrows of Fig. 1, entering the precipitator from the inlet 21, flowing vertically upwardly through the casing 20 wherein it is cleaned, and leaving the apparatus in a cleaned condition by way of outlet 22.

Positioned within the casing successively in the direction of gas flow are a gas flow distributor 23, a charging section 24, a collecting section 25, a liquid spray device 26, and a spray eliminator 27.

As best shown in Figs. 1, 3 and 4, the gas flow distributor has a perforate plate 28 extending transversely across the casing to define the upper boundary of a plenum chamber 29, the side and bottom boundaries of which are delimited by the lower side walls and bottom of the casing 20. Above the plate 28 there is positioned a cell-like structure, the cells of which are open at top and bottom and are formed by a plurality of web members 30 extending interlockingly across the casing. It will be observed that the web numbers 30 define gas passages extending from the perforate plate 28 rectilinearly toward the charging section 24.

The charging section 24 has a set of discharge electrodes 31 and a set of complementary extended surface electrodes 32. The extended surface electrode assembly 32 is formed largely from perforate web material, specifically woven wire screen. The extended electrode surfaces are of substantial vertical extent and are arranged in cellular fashion to provide a plurality of contiguous, vertically extending gas passages 34 having a square cross section. It will be understood that a discharge electrode 31 projects centrally upwardly into each of the gas passages, as indicated in Fig. 1.

Each of the top openings of the gas passages 34 is capped by a liquid distributing member 35, which, in the modification shown, takes the

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form of an equilateral pyramidal cover for the top of the gas passage. Any suitable method of attachment may be employed to secure the caps to the electrodes proper; for example, the caps may be soldered to the extended surface electrodes. Although it is preferred that the bottoms of the caps contact the sides of the electrodes proper along a line somewhat below the tops of the electrodes, since liquid distribution is thereby facilitated, it will be understood that the line of contact may, if desired, be along the top edges of the extended surface electrodes. The caps are of screen or other perforate material.

The complementary discharge electrodes 31, which project into each gas passage of the extended surface electrode structure 32, have fine-wire discharge portions such as are indicated at 40 and 41. The discharge electrodes 31 are supported on transverse bus bars 42 carried by insulators 43 and insulating bushings 44 secured to the casing 20 in protected recesses 45 at the sides of the casing.

A source of high tension current (not shown) supplies power to the discharge electrodes 31 through a lead 46 which passes through the insulating bushing 44 and is connected to the bus bar 42. The casing may be grounded as indicated at 47, and through the casing, the extended surface electrode structure 32 may also be grounded.

The collecting section 25 is very similar in construction and arrangement to the charging section 24. It has complementary precipitating electrodes 48 and collecting electrodes 49.

The precipitating electrodes are mounted similarly to the discharge electrodes 31 on transverse bus bars 50 supported by insulators 51 and insulating bushings 52 housed in recesses at the sides of the casing. A conductor 53, which passes through the bushing 52 and is connected to the bus bar 50, leads high tension current to the precipitating electrodes 48. It will be noted that precipitating electrodes 48 have no discharge points or fine wires.

The collecting electrodes 49 are in the form of perforate web structures similar in every respect to the extended surface electrode structures 32 hereinbefore described in connection with the charging section 24, although the size and shape of the gas passages in the two sections of the precipitator may be different. Specifically, the gas passages 54 provided by the collecting electrode structure 49 may be smaller in cross section than the gas passage 34 of the charging stage to enable the use of lower potentials in the collecting stage. The gas passages 54 may be formed in any appropriate transverse sectional configuration and are capped by the liquid distributing members 55 that are similar in construction to the liquid distributors 35 described hereinbefore.

The liquid spray device 26 is positioned above the collecting electrode structure 49 to direct a spray of flushing liquid upon the liquid distributors 55 from a plurality of nozzles 56.

Spray eliminator 27 may be of any suitable or conventional design but it is specifically shown as comprising a plurality of horizontally spaced, transverse slats 57 having hooked upper and lower edges. The slats may be inclined in the direction of gas flow and function to remove entrained water from the cleaned gas stream leaving the precipitator.

At the bottom of the plenum chamber 29, a liquid outlet 58 is provided for the discharge

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of liquid from the sump. Conventional trap means (not shown) may be included in the liquid outlet to prevent leakage of gas therethrough while permitting discharge of liquid.

In operation of the precipitator of Fig. 1, gas to be cleaned is passed through the precipitator from bottom to top. Corona discharge is established in the charging section 24 and a high tension electrostatic field is set up in the collecting section 25 by applying suitable high potential electric currents to the complementary electrodes of these sections, as will be apparent to those skilled in the art of electrical precipitation.

Either continuous or intermittent flushing may be employed. If the flushing of the electrodes is to be carried on continuously during gas cleaning, the spray device 26 is put into operation to deliver steady sprays of flushing liquid, which may be oil, water or water containing wetting agents or other additive materials, to the liquid distributors 55. If the conditions of operation do not require continuous flushing, the spray device may be turned on periodically or occasionally as desired, either manually or by automatic time-controlled means (not shown), for a time sufficient to effect the desired washing of the electrodes.

The spray of flushing liquid is directed downwardly upon the tops of the distributors 55 of the collecting section, and is intercepted by these distributors. The intercepted liquid is conducted or directed by the distributors to the vertical collecting electrodes proper down which it flows in a uniform film to wash the collecting electrodes free from precipitated material.

Flushing liquid drops from the bottoms of the collecting electrodes 49 and falls in the form of a spray upon the tops of distributors 35 of the charging stage. The distributors 35 serve to intercept and direct flushing liquid downwardly over the surfaces of extended surface electrodes 32 from which the liquid falls to and through the gas flow distributor 23 to the sump at the bottom of the plenum chamber 29 from which the liquid is discharged through outlet 58 to waste or to means (not shown) for recirculating it to the spray device 26.

The gas to be cleaned passes into the plenum chamber 29 from the gas inlet 21. In the plenum chamber, the gas must change direction to flow upwardly through the precipitator. The perforated plate 28 of the gas flow distributor serves to create back pressure in the plenum chamber and to distribute the flow of gas substantially uniformly across the casing. The transverse web members 30 function to straighten the flow lines of the gas stream and to direct the gas stream substantially rectilinearly toward the gas passages 34 of the charging section.

In the charging section, ionization of the gas and charging of suspended particles occurs, in general together with some precipitation of charged particles upon the extended surface electrodes 32. The gas carrying the charged particles then passes through the gas passages 54 of the collecting stage where the charged particles are largely precipitated upon the collecting electrodes 49. Cleaned gas passes upwardly through the spray eliminator 27, where the bulk of entrained flushing liquid is removed, and out of the precipitator through outlet 22 to use.

The embodiment of the invention shown in Fig. 2 is similar to that shown in Fig. 1. In Fig. 2, primed reference numerals denote parts corre-

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sponding to parts bearing like but unprimed numerals in Fig. 1.

Referring to Fig. 2, the precipitator shown is of the vertical-flow, down-draft type having a casing 20', a gas inlet pipe 21' at the top and a gas outlet pipe 22' at the bottom. Disposed within the casing successively in the direction of gas flow in a gas flow distributor 23', a liquid spray device 26', a charging section 24', and a collecting section 25'. A liquid discharge pipe 58' is provided for draining the sump of the precipitator. The upper part of the casing together with the gas flow distributor 23' defines a plenum chamber 29' into which the gas inlet pipe 21' leads gas to be cleaned. Gas flow is indicated by the arrows.

The operation of the modification of Fig. 2 is substantially the same as the operation of the device of Fig. 1 as previously described herein, allowances being made for the reversal of gas flow. If desired, a spray eliminator similar to the spray eliminator 21 of Fig. 1 may be employed at the gas outlet of the down-draft unit of Fig. 2.

The spray intercepting devices and the extended surface electrodes proper where made of screen advantageously are formed from wire screening, preferably of one-eighth to three-sixteenths inch mesh, or the like, but may, if desired, be formed from other foraminous material.

The spray intercepting and distributing elements may be used in some two-stage precipitators on only one set of the extended surface electrodes; for example, it may be desirable to dispense with the elements on one set of extended surface electrodes where the cross section of the gas passages defined by them is relatively small and/or the need for flushing the electrodes of that section is relatively minor as compared with the need for flushing the electrodes of the other section.

The spray intercepting and distributing elements may induce a slight back pressure on the gas flowing through the gas treating zones and thereby assist in the even distribution of gas flow through the several gas passages. It will also be seen that the elements provide an effective additional extended electrode area which may serve for collecting charged particles.

In the devices of Figs. 1 and 2, the discharge electrodes 31 and 31' are shown as having a plurality of discharge points. Such an arrangement allows the use of an increased amount of corona current over an arrangement wherein only one discharge point is provided at the end of the high tension electrode, and this without increasing the undesirable formation of ozone. Such arrangement also serves to distribute the corona discharge over a relatively wide area and thus to charge suspended particles more completely with resultant higher gas cleaning efficiency.

It will be evident that the gas distributor and straightener of the invention may be constructed as a unit for installation in pre-existing precipitators.

The straightening vanes 30 may define gas straightening zones having cross-sectional areas other than square; for example these areas may be rectangular, hexagonal or of any other convenient shape as long as the gas straightening zone is boxed in by numerous rectilinear dividing walls. The gas straightening compartments defined by the vanes 30 may be of any convenient

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size which depends to some extent upon gas velocity. With gas velocities of about 6 to 10 feet per second through the vanes, the gas straightening compartments may be in the form of cubes measuring 4 to 5 inches on a side. It is not essential that the cellular gas straightening vane assembly about the perforated plate; it may be spaced somewhat from the plate on the downstream side thereof.

The perforated plate 38 should be fairly thin consistent with adequate mechanical strength. Plates from $\frac{1}{16}$ " to $\frac{3}{8}$ " or even $\frac{1}{2}$ " in thickness are generally suitable. The perforations in the plate are relatively small, being of the order of $\frac{1}{4}$ " to $\frac{1}{2}$ " in diameter, and are regularly spaced to give 30% to 40% of open space through the plate. The percentage area of the perforations, based on the total plate area, will depend in part on the gas velocity. A small back pressure of the order of 0.03 to 0.15 inch of water should exist across the perforated plate for the purpose of securing even gas distribution over the entire plate area.

The gas distributor and straightener of the invention is particularly useful for installations in which a relatively small gas inlet conduit feeds into a plenum chamber of relatively large cross-section. The resultant decrease in gas velocity and expansion laterally of the direction of flow cause large variations in velocity and direction of flow of the gas, which inequalities are effectively removed by the construction of the present invention. Also, the distributor and straightener of the invention is practically equally effective whether the gas inlet conduit is in line with the gas flow through the treator or whether it is disposed at more or less of an angle thereto.

Although the invention has been particularly described in its use in vertical-flow, liquid-flushed precipitators, it will be apparent that the gas distributor and straightener may be employed in horizontal flow precipitators and the like.

The term "casing" is used herein in a broad sense and is intended to include a shell, housing, or other enclosure such as a specially constructed room for containing the precipitator equipment, and in which the equipment may be removably mounted.

This application is a division of my co-pending application Serial No. 698,978, filed September 24, 1946, now Patent 2,555,216 dated May 29, 1951 for "Electrical Precipitators."

I claim:

1. In an electrical precipitator including a casing, extended surface electrodes defining a plurality of gas passages extending longitudinally of said casing, complementary precipitating electrodes in each of said gas passages, a plenum chamber in said casing on the upstream side of said gas passage and gas inlet means opening into said plenum chamber, means or establishing substantially uniform gas flow through said gas passages comprising a perforate plate member extending transversely of said casing between said plenum chamber and said gas passages and a plurality of laterally spaced web members extending longitudinally of said casing between said perforate plate and said gas passages, each of the spaces between the web members being located to receive gas from a plurality of the perforations of said plate member.

2. In an electrical precipitator including a casing, extended surface electrodes defining a plurality of gas passages extending longitudinally of said casing, complementary precipitating elec-

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trodes in each of said gas passages, a plenum chamber in said casing on the upstream side of said gas passages and gas inlet means opening into said plenum chamber, means for establishing substantially uniform gas flow through said gas passages comprising a perforate plate member extending transversely of said casing between said plenum chamber and said gas passages and a plurality of web members defining other gas passages extending from said perforate plate rectilinearly toward said first gas passages, each of the gas passages defined by said web members being located to receive gas from a plurality of the perforations of said plate member.

3. In an electrical precipitator including a casing, extended surface electrodes defining a plurality of gas passages extending longitudinally of said casing, complementary precipitating electrodes in each of said gas passages, a plenum chamber in said casing on the upstream side of said gas passages and gas inlet means opening into said plenum chamber, means for establishing substantially uniform gas flow through said gas passages comprising a perforate plate member extending transversely of said casing between said plenum chamber and said gas passages and a plurality of spaced web members defining gas straightening passages of substantially greater cross-sectional area than the cross-sectional area of the perforations of said plate member extending longitudinally of said casing between said perforate plate and said gas passages, each of the spaces between said web members being located to receive gas from a plurality of the perforations of said plate member.

4. In an electrical precipitator including a casing, extended surface electrodes defining a plurality of gas passages extending longitudinally of said casing, complementary precipitating electrodes in each of said gas passages, a plenum chamber in said casing on the upstream side of said gas passages and gas inlet means opening into said plenum chamber, means for establishing substantially uniform gas flow through said gas passages comprising a perforate plate member extending transversely of said casing between

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said plenum chamber and said gas passages and a plurality of spaced web members defining cellular gas straightening passages of substantially greater cross-sectional area than the cross-sectional area of the perforations of said plate member extending longitudinally of said casing between said perforate plate and said gas passages, each of said cellular gas straightening passages being located to receive gas from a plurality of the perforations of said plate member.

5. In an electrical precipitator including a casing, extended surface electrodes defining a plurality of gas passages extending longitudinally of said casing, complementary precipitating electrodes in each of said gas passages, a plenum chamber in said casing on the upstream side of said gas passages and gas inlet means opening into said plenum chamber, means for establishing substantially uniform gas flow through said gas passages comprising a perforate plate member extending transversely of said casing between said plenum chamber and said gas passage and a plurality of spaced web members extending longitudinally of said casing from a surface of said perforate plate towards said gas passages each of the spaces between said web members being located to receive gas from a plurality of the perforations of said plate member.

HARRY A. WINTERMUTE.

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