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ELECTRICAL PRECIPITATING APPARATUS

Filed Oct. 26, 1931

2 Sheets-Sheet 1

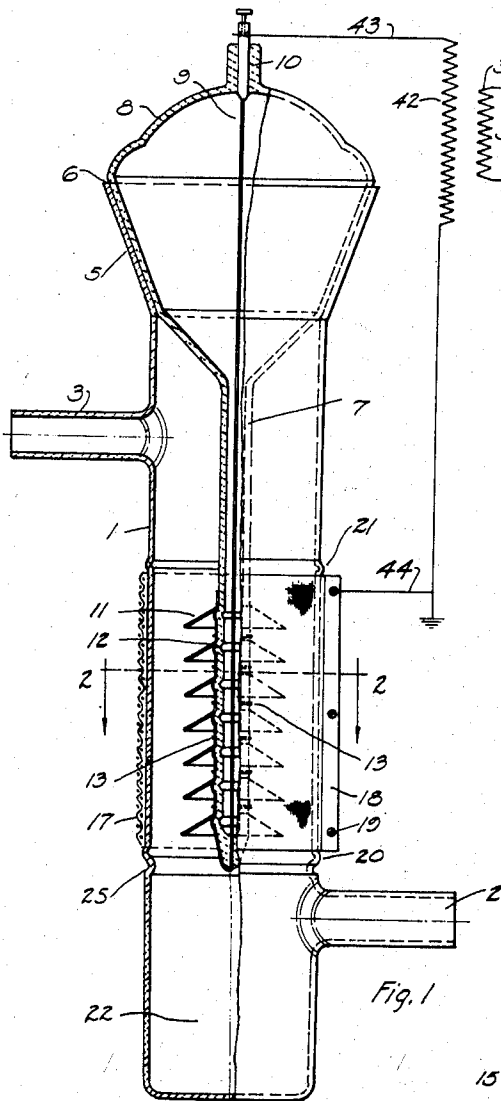


Fig. 1

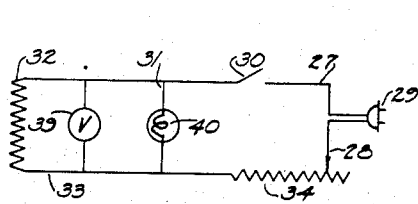


Fig. 3

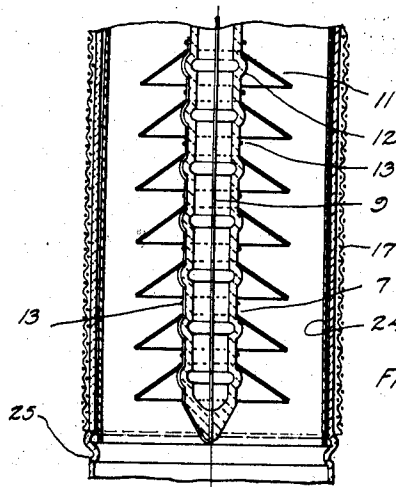


Fig. 2

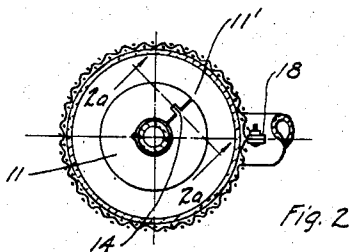


Fig. 2a

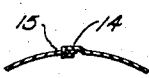


Fig. 2b

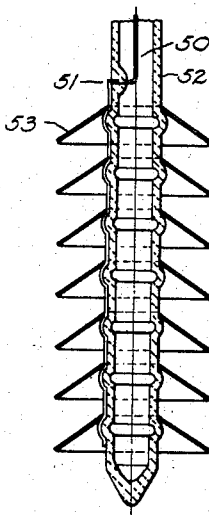


Fig. 4

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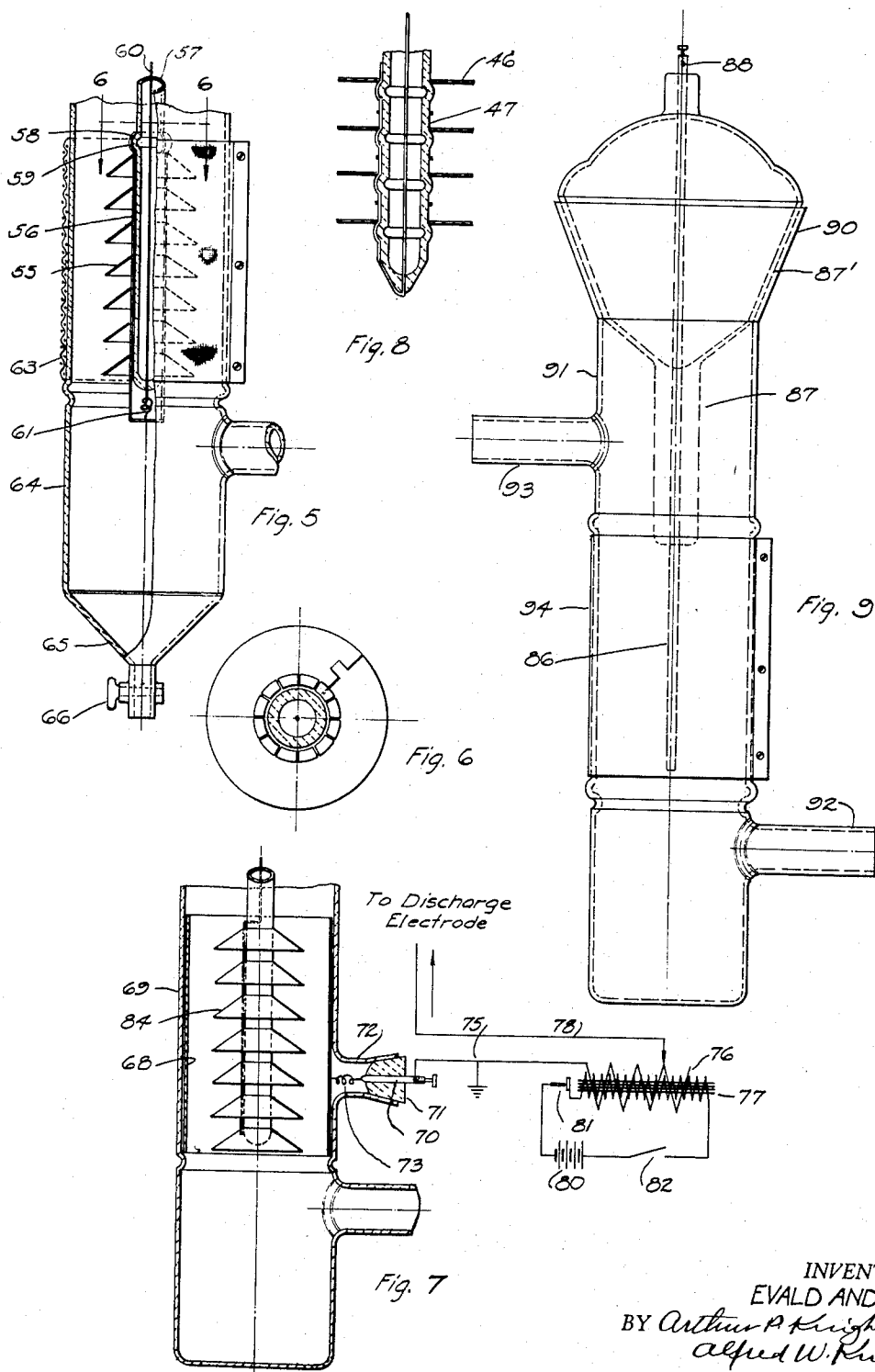
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ELECTRICAL PRECIPITATING APPARATUS

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8 Claims. (Cl. 183—7)

This invention relates to electrical precipitating apparatus and the main object of the invention is to provide a convenient apparatus for effecting electrical precipitation of suspended material from gases in connection with testing operations for determining the amount of such material in the gases.

A further object of the invention is to provide an apparatus for the stated purpose from which the deposited material can be readily removed for weighing and for preparing the apparatus for a new test operation.

The accompanying drawings illustrate embodiments of my invention and referring thereto:

Fig. 1 is a side elevation, partly in section, of one form of the invention, the energizing circuit connections being shown diagrammatically.

Fig. 2 is a section on line 2—2 in Fig. 1.

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

Fig. 3 is a partial vertical section, on a larger scale, of the form of precipitator shown in Figs. 1 and 2, showing in addition an inner collecting electrode member removably mounted in the precipitator to receive the electrically precipitated material and facilitate removal thereof from the precipitator.

Fig. 4 is a vertical section of a modified form of the discharge electrode means.

Fig. 5 is a vertical section, partly in elevation, of a further modification in which the discharge electrode means is removably mounted on its support to facilitate removal and cleaning thereof.

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

Fig. 7 is a partial vertical section of another modification in which a collecting electrode member of conducting material is mounted within the container or precipitator chamber.

Fig. 8 is a partial side elevation of a modified form of discharge electrode.

Fig. 9 is a side elevation of another modification of my invention showing a different form of electrodes.

Referring to Figs. 1 and 2, my invention comprises a container or precipitator chamber 1 formed, for example, of glass or other suitable dielectric or insulating material and provided with a gas inlet 2 and a gas outlet 3, and discharge electrode means removably mounted in said container. The container or precipitator chamber 1 may be formed as a cylinder, closed at the lower end and open at the upper end over the entire cross-sectional area of the interior of said cylinder, and provided at its open upper end with a flaring mouth 5 in which fits a stopper or closure member 6, closing the top of the container.

This construction provides for easy removal of the stopper, when desired, and for easy removal of collected material from the interior of the cylinder when the stopper is removed, as hereinafter explained, due to the fact that the opening is of the full cross-sectional area of the cylinder, and a smooth continuous surface is provided over which the collected material may be brushed or otherwise removed. Said stopper or closure member supports the discharge electrode means, being, for example, provided with a downward extension 7 carrying the discharge electrode. The members 6 and 7 are made of suitable insulating material, for example, glass, and in the preferred construction as shown, said members 6 and 7 are formed as parts of the hollow glass body having at its upper end a bulb portion 8, with the stopper portion 6 forming the side wall of said bulb portion, and terminating at its lower end in a glass tubular portion 7 carrying the discharge electrode means. In case a tight seal is desired, the joint between the members 5 and 6 is made a ground glass joint.

A leading-in wire 9 is connected at its upper end to a binding post 10 sealed into the bulb portion 8 aforesaid and extending downwardly within the tubular member 7 and connected at its lower end to the discharge electrode means. In the form shown in Fig. 1, said leading-in wire extends down through the bottom of the tubular member 7, passing through the bottom end of said tubular portion by a sealed joint and then upwardly on the outside of said tubular member 7 to contact with the discharge electrode means.

The discharge electrode means is shown in this form of the invention as consisting of frusto-conical members 11 of sheet metal, the upper ends of which are provided with openings which fit the tubular member 7, and said upper ends resting on annular ribs or enlargements 12 on said tubular member to support said discharge electrode members in position so that said discharge electrode members are supported one above another in definite spaced relation. The leading-in wire 9 passing upwardly on the outside of the tubular member makes contact with each of the discharge electrode members 11 as shown in Fig. 3 and, if necessary, is retained in position on the tubular member 7 by bands or rings 13 of metal wire or other suitable material. The frusto-conical members slope downwardly toward their rims and are made sufficiently thin to present a sharp edge at their rim portions, so as to facilitate silent electrical discharge. For convenience in assembling, each member 11 is

made with a radial cut 11' as shown in Figs. 2 and 2a, and a tongue 14 on one of the edges of the cut engages in a slot 15 near the other edge, and is bent under to fasten the edges together.

5 An opposing electrode is provided consisting, for example, of a cylinder 17 of conducting material extending around that part of the cylinder body 1 which is opposite the discharge electrode means. Said electrode 17 may be of any suitable material, but in order to facilitate inspection of the precipitating operation it is advantageously made of a sheet of metallic wire mesh bent in the form of a cylinder and clamped at its ends by clamp plates 18 fastened by screws 19. The precipitator body or chamber 1 may be formed with annular enlargements 20 and 21 respectively, below and above the electrode member 17 to assist in properly locating said member to position on the precipitator. I prefer to make the gas inlet 2 at the portion of the precipitator chamber 1 which is below the discharge and collecting electrode means and the gas outlet 3 at the portion of the precipitator chamber which is above said electrode means, so that the gas passes upwardly through the precipitating chamber, but if desired the connections may be reversed so that the gas passes downwardly through said chamber.

The precipitating chamber 1 may be provided with an extension 22 below the gas inlet 2 to receive precipitated material which descends by gravity from the electrodes, this being especially desirable when the apparatus is used for determining the amount of liquid suspended material in the gas.

In the form of the invention shown in Fig. 1, precipitation of suspended material is mainly on the surface of the cylindrical wall of the precipitator chamber 1. If desired, however, an inner tube or sleeve 24 may be inserted within the precipitator chamber 1, as shown in Fig. 3, to receive the precipitated material, said tube fitting within the member 1 and resting on an inwardly extending annular flange 25 on said member 1. To facilitate insertion of this collecting sleeve 24, the tubular body of the precipitator chamber is preferably made with a wide mouth, as shown, of the full diameter of the chamber.

The apparatus being intended particularly for test purposes, the required operative capacity, (in cubic feet per minute) is comparatively small compared with precipitators for commercial purposes, and the dimensions of the precipitator chamber may be made correspondingly small, so that the apparatus is readily portable. Moreover, by making the distance between the discharge electrodes and the opposing electrodes sufficiently short, (for example about one inch) sufficiently effective precipitation is obtained (as hereinafter explained) with alternating current energization of the apparatus, thereby dispensing with the use of rectifying means.

Means are provided for producing and maintaining the high tension electrostatic field between the discharge electrode means and the opposing electrode means 17. Thus, as shown in Fig. 1, an energizing circuit may be provided comprising wires 27 and 28 connected to a plug 29 adapted to receive current from an ordinary alternating current service outlet, wire 27 being connected through switch 30 to wire 31 leading to one side of the primary winding 32 of a step-up transformer, the other side of said winding 75 being connected by wire 33 to an adjustable re-

sistance or impedance 34 which is connected to the wire 28. A voltmeter 39 and an indicator lamp 40 may be connected between the wires 31 and 33. The secondary winding 42 for the step-up transformer is connected by wire 43 to the binding post 10 and by wire 44 to the electrode 17, said wire 44 being preferably grounded.

In the operation of the apparatus the gas whose suspended material content is to be determined is conducted by suitable tubing or other means to the inlet 2, whence it passes between the discharge electrode means 11 and the opposing electrode 17, to outlet 3, which opens either into the atmosphere or into suitable tubing for conducting away the gas from which the suspended material has been removed. By means of the electric connections above described an alternating high potential difference is maintained between the discharge electrode members 11 and the opposing electrode 17, causing ionization of the gas and resultant eventual deposition of suspended material in the gas on the walls of the precipitator and to some extent on the discharge electrode members 11. The interposition of the insulating wall of the precipitator chamber between the discharge electrode means and the opposing electrode 17 enables a relatively high potential difference to be maintained without breakdown or disruptive discharge in the gas, and thereby permits a high degree of ionization. Furthermore, the distance between the discharge edges and the opposing collecting electrode is so small that with the above-mentioned high field and resultant high ion-velocities, the ions and charged dust particles are completely removed between alternations.

When the desired volume of gas has been subjected to treatment as above described, the apparatus may be disconnected from the gas supply means and from the electrical energizing means, the stopper with the discharge electrode means mounted thereon removed from the precipitator body and the precipitated material then removed from both the chamber 1 and the discharge electrode means for weighing or measurement. In case the suspended material which has been precipitated or collected is liquid, it will be eventually collected mainly in the bottom portion of the precipitator chamber and may be poured from said chamber into suitable receiving means. The device being portable, chamber 1 may be readily inverted for pouring liquid material therefrom or for enabling solid material to fall therefrom after being brushed loose.

In case the apparatus is used for determination of solid suspended material in a gas, the shell or sleeve shown at 24 in Fig. 3 may be inserted within the precipitator chamber, said shell being, for example, of celluloid, glass or other suitable insulating material and serving as a collecting means for receiving the deposit which is removed from the gas by the electrical action as above described. When the operation has been completed, this shell or sleeve may be removed bodily from the precipitator chamber through the open mouth at the top thereof, and the deposited material may then be readily removed from said sleeve or shell.

The form of the discharge electrode means above described consisting of frusto-conical sheet metal members is especially advantageous when the device is used for collection of suspended liquid particles, as any liquid deposited on said electrode members runs down the inclined surfaces thereof and drips from the lower edge or

rim to the bottom of the precipitator chamber. This form of discharge electrode means is also advantageous in that it presents, within a limited vertical height, a considerable linear extension of discharge edge constituted by the rim of the members 11, the effective discharge electrode length presented by this edge being a very large multiple of the vertical length of the discharge electrode means as a whole. Inasmuch as the effectiveness of an electrical precipitator is approximately a linear function of the length of the discharge electrode, other things being equal, the working capacity of the precipitator is correspondingly larger.

If desired, the discharge electrode members may (as shown in Fig. 8) consist of discs 46 of thin sheet metal mounted on the insulating members 47, similarly to the mounting of the discharge electrode members in the form shown in Fig. 1.

Instead of passing the leading-in wire through the bottom of the insulating tubular support for the discharge electrode means, said leading-in wire, as shown at 50 in Fig. 4, may be passed through a sealed joint 51 in the tubular insulating supporting means 52 and then downwardly along the outside of said supporting member to contact with the several discharge electrode members 53.

In some cases it is desirable to provide for removal of the discharge electrode means bodily from the support for the purpose of cleaning or repair, and for that purpose a construction such as shown in Figs. 5 and 6 may be used, the discharge electrode members 55, which may be similar to those above described, being in this case mounted on a metallic sleeve 56 which surrounds the tubular insulating supporting member 57 and is provided, for example, with spring fingers 58 at its upper end adapted to engage over an annular enlargement 59 on said tubular supporting member to retain the sleeve in place thereon. The leading-in wire 60 is shown in this case as extending through a sealed joint at the bottom of the supporting member 57 and is provided at its lower end with a coiled spring 61 adapted to make contact with the bottom of the sleeve 56 when the latter is placed in position so as to apply the required high potential to said sleeve and the discharge electrode members carried thereby.

The opposing electrode means 63 and the precipitator body of chamber 64 may be substantially of the construction above described. I have shown, however, in this figure a modification of the precipitator chamber in which said chamber is formed at its lower end with a funnel 65 and with a stop-cock 66 whereby, if desired, collected liquid may be withdrawn from the precipitator chamber for measurement or other purposes.

In some cases in test units of this kind it is desired to use an induction coil as the energizing means for the apparatus and in such cases it has been found desirable to provide the opposing electrode within the precipitator chamber as shown in Fig. 7, such opposing electrode indicated at 68 being inserted within the tubular precipitator chamber 69 which may be constructed similarly to the form shown in Fig. 1, except that provision is made for conducting current through the wall of the precipitator chamber to the sleeve 68. For this purpose a binding post 70 is mounted in a stopper 71 inserted in a nipple 72 at one side of the precipitator chamber 69 and is pro-

vided at its inner end with means, such as a coil spring 73, for contacting with the sleeve 68. The binding post 70 is shown as connected by wire 75 to ground and to one side of the secondary winding 76 of induction coil 77, an adjustable connection 78 being made from said secondary winding to the discharge electrode means. The induction coil 77 is energized by the battery 80 and is provided with an automatically operable interrupter 81 and with a controlling switch 82. The discharge electrode means 84 shown in this figure may be of similar construction to any of the forms above described for example, the form shown in Fig. 4.

The operation of this form of the invention is similar to that above described except that the energization of the electrodes is effected by the intermittent charging action due to the connection with the secondary of the induction coil, so that here the discharge is essentially or at least predominantly of one sign. The high field strengths needed for satisfactory precipitation rates can thus be maintained through having the discharge member negative, as with ordinary size precipitators.

In some cases particularly where the collected material is difficult to clean from discharge electrodes such as above described, a construction such as shown in Fig. 9 may be used, said construction being similar to that shown in Fig. 1 except that the discharge electrode in this case consists of a rod or wire 86 which is mounted on the insulating stopper means 87 and is provided at its upper end with a binding post 88 for connection to the high tension source, the wire 86 being of sufficiently small radius to insure effective ionization of the gas under the action of the electrical field produced. The stopper means 87 is provided with a ground glass face 87' for engagement with a ground glass face on the wide flaring mouth 90 of the precipitator chamber 91. Said precipitator chamber is provided with gas inlet 92 and outlet 93 and with an opposing electrode 94 mounted on the outside of same substantially in the same manner as shown in Fig. 1.

While the opposing electrode in the form illustrated in Figs. 1, 3 and 5, is shown as a wire mesh construction, it will be understood that if desired said electrode may consist of sheet metal or foil or other suitable conducting material. Thus, as shown in Fig. 9, said electrode may consist of a sheet metal band or cylinder. Or a coating of metal in the form of a continuous sheet or of strips or mesh, may be formed directly on the glass or insulating tubular body of the precipitator, by spraying or otherwise. If desired, more complete rectification may be obtained by means of any suitable rectifier included in the high tension connections, for example, a Kenetron, a rectifier of the copper oxide type or a mechanical rectifier.

I claim:

1. An electrical precipitator comprising a precipitator chamber formed of insulating material and provided with gas inlet and gas outlet means, said chamber having an opening at one end, closure means removably mounted in said opening to close the same and making a gas tight joint with the said opening, discharge electrode means mounted on said closure means and extending within the precipitator chamber between the gas inlet and gas outlet means thereof, and an opposing electrode extending within the precipitator chamber opposite the position of the dis-

charge electrode means, and means extending through the wall of the precipitator chamber for conducting current to the opposing electrode.

2. An electrical precipitator comprising a tubular precipitator chamber provided with gas inlet and outlet means, an insulating member removably mounted on the precipitator chamber and having an insulating portion extending longitudinally within the tubular precipitator chamber and discharge electrode means mounted on said longitudinally extending portion of said insulating member and comprising a plurality of discharge electrode members each consisting of a frusto-conical sheet metal body extending around said longitudinally extending portion of the insulating member and inclined downwardly and outwardly, and electrical connection means extending longitudinally within said longitudinally extending portion of said insulating member and also extending outside of said longitudinally extending portion to make contact with the plurality of discharge electrode members, and opposing electrode means mounted on the precipitator chamber opposite the discharge electrode means.

3. A construction as set forth in claim 2 in which the longitudinally extending portion of the insulating member is provided with annular enlargements, and the respective discharge electrode members rest on said enlargements.

4. A construction as set forth in claim 2, and comprising in addition, a conducting sleeve removably mounted on the longitudinally extending portion of the insulating member, the respective discharge electrode members being mounted on said sleeve and means being provided for establishing connection between the leading-in connection and said sleeve.

5. An electrical precipitator comprising a tubular precipitating chamber provided with gas inlet and outlet means and having an opening at one end of said chamber, closure means of in-

insulating material removably mounted within said opening and having an insulating portion projecting longitudinally within said precipitating chamber, discharge electrode means mounted upon said projecting insulating portion and disposed substantially centrally within said chamber, said discharge electrode means being mounted and supported wholly upon said closure means and being otherwise free of mechanical connection with the walls of the precipitating chamber, electrical connection means extending from the exterior of said closure means through said projecting insulating portion and electrically connected to said discharge electrode means, and opposing electrode means mounted on the precipitating chamber opposite said discharge electrode means.

6. A construction as set forth in claim 5, said discharge electrode means being removably mounted on said projecting insulating portion.

7. A construction as set forth in claim 5, said discharge electrode means being removably mounted on said projecting insulating portion and detachably connected to said electrical connection means.

8. An electrical precipitator comprising a precipitator chamber provided with gas inlet and gas outlet means, said chamber having an opening at one end, insulating closure means removably mounted in said opening, discharge electrode means mounted and supported wholly on said closure means and being otherwise free of mechanical connection with the precipitator chamber and being disposed substantially centrally within the precipitator chamber between said gas inlet and gas outlet means, a sleeve fitting slidably within said chamber and removable through said opening upon removal of said closure means, said sleeve being disposed around and spaced from said discharge electrode means, and means for maintaining an electric potential between said discharge electrode means and said sleeve.

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