E. MÖLLER.

ELECTRIC MEANS FOR THE SEPARATION OF SUSPENDED MATTER FROM GASEOUS FLUIDS.

APPLICATION FILED MAR. 7, 1912.

**1,362,128.**

Patented Dec. 14, 1920.

3 SHEETS—SHEET 1.

Fig.1.

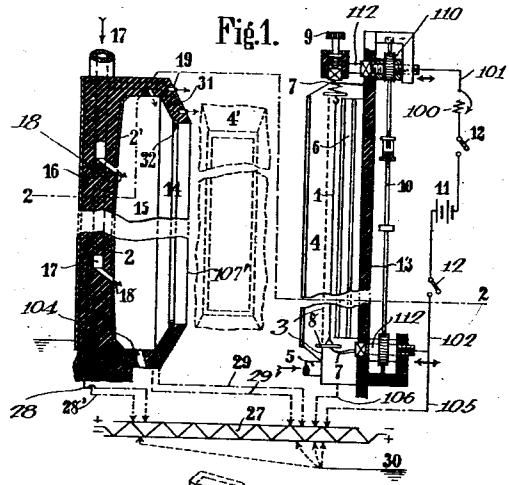


Fig.4.

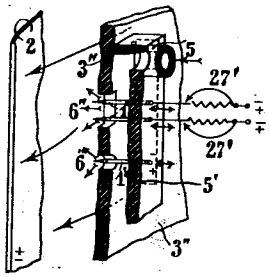
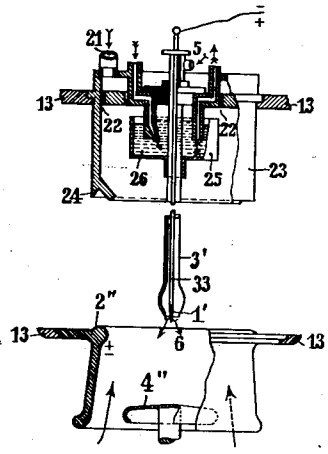


Fig.3.



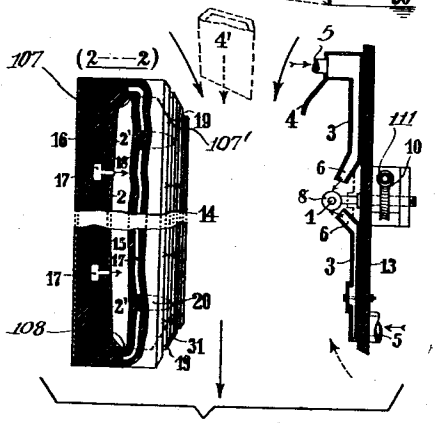


Fig.2.

Fig. 5.

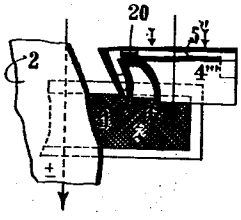
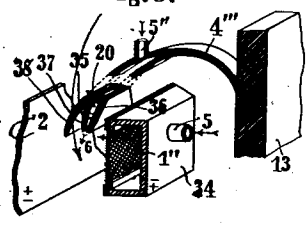


Fig.6.



Witnesses:
Robert J. Heulsizer.
C. H. Potter

Erwin Möller, Inventor,
by Byrnes, Townsend & Brickenstein,
Attorneys.

E. MÖLLER.

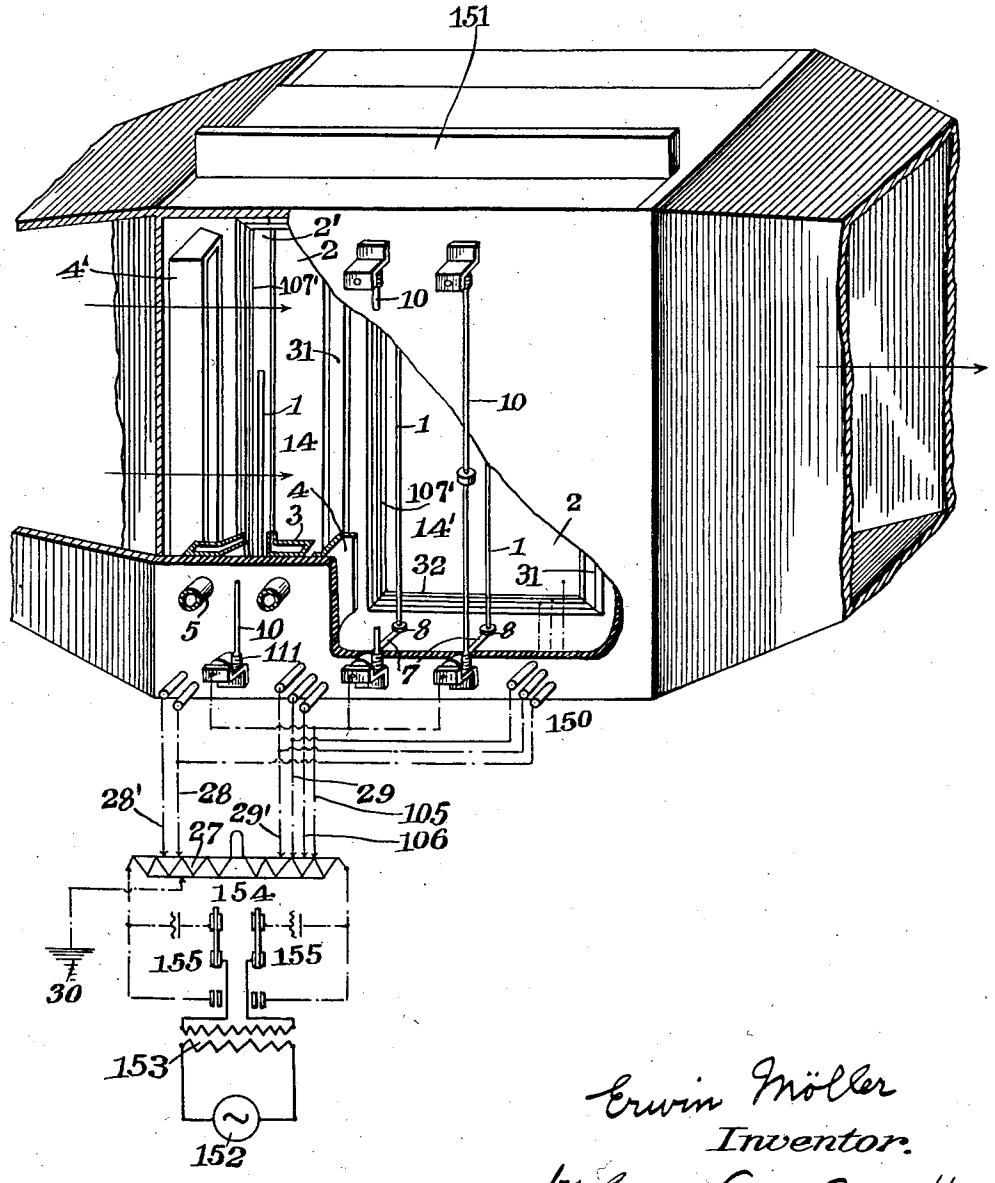
ELECTRIC MEANS FOR THE SEPARATION OF SUSPENDED MATTER FROM GASEOUS FLUIDS.

APPLICATION FILED MAR. 7, 1912.

**1,362,128.** **Patented Dec. 14, 1920.**

3 SHEETS—SHEET 2.

Fig. 1.A




Erwin Möller
Inventor.
by Emery, Varney, Blair & Hogsett
his Attorneys.

E. MOLLER.

ELECTRIC MEANS FOR THE SEPARATION OF SUSPENDED MATTER FROM GASEOUS FLUIDS.

APPLICATION FILED MAR. 7, 1912.

1,362,128. Patented Dec. 14, 1920.

3 SHEETS—SHEET 3.

Fig. 7.

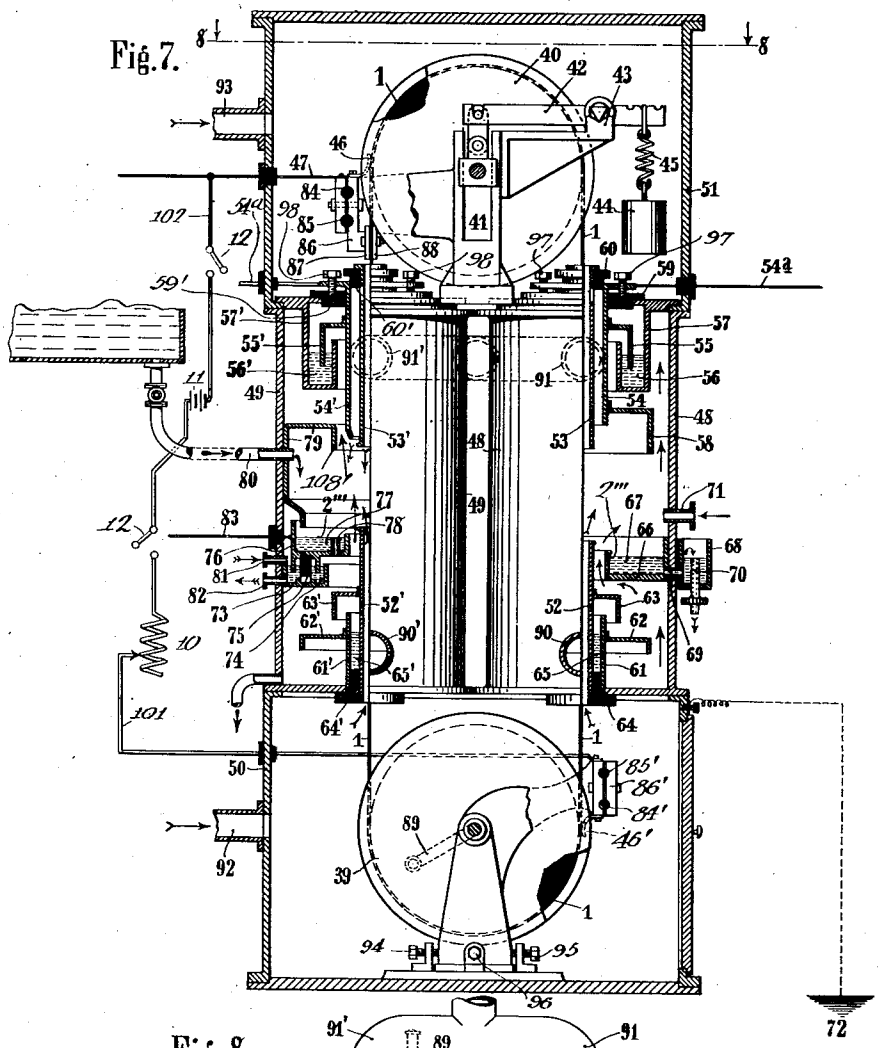
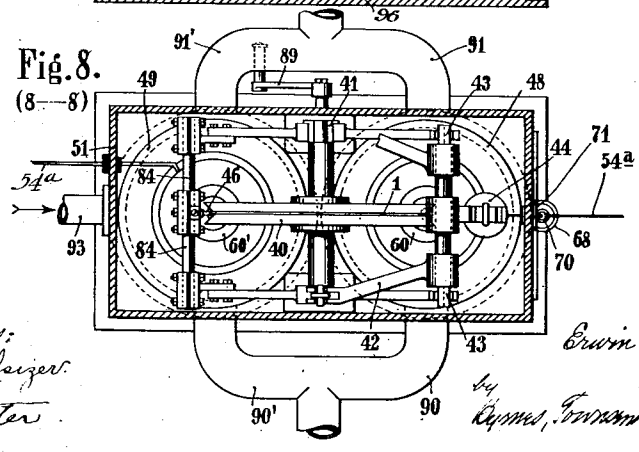


Fig. 8.

(8—8)



Witnesses:
Robert I. Haulsizer.
C. H. Potter.

Erwin Möller, Inventor.
by Dyrenforth, Howard & Brickenstein, attorneys.

# UNITED STATES PATENT OFFICE.

ERWIN MÖLLER, OF BRACKWEDE, GERMANY, ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE CHEMICAL FOUNDATION, INC., A CORPORATION OF DELAWARE.

## ELECTRIC MEANS FOR THE SEPARATION OF SUSPENDED MATTER FROM GASEOUS FLUIDS.

1,362,128. Specification of Letters Patent. Patented Dec. 14, 1920.

Application filed March 7, 1912. Serial No. 682,331.

*To all whom it may concern:*

Be it known that I, ERWIN MÖLLER, a citizen of the German Empire, residing at Brackwede, Germany, have invented certain new and useful Improvements in Electric Means for the Separation of Suspended Matter from Gaseous Fluids, of which the following is a specification.

This invention relates to means for electric separation of suspended matter from fluids, especially from gases, by means of charging electrodes which through certain parts of the surface hereafter called "ionizing parts" act to charge the suspended particles, and electric field surface elements or electrodes, which operate as collecting or precipitating means for the charged particles.

One object of the invention is to provide means for keeping the ionizing parts clean, by preventing suspended or other matter contained in the gases to be treated, from depositing on the ionizing parts. This I effect by introducing a protective fluid, for example a layer thereof, between the ionizing member and the space containing the gas to be treated. This protective fluid layer may be constituted by a portion of the gas being treated, and from which the injurious substances are deflected or removed by a screen, or the protection may be secured by a protective fluid supplied at a suitable point and in the proper direction and quantity.

The invention is preferably carried out with linearly-extending electrodes formed as fine wires and held taut by suitable tensioning means, and this invention comprises means for cleaning such electrodes in case injurious deposits are formed thereon.

Another object of the invention is to prevent the suspended particles from being carried past or along the collecting electrode by reason of the high velocity of the gas being treated. For this purpose I place the collecting electrode in a recess or catch chamber, whose walls, by means of their position relative to the direction of the current, reduce the velocity of gas near the electrode and prevent the deposited material from being carried along in the direction of flow, said chamber having the necessary openings for access of the gas and of the electrified particles to such chamber.

A further object of the invention is to provide for concentrating and increasing the strength of the electrostatic field in a zone at a certain distance in front of the collecting electrode, so as to overcome the tendency of the deposited particles to be repelled from such electrode by a reverse charge. In connection with the catch chamber for the electrode, this local strengthening field action is preferably at the opening of such catch chamber, which establishes communication between the catch chamber and the electrostatic field, so as to more effectively withdraw the suspended charged particles from the current of gas flowing rapidly past such opening.

Another object of the invention is to provide auxiliary field producing means for reinforcing the action of the charging electrode, in causing migration of the suspended particles.

This invention also provides for controlling the potential at different parts of the field, and for adjusting the relative position of the electrodes, in order to produce the conditions best suited for any particular case.

Other objects of the invention will appear hereafter.

The accompanying drawings illustrate embodiments of my invention, and referring thereto—

Figure 1 is a vertical section of one form of the invention, in which the ionizing electrode consists of a wire, the electrical connections being shown diagrammatically;

Fig. 1ª represents a perspective view of an assembled apparatus of the type of Figs. 1 and 2;

Fig. 2 is a section, on line 2—2 in Fig. 1, some of the parts being broken away;

Fig. 3 is a vertical section of another embodiment of the invention, with an ionizing member in the form of a pointed member;

Fig. 4 is a perspective view, somewhat diagrammatic, of a form of the invention in which the ionizing means comprises a plurality of adjustable pointed members;

Fig. 5 is a sectional view and Fig. 6 is a perspective view of a form of the invention in which the ionizing means consists of a pervious member and is provided with means for forcing protective fluid therethrough;

Fig. 7 is a vertical section of a form of

the invention in which the ionizing electrode is movable to provide for mechanical cleaning thereof, and in which the collecting electrode is constituted by a fluid;

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

Referring to Figs. 1 and 2, 1 designates the ionizing electrode and 2 the collecting electrode, said electrodes being mounted on walls or supporting members 13 and 16 respectively, which may be of insulating material.

The ionizing member 1 preferably consists of a fine wire held taut by suitable tensioning means such as spring 7 and weight 8, and supported on suitable means such as the wall 13 which may or may not be a part of a vessel or chamber confining the fluid to be treated. I prefer to make the ionizing part 1 and its supporting means adjustable relative to the opposing electrode and for this purpose carriers 112 for said electrode are mounted to slide in wall 13 and are operated by rotatable members 110 engaging with screw-threads on carriers 112, said members 110 being, for example, worm-gears operated in unison by screws 111 (Fig. 2) on rod 10, to move the upper and lower ends of the electrode simultaneously. The electrode 1 may be connected to one of the carriers by adjusting means such as screw 9, for regulating the tension of said electrode.

It is desirable, in some cases, to provide for removal of matter deposited on the ionizing electrode 1. In case such matter is volatile or otherwise removable by heat, such removal may conveniently be effected by passing an electric current through the electrode to heat the same. For this purpose I provide a circuit including a battery 11 or other source of current, switches 12, 12, regulating resistance 100, and wires 101, 102 leading to the carriers 112 so that by closing said switches, current may be caused to traverse electrode 1 and to heat the same sufficiently to remove deposited material.

Adjacent to and at the side or rear of the ionizing electrode 1, are auxiliary electrodes 3 (Fig. 2) which serve to strengthen the electrostatic field, and whose potential may be controlled by the ionizing electrode, said auxiliary electrode being, for example, insulated, or as shown forming the protective fluid inlet. The potential of these electrodes may be controlled by an independent, adjustable, voltage regulating device 27 (Fig. 1 or Fig. 1ª), wires 105, 106 leading to the electrodes 1 and 3 from parts of said device 27 at different potential.

For protecting the ionizing electrode 1, in a general way from the deposition of material from the gas being treated, a screen or deflector 4 (Fig. 1) is provided in the path of the incoming gas, to deflect the current of gas away from the ionizing electrode. This screen is shown as formed on and connected to (Fig. 2) auxiliary electrode 3. If desired, however, general protection may be secured by directing the gas to be treated into the ionized field, through an outlet means, so as to concentrate the flow of gas in a zone removed from the ionizing electrode and at the same time from the collecting electrode.

For more definite protection of the ionizing electrode 1 from such deposition, outlet means 6 for protective fluid are provided adjacent to said electrode, communicating with supply pipes 5, through which suitable clear protective fluid is forced to cause the electrode 1 to be surrounded by such fluid and thereby protected from the suspended matter in the gas being treated. Such clear protective fluid may consist of a portion of the gas which has previously been purified in the apparatus, or of compressed air or steam, as hereafter referred to. As a matter of convenience the outlet means 6 are shown in Fig. 2 as formed on the auxiliary electrodes 3, which may be hollow or chambered, as shown, to establish connection between the pipes 5 and said outlet means.

The collecting electrode or field surface is divided into parts, for example, an inner or central part, 2, and an outer part 2′ surrounding the part 2, (Fig. 2) said electrode parts being shown separated at the outlets 18, and insulated from one another, and respectively connected by wires 28 and 28′ to the voltage regulating device 27, so as to maintain, preferably a higher potential on the outer electrode portion 2′. Said electrode portions 2 and 2′ are mounted on suitable insulating or insulated supports 16.

To prevent the charged particles from being carried or forced away from the collecting electrode, either by reason of the velocity of the gas being treated, or by reason of the repulsion of the particles from said electrode, due to reversal of the charge of said electrode,—I provide both mechanical and electrical means for holding or forcing the suspended particles toward the collecting electrode. The mechanical means consists of a collecting or catch-chamber 15, (Fig. 2) having an opening or openings 14 at the front for access of the gas from the ionizing field and then to said chamber. The collecting electrode portions 2 and 2′ are mounted at the back of said chamber, so that the walls of said chamber act as obstructions to prevent the deposited material from being swept or carried from the collecting surface by the current of gas and give the suspended particles more time for migrating in the electrostatic field. The collecting chamber 15 enlarges toward the collecting electrodes, and contracts toward its opening 14, communicating with the stream of gas to be treated. If the fluid to be treated be unidirectionally conducted by a flue or a duct into the electric field, the side walls of the catch-chamber

or the corresponding outside edges of the catch aperture 14, of which only one limiting wall 107′ is shown in Fig. 1, are preferably positioned essentially rectangularly to the direction of the main flow of the entering gas current. The electrical means for holding the particles toward the collecting electrode consists of a field-concentrating or constricting surface or member, for example, in the form of sections 31 extending around the mouth or opening 14 of chamber 15, and controlled, as to potential, either by grounding, or by connection by wires 29, 29′ to the potential regulating means 27, so as to graduate the potential of said sections, on the one hand toward the precipitating electrode, and on the other hand, toward the other adjacent parts. These members 31 which may be conductors or semiconductors, also serve, by their electrification, to avoid injurious action in the precipitation due to disturbing indirect charges on the parts around the mouth of the chamber 15, which would interfere with the precipitation. A potential regulating means 32 may also be provided directly in the opening 14 of the chamber 15; consisting, for example, of a conducting member surrounding the said opening and controlled, as to potential, in any suitable manner, for example by connection through the wire 29′ to the potential regulating means 27.

Means are preferably provided for producing jets of insulating fluid adjacent to the collecting electrode, to maintain the precipitating action. For this purpose the supporting member 16 has a conduit 17 for permanent or intermittent supply of fluid, connecting with outlets 18 between the electrode portions 2 and 2′ preferably of annular shape, so as to produce jets of fluid for breaking any "bridges" that may form between the field surfaces. Conduit 17 may also communicate with outlet passages 19 adjacent to the field constricting or regulating surfaces 31 to supply jets of fluid so as to remove deposited matter therefrom. Passages 19 are separated by bridge portions 20. The catch-chamber 15 may have an opening 104, indicated in dotted lines in Fig. 1, for removal of the collected particles.

The main electrification zone of the suspended particles to be precipitated is preferably located near the place where the field is most constricted or concentrated, and in general, it is advantageous to make this zone coincide with the part of the field where the velocity of the fluid is at a maximum, this being effected by placing the field constricting surface at the opening of the catch-chamber.

By providing a nozzle-like surface it is possible to screen the medium to be purified not only on one hand from the ionizing member and on the other hand from the separating field surface, but also from escaping in directions beyond the ends of the ionizing member so that the said medium is properly introduced into the main field of action of the stream of ions, that is to say into the stronger portions of the electric field.

The parts which are assumed to be connected to the high pressure (continuous) current source are marked with $\pm$ or $\mp$, either the upper or the lower sign being applicable.

On the drawings, all the parts which need not be electrically conducting and which are assumed to be suitable insulating bodies are shown with heavy section lines, while the parts section-lined in the usual way are assumed to be conductors. The insulating bodies can be in most cases replaced by corresponding insulated bodies. The arrows without feathers represent the direction of flow of the fluid to be treated, while the arrows with single features represent a dynamically active protective fluid or a bridge-destroying jet.

The operation is as follows: The gas which is to be purified is introduced between the ionizing electrode 1 and the catch-chamber 15, the velocity of the gas being reduced or minimized adjacent to the ionizing electrode by the deflector 4 or by the directing of the current of gas by a nozzle supply means. The ionizing electrode produces a discharge into the gas and the particles suspended in the gas are thereby charged and are forced away or caused to migrate from the said electrode by the electrostatic field set up by the electrode 1, aided by the auxiliary electrode 3. On account of the reduced velocity of the gas near the charging electrode the suspended particles have time to become charged and to be separated by migration, from the gas before such gas reaches the charging electrode, thereby minimizing the deposition of matter on such electrode. Near the mouth of the catch-member 15, the gas is moving more rapidly and it is therefore important that a stronger electrostatic action should be exerted on the particles in this rapidly moving current to prevent their being carried past the collecting electrode. this stronger action being effected by the charged field-constricting surface 31 which concentrates the field near the mouth 14 of the catch-chamber 15. When the particles enter the catch-chamber, they are given full opportunity, because of the slow movement of the gas therein, to migrate toward the precipitating electrode at the back of said chamber, and any tendency of the particles to be pushed laterally off of the collecting surface is resisted by the mechanical obstruction offered by the walls of said chamber, by the electrical obstruction presented by the action of the field constricting surface 31 and by the relatively high potential of the outer member 2′, all of which tend to concentrate the field toward the center.

In Fig. 1ª there is shown an assembled apparatus of the type illustrated by Figs 1 and 2 which may be readily installed within a suitable flue. The reference numerals thereon, 1 to 106, indicate identical parts as the same indications in connection with Figs. 1 and 2. In addition, 150 represents the walls of the flue; 151 are covers for cleaning and repairing the interior parts of the apparatus; 152 is a source of electricity, for instance, a low tension alternating current generator; 153 represents a high tension alternating current transformer, the primary coil of which is connected with the generator 152; 154 is a double pole switch; 155 is a double pole rectifying device (such as a mechanical rectifier, a vacuum rectifier or valve, a mercury rectifier, etc.,) for converting the high tension alternating current produced by transformer 153 into high tension direct current. Evidently it is possible to feed the high tension resistance 27 either with alternating or with direct current by reversing the double pole knife switch 154, if, in certain cases, one or the other kind of current should be desired. As a rule direct current is preferred.

As will be seen from the drawing, the front wall of 150 is broken up in order to show interiorly arranged parts of the suspension separating apparatus and the members 1, 10 and 110 are partially broken away; the members 11, 12, 100—102, 17—19 are not shown.

The gaseous fluid is indicated by the arrows introduced within the space between the charging members 1 and the collecting field surfaces 2 and 2′ by means of a nozzle-shaped screen member or members 4′. The fluid passes a series of charging members of the type 1 and collecting field surface members of the type 2. In Fig. 1ª there are arranged, for instance, three members 1 and two members 2 in series with reference to the direction of the stream of the gaseous fluid. The gaseous fluid first passes the opening 14 and then a second opening 14′. In front of the opening 14 only one charging electrode is arranged, whereas in front of opening 14′ two members 1 are installed. Before the gases arrive at the opening 14′ they are deviated by means of a screen member of the baffle-type 4 from the second and third member 1 which is thereby protected in the manner already described in connection with Figs. 1 and 2. The mode of such arrangements may be varied with the local conditions, for example, the number of ionizing members and field surfaces to be arranged in series may be increased if a more complete separation is desired.

While in Fig. 1 the precipitation is chiefly intended for non-liquid suspended particles, the use of a well known pointed electrode is preferable, for instance in case of large quantities of bodies and the like condensing on the walls and trickling down.

In order to produce a uniform ion current layer with such a point-like electrode, the point must be introduced concentrically into and in front of a surface of revolution forming the precipitating surface. The fluid to be treated is introduced as far as possible symmetrically with respect to the axial direction.

Such an arrangement is shown in Fig. 3 of the drawing.

The point shaped ionizing member is designated with the numeral 1′. It is fixed to an adjustable rod 33 connected to a source of electric energy. The rod 33 is surrounded by the auxiliary field surface 3′ in the form of a co-axial pipe. Mounted on the pipe is a receptacle 25 containing insulating liquid 26 which is adapted to be circulated at will as indicated on the drawing by double feathered arrows. The receptacle 25 is surrounded by an annular guard 23 provided with a part 24 near its lower edge where the material running down the outer surface of annular guard 23 is freed from objectionable electricity. The annular guard 23 is inserted in one of the walls 13 of the precipitation chamber. Slits 22 are provided in the wall 13 carrying the annular guard 23 through which a protective fluid such as compressed air or steam introduced through pipe 21 is blown for keeping clean the inner wall of the annular guard 23 and the outer wall of receptacle 25 and also the outer wall of tube 3′. 5 is an admission tube to tube 3′ through which protective fluid such as pure compressed air is introduced into tube 3′ for keeping clean the ionizing member 1′. 6 is the mouth of tube 3′ through which the above mentioned current of protective fluid leaves said tube. 2″ designates the precipitating field surface. 4″ is a protecting member co-axially arranged to ionizing member 1′ for protecting the same against the fluid to be treated which enters from below in a current concentric to the ionizing member as indicated by the feathered arrows.

The operation of the device is substantially the same as that of the device illustrated in Figs. 1 and 2.

Fluid to be treated such as fog-carrying gases are introduced from below in a current concentric to the ionizing member 1′ and the particles suspended in the gases are precipitated on the field surface 2″ by the action of the ion current flowing from the ionizing member 1′ to field surface 2″. The ion current formed between ionizing member 1′ and field surface 2″ is preferably produced by charging ionizing member 1′ to a suitable negative potential. The precipitating field surface may be charged by connecting with a source of electrical en-

ergy, to a potential different from the earth potential or it may be grounded.

Objectional discharge of electricity between the several parts of the structure are avoided by the described means for keeping said parts free from deposits.

The guard member 4'' may be charged at will with electricity or may be mechanically adjusted with relation to the ionizing member 1' and the field surface 2'' or 3'. A device showing the general arrangement of this circular type in connection with a conducting duct leading the gases from below to the catching space is illustrated by Fig. 7 and Fig. 8.

Fig. 4 shows a somewhat different construction for the dynamic protection of pointed ionizing parts, the pressure and strength of current of each of which can be independently regulated. This regulation is effected by the combination of a movement of the ionizing parts relative to the field surfaces in the direction indicated by the double-headed arrows, with a supplementary adjustment of the voltage by means of the regulating device (resistance) 27'.

Several ionizing parts could be provided with one and the same protective insulating body current 6''.

Figs. 5 and 6 show diagrammatically how a well known multipointed ionizing member for example a pubescent, and especially a pervious electrode, can be protected from injurious influences by screening or by supplementary protective fluid from opening 6'''. The structure illustrated in said figures comprises a pubescent, pervious ionizing member 1'' preferably consisting of fabric.

The fabric 1'' forms a wall of a casing 34 supplied with pure non-conducting fluid introduced through pipe 5. The pubescent, pervious ionizing member or fabric 1'' is screened by two walls 35, 36 forming a slit 37 and by a further screen 38, the screens 35, 36 and 38 being connected to a wall of the precipitating room which is again designated 13 as in Fig. 3. 5'' indicates the fluid current entering the slit 37 between the screen walls 35 and 36. The numeral 2 designates the precipitating field surface. 20 designates a bridge for separating the screen surfaces 35 and 36.

The operation of the device illustrated in Figs. 5 and 6 is as follows:

The fluid to be treated passes between the field collecting surface 2 and the outer screen surface 38 and the particles contained therein are deposited on the surface of the collecting electrode 2 due to the ion current which is formed by the ionizing member 1'' and the said field surface 2. The screen wall 38 protects the pubescent ionizing member or fabric 1'' from being injured by the current of the impure fluid to be treated. Such protection is completed by the current of protective fluid blown through the meshes of the pervious ionizing member and by the current of protective fluid blown through slot 37. The electrical charging of the ionizing member 1'' and eventually of the field surface 2 may be the same as described in connection with the structure of Fig. 3.

Referring more particularly to Figs. 7 and 8 of the drawing the numeral 1 designates again an ionizing member in the form of a wire which in this instance is mounted on two rollers 39 and 40. The upper roller 40 is mounted in a slidable guide 41 suspended on levers 42 oscillatable about a pivot 43 and balanced on the side opposite that of guide 41 by a weight 44 connected to lever 42 by a spring 45. 46 and 46' are brushes contacting with the ionizing wire 1 adapted to be supplied with electric energy by conductor 47, the source of electricity and a resistance unit not being illustrated on the drawing.

48 and 49 are two cylinders interconnected between two lower and upper casings 50 and 51. 52 and 53 and 52' and 53' are two sets of protecting tubes arranged co-axially to the two branches of the ionizing member 1 and the two cylinders 48 and 49 respectively. 54 and 54' are tube like members co-axially surrounding tubes 53 and 53' respectively and provided with petticoats 55, 55' immersed into insulating sealing liquid 56, 56' respectively, said sealing liquid being inclosed within annular vessels 57 and 57' respectively. The vessels 57 and 57' are mounted on cylinders 48 and 49. 58 is a screen for guiding the current of fluid to be treated. 59, 59' and 60, 60' are insulating annular stoppers inserted between members 57, 54, 57', 54' and 54, 53, 54',53' respectively. The members 54 and 54' are adjustably supported by insulating stoppers 59, 59' and connected by conductors $54^{a}$ $54'^{a}$, respectively with potential regulating devices not shown on the drawing. 61 and 61' are tubular members inclosing the tubes 52, 52' and provided with petticoats 62, 62'. The tubes 52, 52' are provided with petticoats 63, 63'. 64, 64' are insulating stoppers between 52, 61 and 52', 61', respectively. 65, 65' are insulating liquid fillings between 52, 61 and 52', 61'. 66 is a receptacle containing preferably conducting liquid 67 the surface of which forms one part of an adjustable separating field device which is designated 2'''. 68 is a receptacle on the outside of cylinder 48 connected with the interior of receptacle 66 by pipe 69; 70 is an adjustable overflow in receptacle 68. 71 is the end of a conduit

for supplying liquid to receptacle 66. The casing of the device is grounded as indicated at 72 so that liquid 67 is likewise grounded.

Cylinder 49 is also provided with a receptacle for liquid, but in the embodiment shown in Figs. 7 and 8 such receptacle is not grounded. Therefore within cylinder 49 an annular vessel 73 is mounted filled with insulating liquid 74. The bottom of vessel 73 carries an insulating ring 75 forming a support for a liquid receptacle 76 filled with liquid 77 the surface of which forming a separating field-surface 2'''. 78 is an overflow. 79 is an annular guard connected to the wall of cylinder 49. 80 is a conduit for introducing liquid to be supplied to receptacle 76. 81 and 82 are conduits for circulating liquid through receptacle 73. 83 is a conductor which is insulated from cylinder 49 and connected to receptacle 76. The conductor 83 serves to supply receptacle 76 and the liquid 77 contained therein with electricity so as to charge it up to a suitable potential. 84 and 85 84′ and 85′ are insulating rods connected with the frame work of the device and carrying the above mentioned brushes 46, 46′, and bracket 86 with a scraper provided with wipers of felt 87, 88 which may be moistened if necessary and embracing the ionizing member 1. 89 is a crank or the like adapted to rotate roller 39 and to displace thereby the ionizing member 1 between the scraper members 87, 88. 90, 90′ and 91, 91′ are openings in the cylinders 48, 49 for conducting fluid to be treated into and out of said cylinders. 92 and 93 are pipes for introducing fluid into the casings 50, 51; 94, 95 and 96 are screws for mechanically adjusting the ionizing member 1 with relation to the field surfaces of the apparatus by suitable displacement of its carrying drum 39. Corresponding adjusting devices may be provided and preferably are provided for the upper ionizing carrying drum 40; such adjusting means, however, are not shown on the drawing in order to avoid complications of same. 97 and 98 are two sets of further adjusting screws for axial adjustment of field surfaces 54, 58 and 54′ respectively.

The operation of the device is as follows.

The fluid to be treated is introduced into cylinders 48, 49 through openings 90, 90′ respectively and is drawn off through openings 91, 91′. The path taken by the gas in passing from the inlet 90 to the outlet 91 is indicated by the unfeathered arrows as is also the path followed by the gas in passing from inlet 90′ to outlet 91′. The path followed in passing from 90 to 91 is as follows: The gas entering through the inlet 90 passes out and upward past the annular members 61, 62 and 63 between the annular member 52 and the liquid reservoir 66 into the depositing chamber above the field collecting surface 2''', thence between the outer wall 48 and the annular member 58 and past annular member 57 to the outlet 91. The path followed by the gas passing from 90′ to 91′ is out and upward past annular members 62′ and 63′ and thence through the space between the annular member 52′ and the inner surface of the field surface container 78 into the chamber immediately above the field collecting surface 2'''. The gas then passes out through the passage between annular members 108′ and 54′ and thence past annular member 57′ to the outlet 91′. The particles contained in the fluid which are to be separated out are taken up by the separating field surfaces 2''' of the annular liquid fillings 67, 77. The separating out of the particles is effected by the influence of the ion current between the ionizing member 1 which is charged to a suitable potential through conductors 47 and 46 and the said separating field surfaces 2''' among which that belonging to receptacle 66 is grounded, whereas that belonging to receptacle 76 is kept at a suitable potential by supplying it with electrical energy through conductor 83.

The ionizing member 1 is rendered less liable to injury from the particles within the fluid to be purified by currents of protective fluid driven through pipes 52, 53 and 52′, 53′ of cylinders 48, 49 respectively. The sealing liquid fillings 56 and 65 and 56′ and 65′ prevent the impure fluid to be treated to commingle with the protective fluid within tubes 52, 53, 52′ 53′, etc. By keeping petticoats or auxiliary field surfaces 58, at a suitable potential, it is possible to direct the ion current between the ionizing member 1 and the precipitating field surface 2''' in any desired way. Such regulation may be assisted by suitable mechanical adjustment of the members 54, 54′.

For further controlling the ion current the overflow tube 70 may be adjusted as desired. Of course it is possible without departing from the spirit of invention to ground both the precipitating field surfaces 2''' or to connect both of them with a special source of electrical energy.

If notwithstanding the provided means for keeping the ionizing member 1 clean it should happen that particles have been deposited thereon from the impure fluid then the ionizing member may be mechanically cleaned by rotating crank 89 through the scraper 87, 88.

The ionizing member 1 may be electrically heated as a further means to keep it free from deposition of injuring matter.

This may be done by providing in a similar manner as already shown and described in connection with Fig. 1 a source of low tension electricity, insulated from high tension current, and connected by switches 12 and

regulating resistance 100 through leads 101 and 102 with two convenient places of the wire 1. Of course, as the latter shall be rotatable by crank 89 (Fig. 7), the electrical connection of leads 101 and 102 with said points of the ionizing wire is to be effected by two contact brushes 46, 46′ or the like, the latter 46′ being fixed to the frame by insulators 84′, 85′ and bracket 86′ in quite an analogous manner as brush 46 is fixed in the manner already described by 84, 85, and 86.

A protected catch space is formed between 2‴ and 79. The circular wall 79, which corresponds to the straight wall 108 of catch space 15 in Fig. 2, is, as well as its outer edge 108′ rectangularly positioned relatively to the direction of the gas current for the purpose of reducing the velocity to a minimum within the catch space, situated between 2‴ and 79.

On the right and left sides of Figs. 7 and 8, the spaces are of different forms. On the left side the parts of the space situated between the separating field surface 2‴ and the screen 79 which is in close connection with the exterior wall, are protected against the free passage of the gas, while on the right side the current of gas in the upper part traverses the catching space situated between 58 and 66 but in such a manner that the speed of the gas above the fluid 67 is greatly diminished on account of the vessel 66 being placed in front, while with the formation of the catching space on the left side in the case of high velocity of current heavy particles can fly past through the ion current to the catching space; on the other hand the lighter particles are drawn down very powerfully under the influence of the separating field surface 2 which is charged with special tension; they are subject in the arrangement shown on the right side of the drawing in the case of reduced velocity above 67 to the simultaneous precipitating effect of gravity by falling into the liquid.

The combination of the two modifications at the left and right in the drawing in one apparatus has the advantage that the separating effect is more satisfactory and more independent of the variable composition of the suspended bodies than if only one of the two modifications were used.

As I have already mentioned in my pending application Serial No. 643568 an auxiliary field surface may be arranged in the neighborhood of the ionizing member, that is to say surrounded by the same fluid as the latter, to form a spark gap for the purpose of preventing injury to the latter, and an auxiliary resistance preferably arranged outside of the precipitation room may be put in series to the ionizing member or a corresponding field surface.

In Figs. 1 and 3 for example the mouths 6 and 6′ of the auxiliary field surfaces 3 and 3′ may serve as protective spark gaps. For this purpose the voltage of the ionizing electrode 1 is regulated, by means of resistance 27, close to and slightly lower than the potential of the auxiliary electrode 3 and said ionizing electrode 1, with the aid of the adjusting gears 10, may be sufficiently adjusted so that it lies in a vertical plane just back of the vertical plane in which the projecting mouth 6 of the auxiliary electrode 3 lies. Then if sparking occurs the sparks will not be formed between the charging electrode 1 and the collecting electrode 2 (or 2′) but between the auxiliary electrode 3 and the collecting electrode 2 (or 2′), whereby the ionizing electrode 1 is protected from injury due to disruptive discharges since all sparking primarily takes place across the auxiliary protective spark gap set up between members 3 and 2 (or 2′).

In a similar way, with reference to Fig. 7, the field surfaces 52, 52′ and 53, 53′ protect the ionizing electrode 1 from injury due to disruptive discharges. In this case the charging of said field surfaces is produced preferably by the ion current produced between the ionizing electrode 1 and the inner surfaces of the field electrodes. An electrical connection may be effected by making contact between both members or the field surfaces may be provided with regulation leads, if desired. It is easily understood that the protective spark gap can be arranged separately from an auxiliary field surface.

In Figs. 1 and 3 the use of protective auxiliary resistances 27 and 27′ arranged in series to ionizing members or field surfaces is illustrated again.

As will be easily understood, Fig. 1 and Fig. 3 are modifications of the combined type shown in Figs. 7 and 8. In particular, for instance 2″, 4″, 3′, 13, 26 in Fig. 3, correspond to 66, 63, 53, 48, 56 respectively in Fig. 7.

I am aware that in means for electric separation of particles from insulating fluids it is known to use a system of co-axial especially cylindrical surfaces being formed of a material adapted to receive electrical charges of different high potential and to produce in such cylindrical or otherwise shaped chambers electrical discharges.

Therefore I do not claim this generally but what I claim is:

1. Means for electrical separation of suspended matter from gaseous fluids comprising a charging electrode, a field surface electrode, means for directing the gaseous fluid to be treated between said electrodes, and means for adjusting the relative position of said electrodes to vary the distance between them.

2. In an apparatus for electric separation of suspended matter from gaseous fluids, a

collecting electrode comprising separate portions and means for maintaining said portions at different potential.

3. In an apparatus for electric separation of suspended matter from gaseous fluids, a charging electrode, a collecting electrode, and an auxiliary field surface member opposite to said charging electrode and to said collecting electrode and connected to a regulatable source of electric tension, for influencing the electrostatic action of the ionizing electrode.

4. In an apparatus for electric separation of suspended matter from gaseous fluids, a charging electrode, a collecting electrode, and an auxiliary field surface member opposite to said charging and collecting electrodes for influencing the electrostatic action of the charging electrode, and means for maintaining on said auxiliary electrode a potential different from those of the charging electrode and of the collecting electrode.

5. Means for electric separation of suspended matter from gaseous fluids, comprising a charging electrode, a collecting electrode, and means for directing the gases in a current extending between but separated from said electrodes.

6. Means for electric separation of suspended matter from gaseous fluids, comprising an ionizing electrode, means for supplying gas to be treated, and means for deflecting the gas from the ionizing electrode.

7. Means for electric separation of suspended matter from gaseous fluids, comprising a charging electrode, a collecting electrode, means for supplying gases to be treated, and means for deflecting such gas from the ionizing electrode.

8. In an apparatus for electric separation of suspended matter from gaseous fluids, a charging electrode, and means for directing fluid free from suspended matter, around said electrode.

9. In an apparatus for electric separation of suspended matter from gaseous fluids, comprising a charging electrode, a collecting field-surface electrode, and a screen member surrounding, at least partly, the collecting field surface electrode and forming with the same a deposit chamber, said screen bounding an opening of said chamber toward said charging electrode.

10. An apparatus for electric separation of suspended matter from gases comprising a charging electrode, a collecting field-surface electrode, and a screen surrounding, at least partly, the collecting field-surface electrode and forming with the same a deposit chamber, said screen bounding an opening of said chamber toward the charging electrode, and said chamber enlarging toward the collecting electrode.

11. In an aparatus for electrical separation of suspended matter from gaseous fluids, a collecting electrode and walls adjacent said electrode for weakening the gas current velocity near the electrode, a number of said walls being directed essentially rectangularly with relation to the main flow of the fluid current passing in front of and separated from said collecting electrode.

12. In an apparatus for electric separation of suspended matter from gaseous fluids, a collecting electrode and walls adjacent such electrode for weakening the gas-current velocity near the electrode, a number of edges of said walls being positioned essentially rectangularly with relation to the main flow of the fluid current passing in front of and separated from said collecting electrode.

13. An apparatus for electric separation of suspended matter from gaseous fluids, comprising a charging electrode, a field-surface electrode, and a conductor spaced from said charging electrode and from said field-surface electrode, to form a spark-gap for protecting the charging electrode from injury by sparking.

14. In an apparatus for electric separation of suspended matter from gaseous fluids, a collecting electrode comprising a plurality of field-surface sections, and means for maintaining said field-surface sections at different electric potential.

15. In an apparatus for electrical separation of suspended matter from gaseous fluids, a charging electrode in connection with a flexible ionizing part consisting of a freely extended essentially smooth wire sufficiently thin, as to allow from is surface a permanent non-disruptive electric discharge, and being adjacent at more than one point of its freely extended length to bodily surfaces of which the discharge potential is higher than the discharge potential of the wire surface.

16. An apparatus for electrical separation of suspended matter from gaseous fluids, comprising a field-surface of revolution and a charging electrode the ionizing part of which having a point-like cross-section, said ionizing part concentrically located with relation to said field-surface of revolution.

17. In an apparatus for electric separation of suspended matter from gaseous fluids, a field electrode, a charging electrode having an ionizing part of point-like cross-section, a tube electrically insulated from and arranged opposite to a projecting edge of said field electrode, said tube surrounding as a protecting jacket-tube said charging electrode, the ionizing part of same being displaceable through said tube.

18. An apparatus for electric separation of suspended matter from gaseous fluids,

comprising an ionizing thin wire electrode, and a collecting field-surface member having a field-surface of revolution coaxially and ionizing wire electrode.

19. An apparatus for electric separation of suspended matter from gaseous fluids, comprising a longitudinal ionizing part, a charging electrode with a collecting field-surface member having a field-surface substantially parallel to said longitudinal ionizing part.

20. An apparatus for electric separation of suspended matter from gaseous fluids, comprising a charging member, and a collecting field-surface member, said last named member consisting of a body of liquid having a free surface in the state of essentially stable equilibrium forming the active separating field-surface.

21. An apparatus for electric separation of suspended matter from gaseous fluids, comprising a charging electrode, means for tensioning same, and a liquid field-surface member having a field electrode in the state of essentially stable equilibrium.

22. An apparatus for electric separation of suspended matter from gaseous fluids, comprising a charging electrode, and field electrodes, a cleaning member adapted for cleaning the ionizing part of the charging electrode, said cleaning member being electrically insulated from the field electrode.

23. An apparatus for electric separation of suspended matter from gaseous fluids, comprising charging electrodes and field-surface members, the combination with a flexible charging electrode of vibration-damping means for preventing objectionable oscillations of the said charging electrode.

24. In an apparatus for electric separation of suspended matter from gaseous fluids, a charging electrode in connection with an ionizing part, and means for cleaning said ionizing part without interruption of its ionizing function.

25. An apparatus for electric separation of suspended matter from gaseous fluids, comprising a charging electrode having a substantially linear ionizing part, a collecting field electrode, a scraper to clean said ionizing part, and means to displace said ionizing part and scraper with relation to each other.

26. An apparatus for electric separation of suspended matter from gaseous fluids, comprising a charging electrode, a collecting field-surface member, and a scraping device adapted to clean said charging electrode and positioned outside the space where the separation takes place.

27. An apparatus for electric separation of suspended matter from gaseous fluids, comprising a charging electrode with an endless flexible ionizing part, means for tensioning the same, and a collecting electrode surface member.

28. An apparatus for electric separation of suspended matter from gaseous fluids, comprising a flexible ionizing member, an endless strip, a field-surface member, means for producing an electric discharge between said flexible ionizing member and field-surface, and means for changing the part of said wire from which the discharge of electricity to the field surface takes place.

29. In electric means for separation of suspended bodies from gaseous fluids, a receptacle containing an insulating liquid, said liquid being adapted to be replenished or renewed in said receptacle by means of an auxiliary conduit, said conduit being preferably so arranged as to enable the liquid to be circulated at will through a purifying device.

30. Means for electrical separation of suspended matter from gases, comprising a longitudinally extended charging electrode, a collecting electrode, and means for directing the gases in a current transversely to, and for limiting said current in the direction of, the longitudinal extension of the charging electrode thereby leading the gases to be treated into the strongest portion of the electric field between said charging electrode and said collecting electrode, and for preventing the gases from escaping beyond the ends of the electrodes in direction of said longitudinal extension.

31. Apparatus for purifying gases comprising a charging chamber, electrode means therein, a precipitating chamber, electrodes of like polarity therein, and means of communication between said chambers of less cross-sectional area than that of said chambers, the electrode means in one of said chambers being of a different polarity with respect to the electrodes in the other of said chambers.

In testimony whereof I affix my signature in presence of two witnesses.

ERWIN MÖLLER.

Witnesses:
HENRY HASPER,
WOLDEMAR HAUPT.