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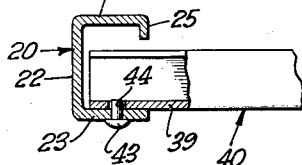
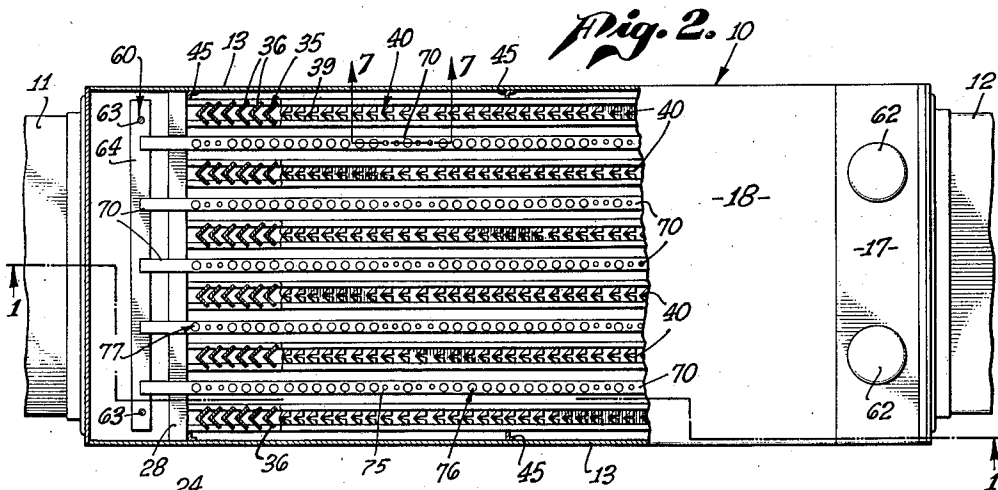
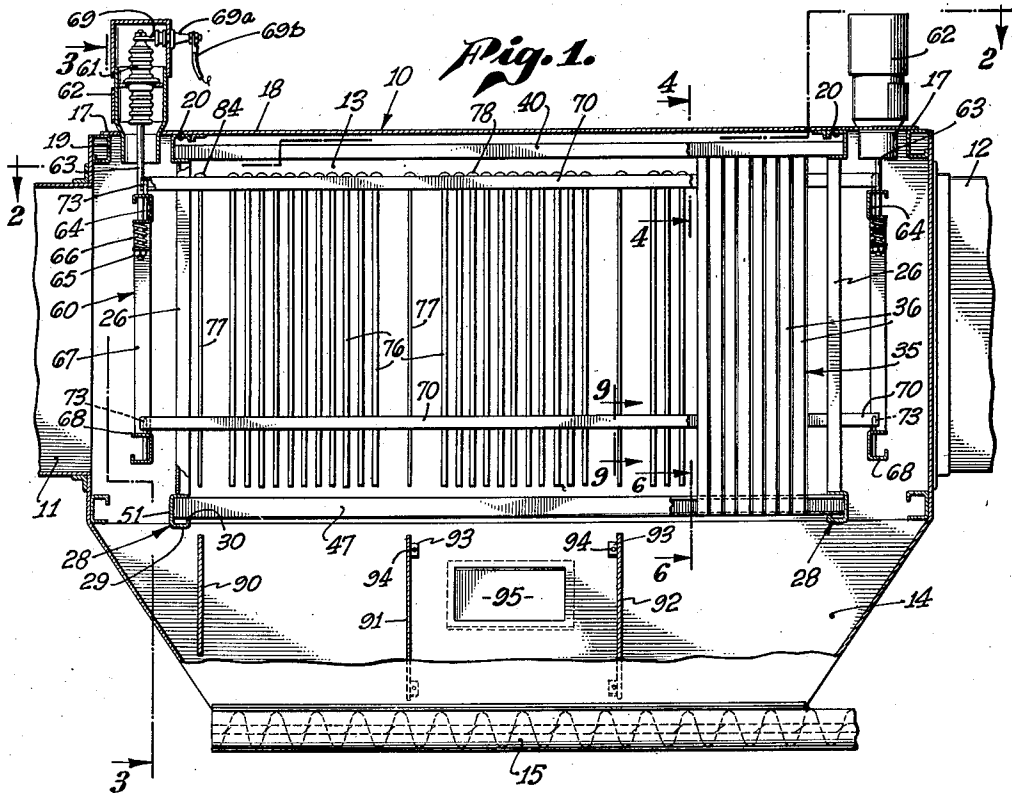
H. J. WHITE

2,369,877

ELECTRICAL PRECIPITATION APPARATUS

Filed July 13, 1942

3 Sheets-Sheet 1



INVENTOR.
HARRY J. WHITE,
BY *Alfred W. Knight*
ATTORNEY.

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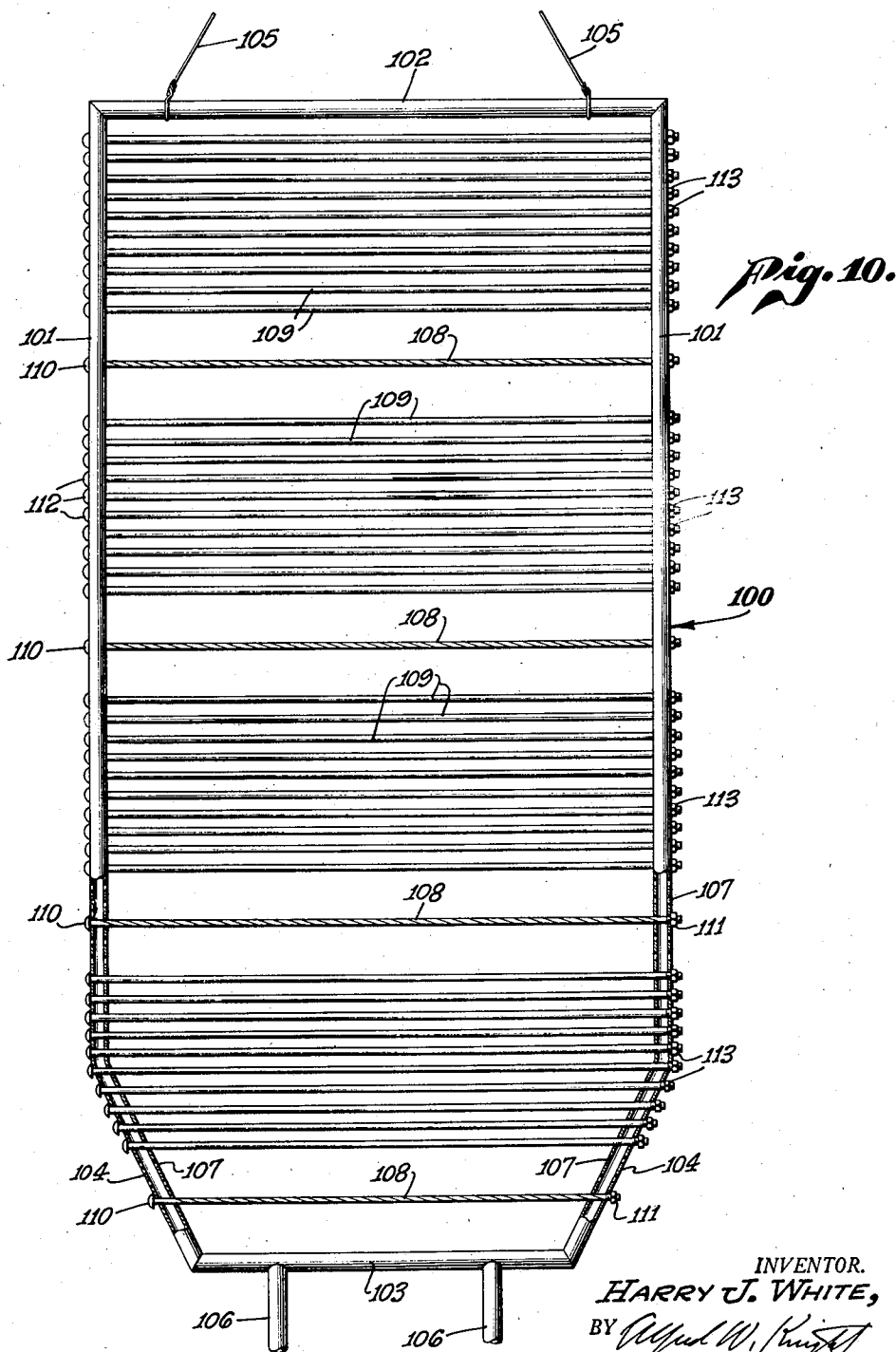
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ELECTRICAL PRECIPITATION APPARATUS

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INVENTOR.
HARRY J. WHITE,
BY *Alfred W. Knight*
ATTORNEYS.

UNITED STATES PATENT OFFICE

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ELECTRICAL PRECIPITATION APPARATUS

Harry J. White, Cambridge, Mass., assignor to
Research Corporation, New York, N. Y., a cor-
poration of New York

Application July 13, 1942, Serial No. 450,711

5 Claims. (Cl. 183—7)

The present invention relates generally to apparatus for electrical precipitation of suspended particles from gases, and more particularly to multiple stage precipitators of the type in which the particle-laden gas passes alternately through electrostatic charging fields, in which corona discharge is maintained to charge the suspended particles, and spatially separate electrostatic precipitating fields, of high stress but substantially free from corona discharge, in which the charged particles are precipitated. There may be one or more charging fields, and there will normally be a precipitating field following each charging field. The gas is thus subjected successively to two kinds of functionally distinct fields, and for this reason a precipitator of this type may be termed a multiple stage precipitator. In its elemental form, such a precipitator has each of its charging fields established between two electrodes, of which one is a discharge electrode and the other is a non-discharging electrode, and has each of its precipitating fields established between two substantially non-discharging electrodes. A multiple stage treater of this general type was disclosed in Patent No. 1,343,285, granted June 15, 1920, to W. A. Schmidt, and the advantages of a precipitator employing a spatially separate precipitating field, as well as the advantages of a multiplicity of sets of alternating spatially separate charging and precipitating electrodes, are set forth therein. Reference is also made to Patent No. 2,199,390, granted May 7, 1940, to E. Anderson, in which the advantages of a precipitating field that is spatially separate from the charging field are set forth in some detail.

In the following description and appended claims, the term "discharge electrode" will be understood to designate an electrode that facilitates corona discharge, because it has a configuration that establishes a sufficiently high potential gradient at or near its surface to create corona discharge before there is a disruptive discharge or sparkover. For this purpose, the discharge electrode usually takes the form of a member of small surface area, such as a small diameter wire or a rod provided with sharp edges or points, whereby there may be created in the immediate vicinity thereof a sufficiently high electric field intensity to cause ionization and corona discharge. The term "non-discharging electrode" will be understood to designate an electrode that minimizes or prevents corona discharge therefrom because it has a configuration that establishes a sufficiently low field concentration at or near the surface to suppress corona discharge at elevated

potentials lower than the voltage required for disruptive discharge or sparkover. For this purpose, a non-discharging electrode is usually one of extended surface area, substantially free from sharp corners or other parts of sharp surface curvature at all portions which are located within the electric field, so as substantially to avoid ionization or corona discharge at that electrode.

The present invention deals with improvements in the construction of multiple stage electrical precipitators of the general type referred to, and, in certain particular aspects, may be regarded as having to do especially with improvements in the precipitation shown in Figs. 5, 6 and 7 of Patent No. 2,275,001, granted March 3, 1942, to E. Anderson. The precipitator disclosed in said patent has collecting electrodes of the so-called "pocket" type, i. e., forming collecting pockets outside but immediately adjacent the main gas stream, but while the present invention is particularly applicable to precipitators having such pocket electrodes, and is here shown in that association, it is nevertheless to be understood that the present preferred use of collecting electrodes of the pocket type implies no necessary limitation thereto. The prior precipitator referred to involves a two-stage electrode construction in which the charging and precipitating stages constitute two entirely separate structures, the charging stage embodying an assembly consisting of a plurality of non-discharging electrodes, as vertical cylinders, opposed by discharging electrodes, such as fine wires, together with a suspension structure, while the precipitating stage embodies an assembly consisting of a plurality of non-discharging electrodes in the form of vertical curtains extending longitudinally of the gas stream and spaced transversely thereof, opposed by longitudinally extending series of pocket type collecting electrodes, all mounted on supporting structure which is entirely separate of the structure making up the first or charging stage.

A general object of the present invention is the provision of simplified and improved electrical precipitation apparatus of the class mentioned in the foregoing discussion.

A further and more particular object is the provision, in electrical precipitation apparatus of the multiple stage variety, of a simple and improved unitary suspension system for both the discharging electrodes of the charging fields and the non-discharging electrodes at one side of the precipitating fields.

A still further object is the provision of an electrode suspension system adapted for interchange-

able support of electrode elements of both the discharging and non-discharging types, arranged in a row or rows extending longitudinally of the gas stream, whereby electrode elements of both such types may be supported thereon in any order dictated by local requirements.

In the construction provided by the present invention, and considering first a horizontal gas flow type of precipitator, the non-discharging high-tension electrode at one side of each precipitating field is of the rod curtain type, comprising a row of vertical rods extending longitudinally of the gas stream, being removably received within and positioned by suitable holes formed, preferably at equal spacing, in two vertically spaced and aligned rails. Heads on the upper ends of the rods engage the upper of these rails to provide vertical support for the rods. The non-discharging electrode at the other side of the field comprises an electrode structure, preferably of the pocket type, spaced transversely of the precipitator from the rod curtain and extending parallel thereto, so that a gas duct is formed between the two electrodes, and the electrical field extends transversely across the gas duct. Wherever along the length of the gas duct it may be desired to have a transverse charging field, one or more of the rods of the high tension rod curtain are removed from the rails, and substituted for by a vertical discharging electrode, which may be a fine wire, twisted square bar, twisted ribbon, or the like, such discharging electrode being provided with suitable adapter means whereby it may be supported by the holes in the rails. The opposed pocket or other grounded electrode then becomes the opposite electrode for the charging field. Thus by this means a charging field may be inserted at any desired location or locations along the length of the gas duct, as may be found most effective for local conditions; and, from a structural standpoint, there is gained the advantage of a single, simple unitary supporting structure for the high-tension electrode elements of both the charging and precipitating fields. The invention may also be incorporated in a vertical gas flow type of precipitator, as will later be set forth in more detail.

A horizontal gas flow electrical precipitator of the class mentioned above ordinarily has a hopper-shaped bottom adapted to receive collected particles falling from the collecting electrodes. In order to minimize gas flow through this hopper-shaped bottom, and consequent re-dispersion of collected dust, transverse baffles have been used therein. With such a partitioned construction, there are still some gas currents in the several compartments of the hopper-shaped bottom, and these gas currents are found to be laden with a certain amount of re-dispersed dust. This re-dispersed dust carries some electrical charge and hence will tend somewhat to precipitate out, but its charge and therefore its tendency to precipitate are very much less than immediately after passage through a corona discharge.

A further object of the invention is, accordingly, the provision of means for substantially increasing the tendency of the re-dispersed dust carried by the gas currents in the partitioned hopper-shaped bottom to precipitate on the collecting electrodes.

In accordance with the invention, this object is accomplished by aligning the transverse baffles in the hopper-shaped bottom with the discharge electrodes carried by the electrode sus-

pension means above. The particle-laden gas currents circulating within the compartments of the hopper-shaped bottom tend to rise along these transverse baffles, and are thus delivered directly to the corona discharge occurring about the discharge electrodes which are positioned immediately over the baffles. Thus a large proportion of the re-dispersed dust is strongly re-charged, and its tendency to precipitate on the collecting electrodes greatly enhanced.

Various additional objects and accomplishments of the invention will appear and be described in the course of the following detailed description of one present illustrative embodiment thereof, reference for this purpose being had to the accompanying drawings, in which:

Fig. 1 is a longitudinal vertical section of a preferred and illustrative horizontal gas flow precipitator constructed in accordance with the invention, being a view taken as indicated by broken line 1—1 of Fig. 2; Fig. 1a is an enlarged detail taken from Fig. 1; Fig. 2 is a plan section taken on broken line 2—2 of Fig. 1; Fig. 3 is a vertical transverse section taken on broken line 3—3 of Fig. 1; Fig. 4 is a detail taken on line 4—4 of Fig. 1; Fig. 5 is a detail section taken on line 5—5 of Fig. 4; Fig. 6 is a detail section taken on line 6—6 of Fig. 1; Fig. 7 is a detail section taken on line 7—7 of Fig. 2; Fig. 8 is a detail section taken on line 8—8 of Fig. 7; Fig. 9 is a detail section taken on line 9—9 of Fig. 1; and Fig. 10 shows an illustrative discharging and non-discharging electrode structure in accordance with the invention for a vertical gas flow type of precipitator.

The precipitator of Figs. 1-9 is provided with a generally rectangular shell or housing 10 defining a horizontal gas passage between an inlet 11 at one end and an outlet 12 at the other. This housing 10, in the embodiment of the invention here chosen for illustration, includes vertical sides 13, a hopper-shaped bottom 14, preferably equipped at the bottom with a screw conveyor discharge means 15 for the collected dust, and a top comprising end sections 17 and a removable central section or panel 18 adapted to be removed to permit access to be gained to the interior of the precipitator. A pair of longitudinally-spaced transverse members 19 and 20 at each end of the housing supports the corresponding top end section 17, and the removable central panel 18 of the housing top rests at opposite ends on the members 20 and abuts top end sections 17, in the manner clearly illustrated in Fig. 1. The ends of the transverse members 20 are shown in Fig. 3 to be supported from side walls 13 by means of brackets 20a, and the transverse members 19 may be similarly supported.

The transverse members 20 may be described generally as of channel cross-section, having web 22, side flanges 23 and 24, and a flange portion 25 turned inwardly from flange 24. The two members 20 are arranged with their flanges 24 uppermost, and with their channels facing one another, as shown in Fig. 1. The members 19 may be of similar cross-section, and arranged as in Fig. 1.

Engaging and welded to the under sides or flanges 23 of the channel members 20, near the two ends of the latter, are the upper ends of vertical members 26, preferably of U-shaped cross-section. The lower ends of these U-shaped members 26 engage and are welded to transverse channel-shaped members 28, of cross-section similar to members 20, extending across the hous-

ing at the dividing plane between the rectangular portion of the housing and the hopper-shaped bottom 14. These members 28 are oriented with their channels facing one another, the flanges 29 having the intumed flange portions 30 being at the bottom, and they are preferably connected to side walls 13 through brackets 28a (Fig. 3) to restrain sway longitudinally of the housing. The described channel members 20 and 28 carry the supporting structure for the preferred pocket-type collecting electrodes. In the preferred construction here illustrated, there is a plurality of collecting electrodes 35 extending longitudinally and spaced transversely of the housing, each comprising a series or row of V-shaped electrode elements 36 which are aligned and spaced from one another in the direction of gas flow, as may be seen best in Fig. 2. Sharp edges are removed from the open ends of each V-shaped element by turning the vertical edge portions 37 back, as illustrated in Fig. 5. The upper end portions of the series of V-shaped elements 36 of each collecting electrode are received within V-shaped slots 38 formed in the web 39 of a longitudinal channel-shaped member 40 (Fig. 4) whose ends extend into the channels of the members 20 and rest on and are supported by the lower flange portions 23 thereof. The V-shaped members 36 are hung from members 40 in any suitable manner; for instance, as indicated in Fig. 5, their upper corner portions 42 may be turned over so as to engage the web of the member 40. Members 40 are transversely spaced at desired intervals on the members 20; for instance, rivets 43 set into and projecting upwardly from the lower flanges 23 of the members 20 may be engaged with holes 44 in the webs of the members 40.

The two outside rows or series of V-shaped electrode elements 36 are preferably positioned at relatively close spacing to the side walls 13 of the shell. To close off gas circulation through any space that may be left, vertical baffle strips 45 may be mounted at suitable intervals therein (see Fig. 2).

Preferably, though not constituting a part of the present invention, baffle members 47 are employed between the lower portions of the several transversely-spaced series of collecting electrodes 35, at the level of the top side of the hopper-shaped bottom 14. These baffle members 47 extend longitudinally of the collecting electrodes between the two lower transverse members 28, being received at their ends within the channels of said members 28 and supported by the flange portions 30 thereof, as clearly illustrated in Figs. 1 and 6. In the form illustrated, these baffles have portions 48 sloping downwardly and away from the edges of the V-shaped electrode elements 36, and are formed at the bottom of portions 48 with inwardly turned flanges 49 resting at the ends on flange portions 30 of transverse members 28, and at the top with inwardly turned flange portions 50 notched suitably to receive the edge portions of the electrode elements 36. The ends of the baffle members 47 engage and are welded to the webs 51 of members 28. It will be evident that these baffles serve to space the lower end portions of the electrode elements 36 both transversely and longitudinally of the precipitator. As may be seen in Fig. 3, the baffles 47 provide a relatively narrow longitudinally-extending space 52 between the various series or rows of electrode elements 36 through which dust may be discharged into the hopper-shaped bottom 14, the incline of the walls 48 being sufficient to prevent

collection of dust thereon. The purpose of these baffles 47 is, in general, to prevent substantial circulation of gas between the hopper bottom and the main gas passage above, such as may otherwise tend to cause substantial re-dispersion of dust collected on the electrodes. Reference is here directed to a co-pending application of James Hugh Hamilton, entitled "Electrical precipitation apparatus," Serial No. 450,898, filed July 14, 1942, in which the baffle members 47 are disclosed and claimed.

Rows of high-tension alternate discharging and non-discharging electrodes are positioned in the longitudinally-extending spaces or gas ducts defined by the several series or rows of collecting electrodes 36, the latter being spaced properly (see Fig. 2) to accommodate these rows of discharging and non-discharging electrodes with proper transverse spacing for the necessary electrical action. The supporting structure for these high-tension electrodes includes a frame 60 at each end of the housing, spaced somewhat beyond the ends of the rows of collecting electrodes 36, and hung from suitable suspension insulators 61 mounted in tubular housings 62 extending through and supported by the top sections 17 of the enclosing housing of the precipitator. There are four of these suspension insulators 61, two for each frame 60. Each insulator has a central vertical supporting rod 63 extending therethrough and on downwardly through the upper horizontal transverse member 64 of the frame 60. These members 64 are preferably of the same channel cross-section as the member 20, being arranged with their channel sides facing away from the electrode structures, and oriented as clearly illustrated in Fig. 1. Thus, the high-tension supporting rods 63 pass downwardly through the upper and lower flanges of the member 64. Nuts 65 threaded onto the lower ends of rods 63 support the lower ends of coil compression springs 68, the upper ends of which engage and support the lower flanges of the members 64. The frames 60 are thus spring-supported from high-tension supporting rods 63. Frames 60 each include two vertical end members 67, preferably aligned with rows of pocket collecting electrodes 36 (see Fig. 3), so as not to interfere with the gas passages between the rows of electrodes 36, the upper ends of the members 67 engaging and being welded to the lower flanges of the members 64, and the frames 60 also include a lower transverse member 68 welded to the lower ends of vertical members 67, members 68 being preferably of the same cross-section as the members 64, and also disposed with their channel sides facing away from the electrode structures.

Connected to electrode rod 63, at the upper end of one of the insulators 61, is a conductor 69, which passes through insulator 69a in the side of bushing housing 62, and connects on the outside to electrical conductor 69b, which will be understood to be energized from one terminal, usually the negative terminal, of a suitable high-tension source of uni-directional current. The precipitator housing, and therefore the pocket collecting electrode structure, is electrically grounded, as is the positive terminal of the source of current.

The upper and lower transverse members 64 and 68 of the two high-tension frames 60 support parallel upper and lower longitudinally-extending rails 70, spaced uniformly between the rows of collecting electrodes 36, and adapted for support of the presently described high-tension discharging and non-discharging electrodes. These rails

70 are generally of inverted U-shape in cross-section, with inwardly turned flange portions 71 at the edges of the two sides 72. They are supported at their ends on the upper ends of pins 73, which project upwardly from the cross members 64 and 68 of high-tension frames 60. As here shown, these pins 73 pass through suitable holes in the upper flanges of members 64 and 68 and rest at their lower ends on the lower flanges of said members (Fig. 1). The pins 73 pass between the flange portions 71 of rails 70 and engage the under sides of their U-tops, as will be understood from an inspection of Fig. 1. The U-tops of the upper and lower rails 70 are provided with uniformly and relatively closely spaced pairs of vertically-aligned holes 75 adapted to receive with free sliding fit vertically-disposed non-discharging electrode rods 76 and discharging electrode members 77. The former may be solid rods or tubes, though it is preferred, for simplicity and inexpensiveness of construction, to employ seamed tubing. The non-discharging electrode rods 76 will, of course, be understood to be of sufficient diameter that high electrostatic field stresses at their surfaces, such as might cause ionization of the surrounding gases, will be avoided. The upper ends of the electrode rods 76 are furnished with heads 78 adapted to engage the U-shaped tops of upper rails 70 for the purpose of support of the rods. These heads 78 are conveniently provided by the simple expedient of welding rivets 79 in the upper ends of members 76.

The discharging electrode members 77 include portions having formations of relatively small radius of curvature, such as will establish high electrostatic stress, sufficient to cause ionization of the surrounding gases. Suitable known forms include fine wires, twisted square bars, twisted ribbons, and the like. The preferred form here chosen for illustrative purposes embodies a twisted ribbon 80. As here illustratively shown, the upper end of the twisted ribbon is inserted and welded within a slot 82 cut in the lower end of rivet 83, which is removably mounted in a selected hole 75 of upper rail 70, the head 84 of the rivet engaging the top of the rail, as illustrated. A short cylinder 85 is incorporated in the ribbon where the latter passes through the lower rail 70 (see Fig. 9). As shown, the ribbon is broken at the lower rail 70 and its ends inserted and welded within slots 86 cut in the ends of the cylinder 85. The cylinder 85 thus serves as a filler or spacer element being received with sliding fit within the hole 75 of the rail, and serving to center and support the electrode with respect to the lower rail 70.

As will be evident from Fig. 2, the first electrode-receiving holes in the rails 70 are located in transverse alignment with the first transverse row of V-shaped pocket collecting electrode elements 36, and are continued at uniform, relatively close spacing to the last transverse row of V-shaped electrode elements. In the first transverse row of electrode-receiving holes 75 are placed a transverse row of discharging electrodes 77, and beyond discharging electrodes 77 is a series of non-discharging rod electrodes 76, one or two holes 75 preferably being left unoccupied between the discharging electrodes 77 and the first non-discharging electrode 76, in order to prevent electrical shielding of the former by the latter. At suitable points along the length of the electrode structures, additional transverse rows of discharging electrodes may be inserted. As here shown, two such additional rows are illustrated, one

about one-third the length of the electrode structure and the other about two-thirds the length thereof. As before, one or two rod-receiving holes 75 are left unoccupied between the additional rows of discharging electrodes 77 and the next adjacent rows of non-discharging electrodes 76, in order to avoid electrical shielding of the discharging electrodes.

The discharging and non-discharging electrodes 76 and 77, being mounted on the rails 70 connected to the high-tension frames 60 supported directly from the conductor rods 63 of the high-tension insulator bushings 61, are maintained at a high direct-current potential, usually of negative sign. The housing structure 10, and therefore the pocket-type V-shaped electrodes 36, are electrically grounded, as previously stated. It will be understood that an electrostatic field will be established between each electrode member mounted on the rails 70 and the adjacent V-shaped collecting electrodes 36, and that this field will be of very high intensity at the sharp edge formations of the discharging electrode 77, sufficient to cause ionization of the surrounding gases, while being of insufficient intensity at the surfaces of the non-discharging electrodes 76 to cause gas ionization. Thus, the dust-laden gas, passing first between the discharging electrodes 77 and the first V-shaped electrodes 36, is ionized, causing the dust particles to become electrically charged so as to migrate toward the positively charged collecting electrode structure. Passing beyond the charging field, the charged dust particles come within the influence of the precipitating field between the rods 76 and the V-shaped pocket electrodes 36, and continue their migration toward the latter and into the spaces between them, finally to deposit on their surfaces.

The dust particles thus received within the "pockets" between adjacent V-shaped electrode elements 36 are removed from the gas currents into relatively quiescent zones, and the tendency for re-dispersion of particles deposited on the electrode elements 36 due to "erosion" by the gas stream is minimized. The gas then passes through a second charging or ionizing field at the transverse plane defined by the second transverse row of discharging electrodes 77, whereby the dust still carried by the gas is re-charged, and precipitation on the following collecting electrode elements 36 under the influence of the next following precipitating field is substantially enhanced. Finally, the gas passes through a third ionizing field provided by the third transverse row of discharge electrodes 77, and then through a third precipitating field, and the process thus repeated. Of course, as many such transverse rows of discharging electrodes may be incorporated as desired, depending largely upon local requirements, though more than two such rows in addition to the first will usually fail to increase the dust recovery to any substantial extent. The construction described permits adjustment of the transverse rows of discharging electrodes 77 in directions longitudinally of the gas passages, and permits them to be readily placed at whatever location may yield best recovery for any given field installation. As will be quite evident, it is a very simple matter to adjust the number or the longitudinal positions of these additional transverse rows of discharging electrodes, it being only necessary to lift the removable housing cover 18, and to place the discharging electrodes in any desired holes of the supporting rails 70, several of the non-discharg-

ing electrode rods 76 being removed or replaced to accommodate the new position of the discharging electrodes. The construction described provides the dual advantage of, first, a simple, unitary mechanical supporting assembly for both the discharging and the non-discharging high-tension electrodes, and, second, a construction permitting adjustment of the number and positions of the discharging electrodes practically at will.

The dust particles gathered on the surfaces of the V-shaped collecting electrodes 36 fall from time to time, aided preferably by intermittent operation of a suitable rapping mechanism, not illustrated herein, the dust descending between the outside surfaces of the sloping portions 48 of adjacent baffles 47, and also between the edges of the flange portions 50 of the baffles, to be received by the hopper-shaped bottom 14. To prevent substantial circulation of gas longitudinally of the hopper-shaped bottom 14, such as would otherwise tend very substantially to re-disperse the dust collected therewithin, transverse vertically-disposed baffle plates 90, 91 and 92 are mounted therein. There is, however, some turbulence within the several compartments defined by these baffles, and despite the provision of the baffles 47 at the top of the hopper, there is some resulting flow of gas from the compartments back upwardly between the baffles 47 and into the spaces between the electrode elements above. It is a feature of the invention that the baffles 90, 91 and 92 are mounted in the same vertical transverse planes with the transverse rows of discharging electrodes 77, so that the gas so flowing upwardly from the hopper will be guided by the baffles to pass largely through the ionizing fields established by the discharging electrodes. Any re-dispersed dust carried by this upflowing gas is accordingly passed, to a large extent, through these ionizing fields and is therefore immediately strongly re-charged, giving it an immediate tendency to re-precipitate. In order to permit placement of the baffles 91 and 92 in the transverse planes in which the second and third transverse rows of discharging electrodes are finally located, the baffles 91 and 92 are here illustratively shown as provided with lugs 93 adapted to be secured to the side walls of the hopper by means of bolts 94, which may be so inserted as to accommodate the positions of the baffles to the planes of the discharging electrodes. Since the first row of discharging electrodes 77 is located in a permanently fixed plane, the first baffle 90 may be permanently installed in that same plane, as by being welded to the walls of the hopper. A door such as 95 may be provided in a side wall of the hopper to permit installation of the baffles 91 and 92.

Fig. 10 shows an electrode supporting means in accordance with the invention, designed for a vertical gas flow type of precipitator. The precipitator itself is not shown, and may be of various well-known or suitable types. The electrode structure shown in Fig. 10 is designed particularly for use in a precipitator of the type shown in Pat. No. 1,882,949 to Rüder, issued October 18, 1932, and reference may be had to that patent for an illustrative showing of a suitable vertical gas flow type of precipitator, though the invention is, of course, not necessarily limited to the specific type there shown.

In Fig. 10, numeral 100 designates generally a vertical, high-tension electrode supporting frame comprising two horizontally-spaced, vertically-

arranged longitudinal members 101, a top horizontal member 102 connecting the upper ends of longitudinal members 101, and a bottom horizontal member 103 connecting the lower ends thereof. The lower portions 104 of longitudinal frame members 101 are shown as inclined inwardly and downwardly, so as to conform to the collecting electrodes of the precipitator of the aforesaid Rüder patent, though such formation is, of course, not essential. The members 101, 102 and 103 of frame 100 are here exemplified in the form of pipes welded together at their junctures, though this is merely illustrative and in no way limitative on the invention. Further, the frame 100 is here indicated as suspended by means of hangers 105, which will be understood as hung from any suitable supporting structure above, as, for instance, that shown in the Rüder patent. It is to be understood that one such frame as here indicated at 100 may be placed in each of the parallel vertical gas ducts of a multiple electrode precipitator such as shown in the aforesaid Rüder patent, and in such case the several frames 100 may be inter-connected and spaced by any suitable spacing means. A fragmentary portion of such spacing means is indicated at 106 in Fig. 10.

The two members 101 of frame 100 are formed with longitudinally-spaced pairs of aligned holes 107 for removable reception of horizontally-disposed discharging and non-discharging electrode elements. The discharging electrode elements, here designated by numeral 108, may be any suitable members having sharp formations or formations of relatively small radius of curvature, and are here illustrated in the form of twisted square bars. The electrode elements 108 are here shown as formed at one end with heads 110 engageable with the supporting member 101 at one side of the frame, and as threaded at the other end to receive nuts 111 engageable with the member 101 at the other side of the frame. The non-discharging electrode elements 109 are shown in form of round rods having heads 112 on one end and nuts 113 screwed on the other end for engagement with the two members 101 of the supporting frame. The nuts 111 and 113 are desirable to prevent longitudinal displacement of the electrode elements, such as would otherwise be likely to occur with the electrodes in the horizontal position.

In the specific arrangement here shown, the first or bottom holes 107 of the frame 100 are occupied by a discharging electrode 108, and there are two additional discharging electrodes 108 at positions approximately one-third and two-thirds of the height of the frame. The remaining holes 107, except for one or two holes on each side of each discharging electrode 108, are occupied by non-discharging electrode rods 109. The electrode elements 108 and 109 are removably received in the holes 107 and, as with the horizontal gas flow type of precipitator heretofore described, their positions may be changed at will, depending upon local requirements. In the horizontal gas flow type of precipitator, the electrode elements retain their position by being suspended from their heads and, hence, no means for fixing them in position is provided; with the vertical gas flow type of precipitator, however, the electrode elements 108 and 109 do not hang vertically and, hence, would have some tendency to work out of position. This is prevented by providing them at one end with heads and at the other end with nuts, as described above.

The electrode supporting structure of Fig. 10 has been particularly described as adapted for use in a vertical gas flow type of precipitator as shown in prior Patent No. 1,882,949 to Rüdér, though by suitable modification, it may be employed in many other types of vertical gas flow precipitator; for instance, it may be substituted for the high-tension electrode system shown in Figs. 1 and 2 of Patent No. 1,926,025 to E. Anderson, or for the high-tension electrode systems of the multiple section precipitator disclosed in Patent No. 2,061,045 to Rüdér, or in others.

It will be understood that the drawings and description are merely illustrative of, rather than restrictive on, the invention, and that various changes in design, structure and arrangement may be made without departing from the spirit and scope of the invention or of the appended claims.

I claim:

1. Electrical precipitation apparatus for removing suspended particles from a gas, comprising a shell enclosing a horizontal passageway for a stream of the gas and provided with a hopper-shaped bottom below said passageway, an electrode system in said passageway comprising grounded collecting electrode structure extending longitudinally thereof and high-tension charging and precipitating electrode structure extending longitudinally thereof in parallelism and at transverse spacing from said collecting electrode structure, said charging and precipitating electrode structure including vertically disposed discharging electrodes spaced longitudinally of said gas passage and creating with said collecting electrode structure charging fields extending transversely of the gas passageway in longitudinally-spaced vertical planes, and baffle plates within and extending transversely across said hopper-shaped bottom and substantially aligned with the planes of said charging fields.

2. Electrical precipitation apparatus for removing suspended particles from a gas, comprising a shell enclosing a horizontal passageway for a stream of the gas and provided with a hopper-shaped bottom below said passageway, an electrode system in said passageway comprising grounded collecting electrode structure extending longitudinally thereof and high-tension charging and precipitating electrode structure extending longitudinally thereof in parallelism with and at transverse spacing from said collecting electrode structure, said charging and precipitating electrode structure including a substantially horizontal rail having a plurality of vertical electrode receiving holes spaced along the length thereof, a plurality of vertically-extended discharging electrode elements supported in selected substantially longitudinally-spaced holes of said rail, vertical non-discharging electrode elements supported in other holes of said rail, said discharging electrode elements creating with said collecting electrode structure charging fields extending transversely of the gas passageway in longitudinally spaced vertical planes, and baffle plates within and extending transversely across said

hopper-shaped bottom and substantially aligned with the planes of said charging fields.

3. Electrical precipitation apparatus for removing dust particles from a stream of gas, comprising a first electrode system which includes transversely-spaced complementary non-discharging and discharge electrodes, a second electrode system which includes transversely-spaced complementary non-discharging electrodes, the transversely-spaced electrodes of said first and second systems being arranged to define a longitudinally-extending gas passage open at both ends and extending between the electrodes of said first and second systems in succession, the non-discharging electrode of said first system being a pocket-type collecting electrode having lateral boundaries spaced apart a substantial distance, said collecting electrode having surfaces for electrical precipitation of suspended particles and having portions that define and shield from the gas stream one or more particle-collecting zones between said lateral boundaries, and means for impressing a high potential across the complementary electrodes of each system.

4. Electrical precipitation apparatus for removing dust particles from a stream of gas, comprising a first electrode system which includes transversely-spaced complementary non-discharging and discharge electrodes, a second electrode system which includes transversely-spaced complementary non-discharging electrodes, the transversely-spaced electrodes of said first and second systems being arranged to define a longitudinally-extending gas passage open at both ends and extending between the electrodes of said first and second systems in succession, the non-discharging electrode of said first system and one of the non-discharging electrodes of said second system being pocket-type collecting electrodes each having lateral boundaries spaced apart a substantial distance, said pocket-type collecting electrodes each having surfaces for electrical precipitation of suspended particles and having portions that define and shield from the gas stream one or more particle-collecting zones between said lateral boundaries, and means for impressing a high potential across the complementary electrodes of each system.

5. Electrical precipitation apparatus for removing suspended particles from a stream of gas, comprising a longitudinally-extending non-discharging collecting electrode structure defining one side of a longitudinal gas duct, and high-tension discharge and non-discharging electrodes positioned in succession in opposition to said collecting electrode structure and defining the other side of said gas duct, said collecting electrode structure being a pocket-type collecting electrode having lateral boundaries spaced apart a substantial distance, said collecting electrode having surfaces for electrical precipitation of suspended particles and having portions that define and shield from the gas stream a plurality of particle-collecting zones between said lateral boundaries.

HARRY J. WHITE.