

Oct. 18, 1932.

H. B. RÜDER

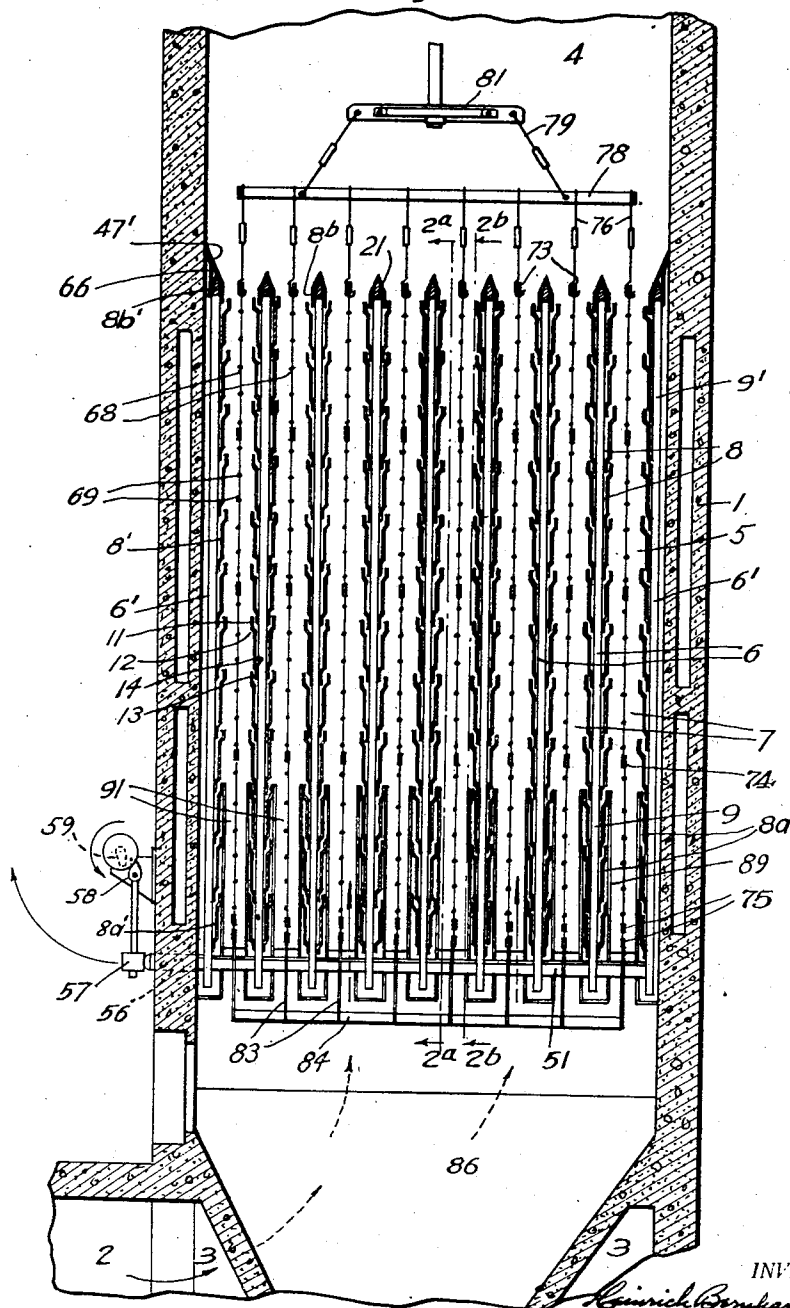
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ELECTRICAL PRECIPITATION APPARATUS

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3 Sheets-Sheet 1

Fig. 1.



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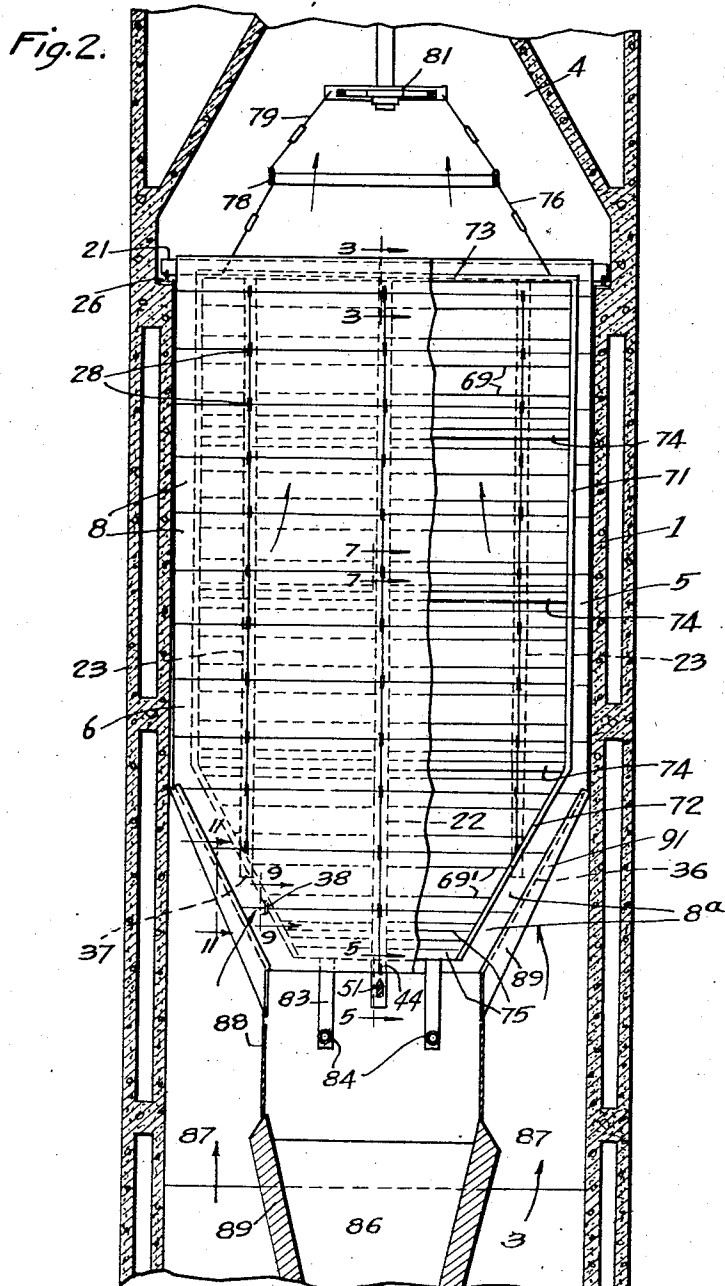
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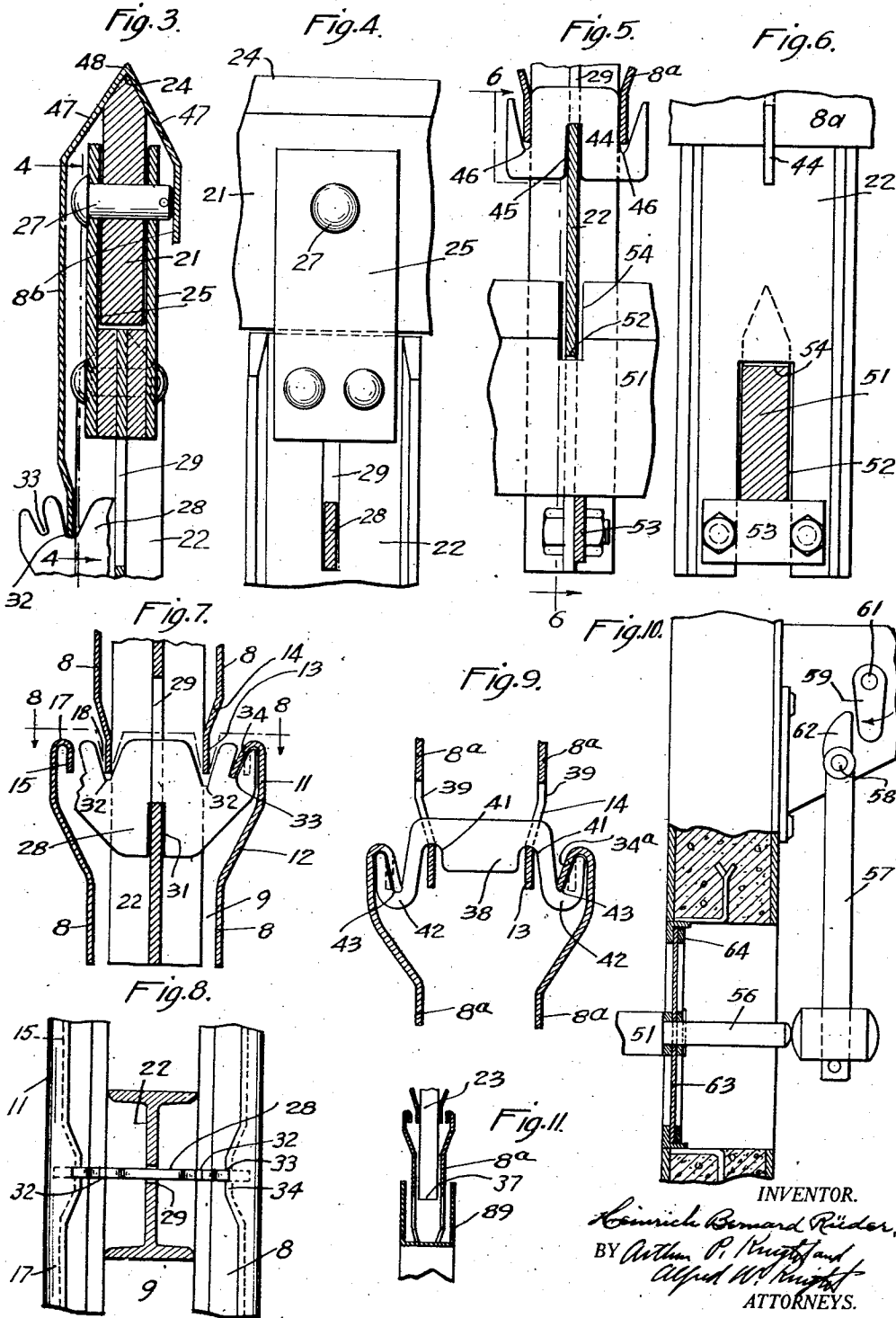
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UNITED STATES PATENT OFFICE

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ELECTRICAL PRECIPITATION APPARATUS

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This invention relates to apparatus for electrical precipitation of suspended material from gases containing the same. The apparatus of this invention is particularly intended for use in the precipitation of extremely fine particles or particles of a light fluffy nature causing them to have a tendency to be again picked up by the moving gas stream after having been once precipitated on the electrodes, but it will be understood that such apparatus may also be used for the collection of other suspended solid or liquid particles. The main object of the invention is to provide an electrical precipitating apparatus of high efficiency and particularly an apparatus having a high efficiency of collection of difficultly collected materials, such as the finely divided or light fluffy solid particles above mentioned. A further object is to provide a precipitator capable of effecting a high degree of separation and removal of such materials from the gas, while at the same time permitting a high velocity of gas flow therethrough, so that an apparatus of a given size is capable of handling a relatively large volume of gas.

A particular object of the invention is to provide an advantageous construction of the collecting electrodes of an electrical precipitator, such as to cause material precipitated on the collecting surfaces thereof to pass by gravity through suitable openings distributed over said surfaces and into quiescent zones provided within the collecting electrodes, and to also minimize the possibility of deflection through said openings and into said quiescent zones of the gas flowing between the discharge electrodes and the collecting surfaces of the collecting electrodes.

A further object of the invention is to provide advantageous means of mounting and supporting the collecting electrodes of the above described type.

It has heretofore been proposed to use collecting electrodes formed of strips or channel-shaped members providing openings for passage of precipitated material into the interior of said electrodes, but in apparatus of this type heretofore used it has been customary to utilize the frictional effect or drag of the flowing gas on the precipitated material to effect

or assist in the movement of such material into and through said openings, and for this purpose said openings have heretofore been directed toward the gas inlet end of the precipitator, so that the precipitated material carried along the surfaces of the collecting electrodes is skimmed off by the further edges of said openings and diverted through said openings.

It has been found, however, that with such a construction a considerable portion of the gas stream is also diverted or skimmed off by the further edges of the openings and caused to pass through said openings into the interior of the electrodes, thus causing considerable turbulence or movement of gas in the spaces within the electrodes and interfering with the collection, by gravity settling, or otherwise, of the material entering said spaces. As stated above, therefore, a particular object of this invention is to minimize the diversion of gas through the material receiving openings into the quiescent zones within the collecting electrodes and thus minimize the turbulence or movement of gas within said zones, so as to facilitate free and undisturbed gravity settling of the material to the bottom of said zone, whence such material is removed.

The invention may be considered as comprising a novel and advantageous construction of collecting electrode for electrical precipitation apparatus and also a complete precipitation apparatus provided with collecting electrode means of such construction and also having discharge electrode means disposed in suitable relation to said collecting electrode means and a housing enclosing said collecting and discharge electrode means and having gas inlet means below said electrode means and gas outlet means above said electrode means. The invention may be best understood by reference to the accompanying drawings in which:

Fig. 1 is a vertical section of an electrical precipitating apparatus according to this invention.

Fig. 2 is a sectional view thereof, the left-hand portion of which is taken on the line

2a—2a in Fig. 1 and the right-hand portion on the line 2b—2b in Fig. 1.

Fig. 3 is a transverse section of the upper portion of one of the collecting electrodes, taken on line 3—3 in Fig. 2.

Fig. 4 is a view showing the mounting of the vertical frame members of the collecting electrode on the top frame member thereof, taken on line 4—4 in Fig. 3.

Fig. 5 is a transverse section on line 5—5 in Fig. 2, showing the connection between the lower end of the central vertical frame member of one of the collecting electrodes and a bar extending transversely of the collecting electrodes for use in jarring the same.

Fig. 6 is a section on line 6—6 in Fig. 5.

Fig. 7 is a transverse section on line 7—7 in Fig. 2, showing a preferred form of means for mounting the elements of each collecting electrode on the supporting frame thereof.

Fig. 8 is a horizontal section on line 8—8 in Fig. 7.

Fig. 9 is a section on line 9—9 in Fig. 2.

Fig. 10 is a detailed view of the rapping mechanism and a portion of the transverse bar for jarring the collecting electrodes.

Fig. 11 is a section on line 11—11 in Fig. 2.

Referring to Figs. 1 and 2, the precipitator is shown as comprising a vertically extending housing 1 of general rectangular horizontal section and formed of concrete or other suitable material, said housing being provided at the lower end with gas inlet means such as flue 2 which communicates with a chamber 3 in the lower portion of said housing, and being provided at its upper end with gas outlet means such as outlet passage 4 formed within the upper portion of said housing. The intermediate portion of housing 1, between inlet chamber 3 and outlet passage 4 constitutes a precipitating chamber 5, in which are mounted the discharge and collecting electrodes.

In said precipitating chamber a plurality of suitably spaced parallel collecting electrodes 6 are mounted, said collecting electrodes preferably extending in substantially vertical planes and from side to side of said chamber so as to define a plurality of passages 7 therebetween through which the gas to be cleaned is caused to pass upwardly from the chamber 3 to the outlet passage 4. Each of said collecting electrodes, preferably with the exception of the two electrodes 6' which are located at the extreme opposite sides of the precipitator chamber and substantially against the walls of said chamber, comprises two spaced parallel sets of horizontally elongated electrode strips or elements 8 extending throughout the width of the electrode. Said strips lie preferably in substantially vertical planes and serve to enclose a quiescent internal material receiving space 9 between the opposing sets of strips of each electrode. Furthermore, said strips overlap

one another, and while the major portion of each strip lies in a vertical plane, the lower edges of the respective strips are offset or displaced inwardly with respect to the upper edges of the next lower strips so as to provide openings or passages therebetween which are directed upwardly and outwardly from the internal space 9 to the space 7 outside the collecting electrode where the particle laden gas is passing. Thus, as shown in Fig. 7, each collecting electrode strip 8 is provided at its upper edge with an outwardly offset portion 11 connected thereto by an upwardly and outwardly inclined portion 12 and at its lower edge with an inwardly offset portion 13 connected thereto by the downwardly and inwardly inclined portion 14. The upper edge of the outwardly offset portion 11 of each strip is also preferably bent inwardly and downwardly as shown at 15, so as to provide a rounded edge 17, and the extent of offset of the upper and lower edges is sufficient to provide an elongated space or opening 18 between the lower edge 13 of each strip and the bent over upper edge portion 15 of the next lower strip to permit passage of precipitated material there-through.

The respective sets of electrode strips of each collecting electrode may be mounted on a supporting frame comprising a top frame member 21, a central vertical frame member 22 and two additional vertical frame members 23, all of said vertical frame members depending from said top frame member 21 and being spaced at suitable intervals along the width of each collecting electrode. As shown in Figs. 3 and 4, the top frame member 21 may comprise a bar of relatively small horizontal thickness and of sufficient vertical width to provide the desired strength and stiffness therein, said bar being preferably tapered or beveled to a sharp point at its upper edge as indicated at 24. Each of the vertical frame members 22 and 23 may consist of an I-beam having its upper end connected to the top frame member by means of straps or clips 25 riveted or otherwise secured to both the vertical I-beams and the top frame member. The top frame member 21 projects beyond the edges of the collecting electrode, and these projecting portions of the top frame members of all of the collecting electrodes may be supported on supporting beams 26.

Said top frame members preferably rest loosely in properly spaced notches in beams 26, and the vertical frame members 22 and 23 are preferably loosely hung on the top frame members as by means of pins 27, so as to decrease the rigidity of each individual collecting electrode and make the same capable of being easily jarred for dislodging precipitated material as hereinafter described.

The strips 8 may be mounted upon the

vertical frame members 22 and 23 in any suitable manner, but I prefer to mount said strips loosely thereon by means of supporting brackets or members 28, which are shown particularly in Figs. 7 and 8. All of the strips throughout the major portion of the height of each collecting electrode are of identical shape, and the supporting brackets therefor are also identical. Each of said supporting brackets is formed of a thin piece of metal adapted to be inserted through an opening 29 in the web portion of the vertical frame member 22 or one of the additional frame members 23 as the case may be, and provided with a notch 31 extending upwardly from the central portion of its lower edge, said notch being of sufficient width to be lowered over the web portion at the lower edge of the opening 29, and thus retain the supporting bracket 28 in position on the vertical frame member. The openings 29 in the respective frame members 22 and 23 are horizontally aligned with one another, so that the supporting brackets mounted therein are also in horizontal alignment. Said supporting bracket is also provided at its upper edge with two notches 32 spaced to correspond to the width of the flanges of the vertical frame member and adapted to receive the lower edge portions 13 of a pair of electrode strips 8, and also with two additional notches 33 spaced outwardly from the respective notches 32 and adapted to receive inwardly and downwardly bent supporting fingers 34 on the upper edge portions of the next lower pair of electrode strips. The notches 32 and 33 are so positioned with respect to one another that when each of the electrode strips 8 has its upper and lower edge portions engaged in the respective notches of two adjacent supporting brackets, as above described, the flat major portion of the width of said strip, between the inclined portions 12 and 14, lies in a substantially vertical plane, as shown.

For reasons pointed out hereinafter, each of the collecting electrodes preferably has its portion tapered downwardly and inwardly, as indicated at 36, so that a certain number of the electrode strips such as indicated at 8a are of special shape and are tapered inwardly and downwardly at their respective ends, each successively lower strip 8a being progressively shorter length. By reason of this tapering and of the fact that the two vertical frame members 23 are spaced at some distance from the center of the collecting electrode, such frame members stop short of the bottom of the collecting electrode, as indicated at 37, and the end portions of the strip or strips 8a which extend below the lower ends of said frame members are, therefore, supported from the lower edges of the next higher strip by means of special supporting brackets, such as indicated at

38 and shown particularly in Fig. 9. Each of these special supporting brackets also consists of a thin piece of metal adapted to pass through openings 39 in a pair of electrode strips 8a and having two spaced notches 41 engaging the lower edges of said openings so as to properly position said bracket and also maintain the proper spacing between the lower edges of said strips 8a. The portions 42 of said bracket which project beyond the openings 39 are provided with notches 43 adapted to receive inwardly and downwardly bent supporting fingers 34a at the upper edges of the next lower pair of electrode strips 8a.

As shown in Fig. 5, a special form of supporting bracket may also be provided for supporting the lower edges of the lowermost pair of electrode strips 8a on the central vertical frame member 22. Said bracket, indicated at 44, is provided as before with a notch 45 engaging the lower edge of the opening 29 in said frame member and with two notches 46 adapted to receive and properly space the lower edges of said strips 8a.

The uppermost pair of electrode strips may advantageously be formed in a single piece, the two side portions 8b, shown in Fig. 3, being integrally connected together by upwardly and inwardly inclined portions 47 meeting in a sharp ridge 48 extending over and resting upon the sharp pointed upper edge 24 of the top frame member 21. This provision of a sharp upper edge at the top of each collecting electrode with downwardly inclined portions at both sides thereof prevents any collection of dust or suspended material on the tops of said electrodes. The lower edge portions of this upper pair of electrode strips may be held in proper position by notches 32 in supporting brackets 28, as above described.

The two collecting electrodes 6' at the opposite sides of the precipitating chamber are similar in construction to the intermediate electrodes 6, with the exception that the strips 8', 8a' and 8b' are provided at only one side thereof, that is, at the side which is exposed to the gas streams in the respective passages 7 which are adjacent said electrodes. The side walls of the precipitator housing 1 cooperate with said strips to define an internal material receiving space 9' within these electrodes, which is similar in mode of operation to the internal spaces 9 of the remaining electrodes 8. The strips 8' and 8a' are substantially the same as the strips 8 and 8a of the intermediate electrodes. The uppermost electrode strips 8b' differ slightly from the uppermost strips of the intermediate electrodes, in that they are provided with apron-like portions 47' inclined outwardly and upwardly into contact with the side walls of the precipitator housing. Said uppermost electrode strips may be

mounted in any suitable manner, for example by means of brackets 66 supported upon the top frame members 21 of these collecting electrodes 6'.

It may be seen, therefore, that the entire construction of the collecting electrodes is such that each individual strip 8, 8a and 8b of all the intermediate electrodes, as well as the corresponding strips of the outermost electrodes 6', is individually and loosely mounted on the supporting frame of the electrode of which it forms a part, being either mounted directly on a member of this frame or by means of supporting brackets or clips which are in turn supported either on a member of the supporting frame, or on another electrode strip. This construction permits effective vibration or movement of all of these strips to be obtained by delivery of only a moderate vibration or other jarring force against a suitable portion of the collecting electrode structure, since the individual strips are of relatively light weight and therefore easily vibrated or moved. Furthermore, the construction is such that the individual strips may be removed by simply lifting the same off of their supports, without disturbing the adjacent strips, and the supporting brackets 28, 38, and 44 may also be readily removed from the openings 29 and 39 in which they are inserted.

In order to permit jarring or rapping of the collecting electrode, to assist in dislodging of precipitated material from the collecting surfaces thereof and in the delivery of this material into the internal spaces of the collecting electrodes, a transverse bar 51 is shown as extending through the lower edge portions of all the collecting electrodes, said bar passing through openings 52 at the lower edges of the central vertical frame members 22 of the respective collecting electrodes and being supported by strips 53 connected to said frame member at both sides of said openings, as shown in Figs. 5 and 6. Said bar is also notched downwardly from its upper edge as indicated at 54, in position to embrace the web portion of each frame member 22 above the opening 52 so that upon longitudinal vibration or oscillating movement of bar 51, the sides of the respective notches 54 will engage the frame members of the corresponding collecting electrodes and impart sufficient movement to the entire collecting electrode structure including the loosely mounted strips 8, 8a, 8b, 8', 8a', and 8b', to dislodge material from the collecting surfaces. Said bar 51 may be provided at one end with an anvil portion 56 projecting through a side wall of the housing 1 and having its outer end in position to be struck by a hammer 57 pivotally mounted at 58. Said hammer may be operated by means of a cam member 59 on a rotatably driven shaft 61 engaging an arm 62 connected to said hammer, so as to

raise the hammer and then allow the same to fall against the anvil 56 upon each revolution of shaft 61. In order to permit free movement of the anvil 56 and bar 51, while preventing leakage of air or gas through the wall of the precipitator housing around the same, said bar and anvil may be secured to the central portion of a flexible diaphragm 63 whose outer edge portion is secured to the housing at 64.

The discharge electrode system may comprise a plurality of discharge electrode units 68 disposed in the gas passages 7 between the respective collecting electrodes, each of said units advantageously comprising a plurality of vertically spaced horizontally extending wires or other discharge elements 69 of sharp surface curvature, disposed in a single vertical plane and supported at their ends on frame members 71. The frame members 71 may extend vertically throughout the major portion of the height of each discharge electrode, but in order that the discharge electrode units shall conform to the shape of the collecting electrodes, the lower portions of said frame members are preferably inclined inwardly and downwardly, and the discharge electrode elements 69' at the lower portion of each discharge electrode unit are of gradually decreasing length toward the bottom of said unit. The supporting frame of each discharge electrode unit preferably also includes a horizontal top member 73, intermediate horizontal members 74, and one or more horizontal bottom members 75, all of said horizontal members being connected to the side members 71 and 72 in any suitable manner. The discharge electrode frames may be supported in any suitable manner, for example, by means of hangers 76 consisting for example of wires or rods connecting the top frame member 73 of the respective discharge electrode units to a rectangular supporting structure 78 which may be in turn supported by similar hangers 79 from a common supporting member 81. Said supporting member 81 may be supported upon any suitable fixed supporting structure or upon the precipitator housing in any suitable manner, suitable provision being also made for insulating said supporting member, and hence the entire discharge electrode system, from said housing and from the collecting electrode means.

In order to assist in holding the discharge electrode units in properly spaced positions in the respective gas passages, the lower frame members 75 of said units may be connected by bars 83 to transverse connecting rods 84 which are suspended thereby and which are disposed sufficiently below the lower edges of the collecting electrodes to prevent objectionable electrical discharge therebetween.

The apparatus preferably also includes ad-

5 vantageous means for receiving the precipitated material falling from the bottoms of the collecting electrodes and for delivering such material into a common receptacle for delivery outside the precipitator housing, while at the same time providing for upflow of gas past said common receptacle and said receiving means into the gas passages between the collecting electrodes. The means which I have shown for this purpose comprises a hopper-like receptacle 86 formed of concrete or the like and preferably extending at its upper end entirely across the precipitator housing in a direction transverse to the planes of the collecting electrodes, as shown in Fig. 1, but having a width in the direction of said planes somewhat less than the width of the precipitator housing so as to provide passages 87 at the respective sides thereof for upflow of gas. Partition members 88 preferably extend upwardly from the side walls 89 of said receptacle, said partition members also extending across the full width of the precipitator housing in a direction perpendicular to the planes of the collecting electrodes and having their upper edges spaced from one another by a distance somewhat greater than the width of the lower edges of said collecting electrodes.

30 Material receiving channel members 89 are disposed below and around the inclined edge portions 36 of the respective collecting electrodes, said channel members being also inclined downwardly and inwardly to conform substantially to the inclination of these edge portions of the collecting electrodes. The lower ends of said channel members may be supported in any suitable manner on the partition members 88, and said channel members open at their lower ends into the space between said partition members, which space constitutes in effect a part of the receptacle 86. Between the channel members 89 are provided spaces 91 for upward passage of gas. The downward inclination of channel members 89 is for the purpose of causing material received therein from the internal spaces of the collecting electrodes to pass by gravity down the channel members and into the receptacle 86, and this in turn makes necessary the inward tapering of the lower portion of the collecting electrodes.

55 It will be understood that the discharge and collecting electrode means may be connected to any suitable source of high tension current, either alternating or unidirectional, but preferably unidirectional current produced by rectification of alternating current, as is customary in electrical precipitation apparatus.

60 In the operation of the above described apparatus the gas to be cleaned and containing finely divided particles in suspension is delivered to the apparatus through the inlet flue 2 and inlet chamber 3, whence it passes

upwardly through passages 87 at the sides of receptacle 86 and also through passages 91 between the channel members 89, into the region of the electrical field maintained between discharge and collecting electrodes. 70 The gas passes upwardly in the passages 7 and is subjected to the action of silent discharge from the discharge electrode elements and also to the electric field between the discharge and collecting electrodes, whereby the suspended particles become charged and are caused to be precipitated upon the outer or collecting surfaces of the collecting electrode strips 8, 8a, etc. The material thus precipitated on these collecting surfaces and 75 tending to fall therefrom by gravity is prevented from falling any great distance in contact with the upwardly moving gas stream, since the material precipitated on any one of the strips falls into the slot or passage 18 between that strip and the next lower strip and thus enters the internal space 6 within the collecting electrode. This removal of the precipitated material from the collecting surfaces to the interior of the collecting electrode through an opening which is in any case closely adjacent to the portion of the collecting surface on which the material is precipitated is of material advantage, since it minimizes the opportunity for the precipitated material to become re-suspended in the upwardly moving gas stream as would often be the case if the material precipitated for example on the upper portions of the collecting electrode surfaces were permitted to fall throughout the major portion of the height of the collecting electrode in contact with such gas stream.

100 The upwardly moving gas, on the other hand, tends to follow a stream line flow past the surfaces of the electrode strips and is prevented from entering to any appreciable extent through the slots or openings 18 into the internal spaces of the collecting electrodes, due to the fact that the upper portion 11 of each strip 8 and the corresponding portion of the other strips overlaps and extends outside of the lower portion of the next higher strip. There will, therefore, be a minimum of circulation of gas within the internal spaces of the collecting electrodes and the precipitated material entering such spaces will be permitted to fall therein by gravity substantially undisturbed. As the gas passes upwardly the concentration of suspended material therein is gradually reduced by precipitation, and the cleaned gas, freed of all or a certain part of its suspended material, passes out through the outlet passage 4 at the top of the precipitator. 125

The precipitated material falls downwardly in the internal spaces 6 of the collecting electrodes. The material falling in the central portions of the collecting electrodes falls directly through the bottoms thereof into 130

the receptacle 86, while the material falling in the side portions of said collecting electrodes falls through the inclined edge portions 36 and into the channel members 89, and is delivered by said channel members into said receptacle. The material so collected in receptacle 86 may be removed therefrom either continuously or from time to time in any suitable manner. It should be noted in this connection that the frame members 23 and the supporting brackets 28, etc., extend substantially vertically, and these are the only parts disposed in the internal spaces of the collecting electrodes, such spaces, including the spaces between the lower edges of the respective sets of electrode strips, are substantially free from horizontally extending obstructions and are open so as to permit free falling by gravity of material throughout the entire height thereof.

The above described apparatus may in certain cases be operated with only intermittent rapping or jarring of the collecting electrodes in any suitable manner for dislodging precipitated material which fails to fall from the collecting surfaces by gravity. However, it is preferable in most cases, in order to maintain the collecting surfaces continuously free from accumulations of precipitated material and thus maintain maximum operating efficiency of the precipitator, to continuously operate the rapping mechanism by rotation of shaft 61 at any suitable speed. The weight 57 is thus repeatedly raised and allowed to fall, striking against the anvil member 56 and causing the force of the hammer blows to be transmitted through transverse bar 51 to the frame members of all of the collecting electrodes and hence to the electrode strips themselves. Said electrode strips are thus repeatedly jarred or vibrated so that the material precipitated on the collecting surfaces thereof is quickly dislodged and caused to fall by gravity into the internal spaces of the collecting electrodes, as above described.

The discharge electrode means may, if desired, be jarred from time to time, either by hand or by means of suitable mechanism, to dislodge such material as may collect thereon.

I claim:

1. An electrical precipitation apparatus comprising a housing, a plurality of spaced vertically disposed collecting electrodes extending across said housing and each consisting of two sets of horizontally extending strips, the strips of each set having their major portions disposed substantially in a common vertical plane and the upper edge portion of each strip being offset outwardly with respect to and overlapping the lower edge portion of the next higher strip of that set so as to define upwardly and outwardly opening slots between the respective strips of said set, and the planes of the two sets of

strips of each electrode being parallel to one another and spaced apart so as to provide an internal material receiving space within said electrode, said space and the space between the lower edges of the sets of strips of each electrode being open and substantially free from horizontal obstructions so as to permit material entering said space within such electrode to fall freely by gravity to and through the bottom thereof, means positioned within said housing and below the lower edges of all of said electrodes to receive material falling therefrom, said material receiving means comprising a hopper extending substantially across the width of the entire group of collecting electrodes in a direction transverse to said collecting electrodes but having a width in the direction of said collecting electrodes somewhat less than the width of said electrodes and individual spaced channel members extending upwardly and outwardly from the sides of said hopper beneath the portions of the respective collecting electrodes which project beyond said hopper, and a plurality of discharge electrode units extending parallel to and between the respective collecting electrodes and spaced from the outer surfaces of said strips, said housing being provided with inlet means below said channel members and outlet means above the upper ends of said collecting electrodes.

2. A collecting electrode for electrical precipitation apparatus, comprising a frame consisting of a top member and a plurality of vertical members secured thereto and depending therefrom, a plurality of supporting brackets mounted at intervals throughout the height of each of said vertical frame members, the brackets on the respective frame members being horizontally aligned with one another, and two sets of horizontally extending strips disposed at the respective sides of said frame, all of the strips of each set having their major portions disposed substantially in a common vertical plane and the upper edge portion of each strip being offset outwardly with respect to and overlapping the lower edge portion of the next higher strip, each of said strips being mounted adjacent its upper edge on aligned supporting brackets on the respective vertical frame members and the supporting brackets on which each of said strips is mounted being provided with spacing means engaging the lower edge portion of the next higher strip.

3. An electrical precipitation apparatus comprising a housing, a plurality of spaced vertically disposed collecting electrodes extending across said housing and each consisting of two sets of horizontally extending strips, said strips having their major portions disposed substantially in parallel vertical planes but having their upper and lower edge portions overlapping in such manner

as to define upwardly and outwardly opening slots between the respective strips of each set, and the two sets of strips of each electrode serving to define a substantially unobstructed material receiving space within said electrode and opening through the lower edge of said electrode, a hopper disposed within said housing beneath said collecting electrodes and extending substantially across the width of the entire group of collecting electrodes in a direction transverse to said collecting electrodes but having a width in the direction of said collecting electrodes somewhat less than the width of said electrodes, the portions of said collecting electrodes which project beyond said hopper in said last named direction having their lower edges sloping upwardly and outwardly from the sides of said hopper to said housing, individual spaced channel members disposed beneath said sloping lower edge portions of the respective collecting electrodes and conforming substantially to the inclination thereof, said channel members being positioned to receive material falling from the material receiving spaces of the respective collecting electrodes and having their lower ends so disposed as to deliver such material into said hopper, and a plurality of discharge electrode units, extending parallel to and between the respective collecting electrodes and spaced from the outer surfaces of said strips, said housing being provided with inlet means below said channel members and outlet means above the upper ends of said collecting electrodes.

4. An apparatus as set forth in claim 3, each of said collecting electrodes also comprising a vertical frame member disposed adjacent the vertical center line thereof between the two sets of strips of said electrode and extending throughout substantially the entire height of said sets of strips, means supporting all of said strips on said frame member, and additional vertical frame members disposed adjacent the lateral edges of said electrode between said two sets of strips and extending from the top of said electrode to adjacent the respective sloping lower edge portions thereof, means supporting on said additional frame members those strips which are positioned above the lower ends of said additional frame members, and means supporting the lateral portions of each strip which is disposed below said lower ends upon the next higher strips.

In testimony whereof I have hereunto subscribed my name this 21st day of October, 1930.

HEINRICH BERNHARD RÜDER.