A. F. NESBIT.

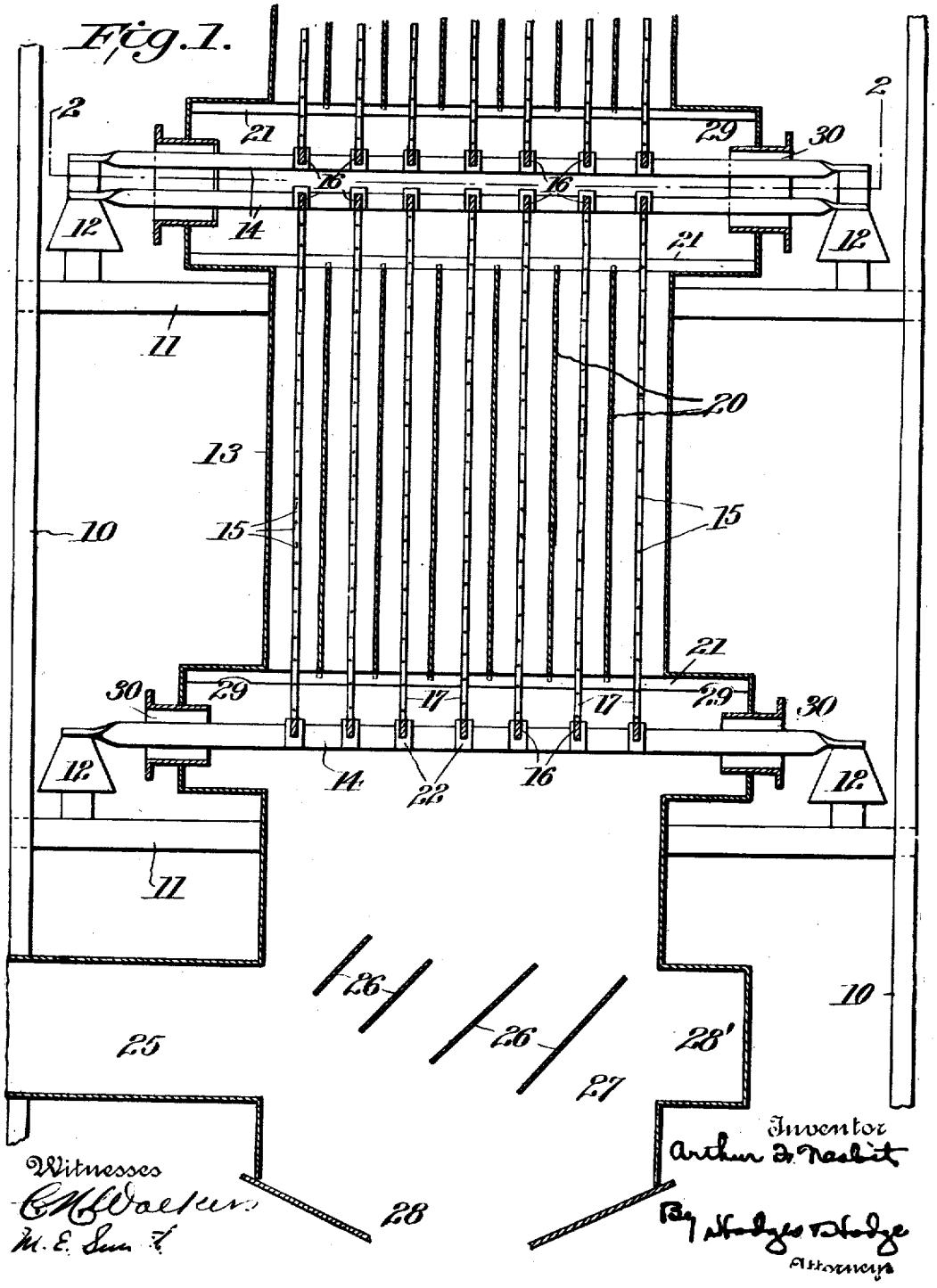
APPARATUS FOR THE ELECTRICAL PRECIPITATION OF SUSPENDED MATTER IN GASEOUS AND FLUID BODIES.

APPLICATION FILED NOV. 17, 1914.

1,356,462. Patented Oct. 19, 1920.

3 SHEETS—SHEET 1.

Fig. 1.



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3 SHEETS—SHEET 2.

Fig. 2.

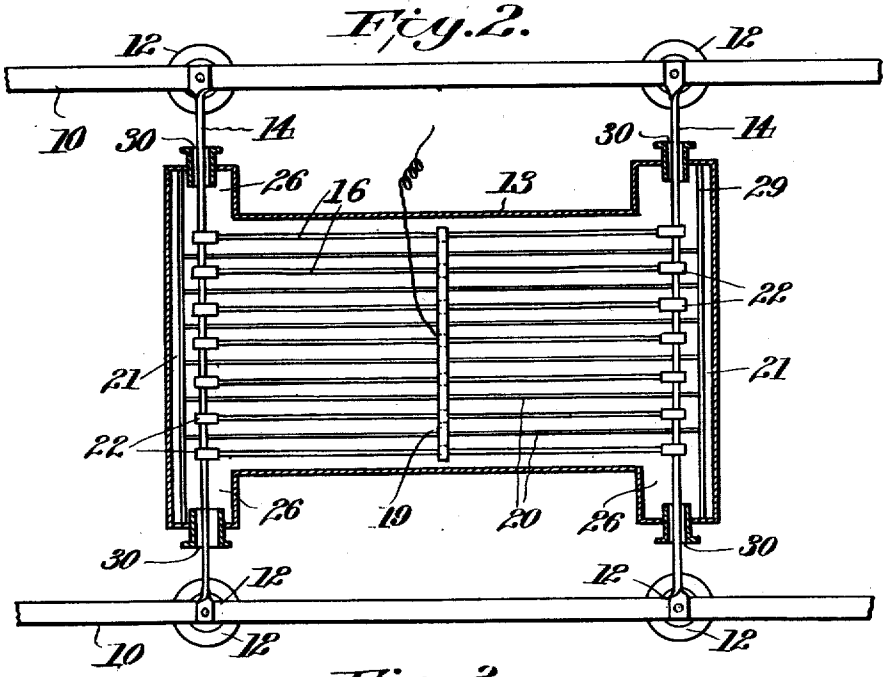
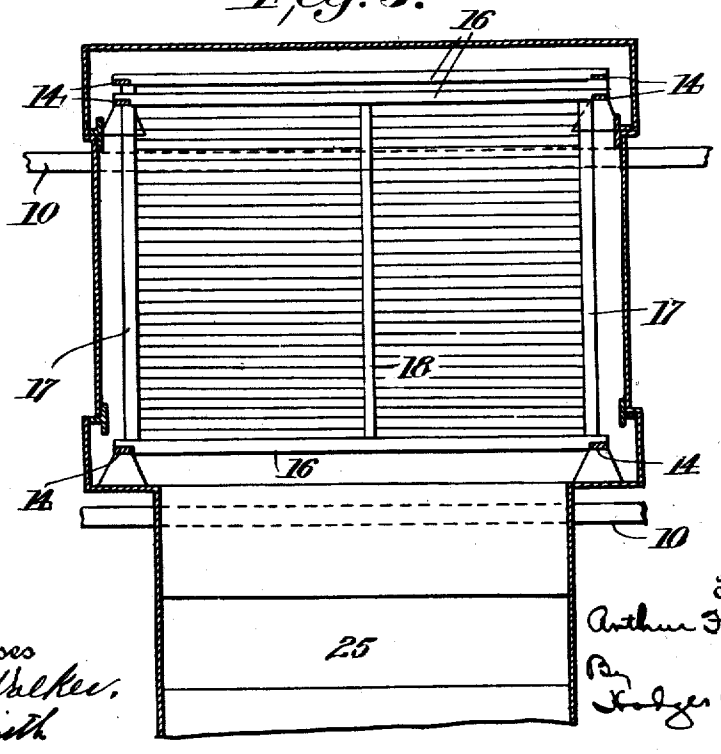


Fig. 3.



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3 SHEETS—SHEET 3.

Fig. 4.

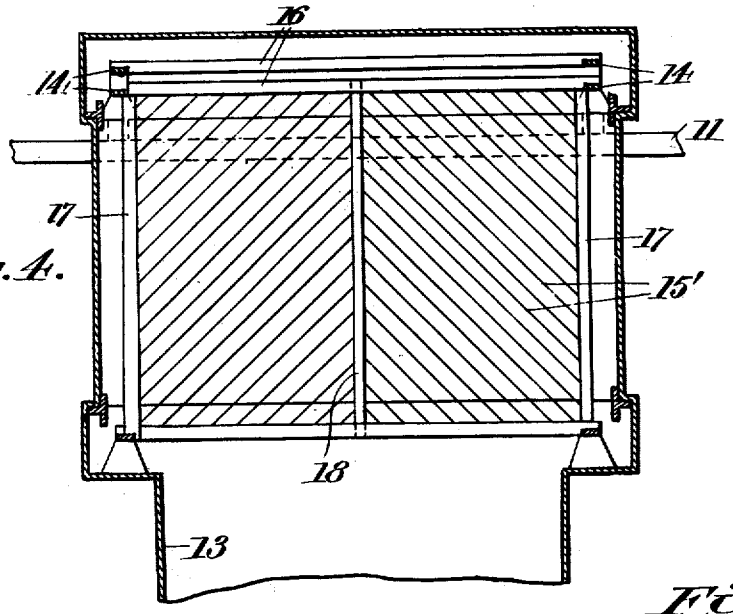
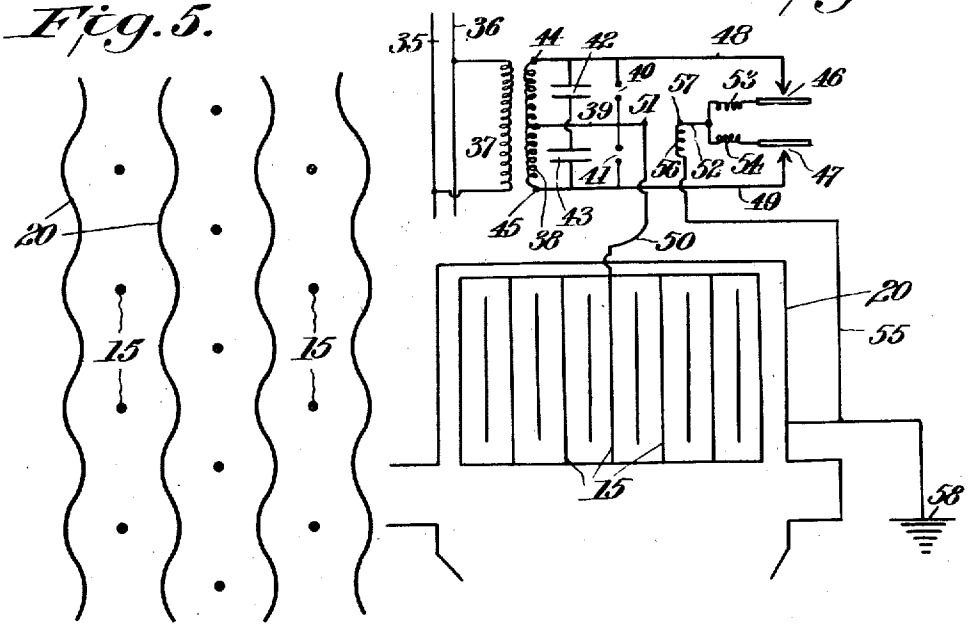


Fig. 6.

Fig. 5.



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UNITED STATES PATENT OFFICE.

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APPARATUS FOR THE ELECTRICAL PRECIPITATION OF SUSPENDED MATTER IN GASEOUS AND FLUID BODIES.

1,356,462. Specification of Letters Patent. Patented Oct. 19, 1920.

Application filed November 17, 1914. Serial No. 872,620.

To all whom it may concern:

Be it known that I, ARTHUR F. NESBIT, a citizen of the United States, residing at Wilkinsburg, in the county of Allegheny and State of Pennsylvania, have invented new and useful Improvements in Apparatus for the Electrical Precipitation of Suspended Matter in Gaseous and Fluid Bodies, of which the following is a specification.

This invention relates to an improvement in means for removing suspended matter from gaseous and fluid bodies by the electrical precipitation process.

It has long been known that electrical discharges, whether of the brush, point, corona, or other types, may be utilized for the removal of suspended particles from gaseous and fluid media. Very copious ionization may be produced by the types of electric fields mentioned, the ions being most easily produced by the use of one or more electrodes placed in or near the same fluid or gaseous medium, and the electrical discharge may be made to take place from one electrode to another, the surface of the active electrode being smaller than the surface of the other electrode, said electrodes constituting an asymmetrical pair. The electrode from which the discharge takes place is called the active electrode because the electrical intensity at or near its surface is very great in comparison with its value at any other portion of the electric field. The luminous, heat, and ionizing effects are usually localized and very intense in the neighborhood of this active electrode. Secondary ionization of the gaseous or fluid medium may also contribute very materially to the breaking down of the insulating properties of said medium. This secondary ionization, which may be due to the collisions of the ions with the gaseous or fluid particles, gives rise to the production of a large number of positive and negative ions. The ions having charges unlike that of the active electrode, are attracted toward it, and are said to give up their charge to this electrode. Ions which possess a sign of charge which is the same as that of the active electrode are repelled from the latter, and if the secondary ionization is sufficiently intense and continuous, this flow of ions will be designated as a stream of ions, or an electric current. The removal of suspended particles in gaseous and fluid bodies, by the electrical precipitation method, involves the action of electric winds, the ionization of the medium, and to a large extent, the formation of nuclei.

The electromagnetic wave, it is well known, is made up of two components, the electrostatic and the magnetic, and the former accounts for the electric currents in the form of electrical discharges, whether steady, disruptive, alternating, pulsating, or oscillating in character. These electromagnetic waves may be the so called pure waves, in that their two components, due to the electrostatic field and the magnetic field, are of equal magnitude, and constitute the ether-distortion or ether-motion states, both traveling along together and mutually sustaining each other. These electromagnetic waves may be made to travel along between two wires, between two broad sheets of metal, between two outer sheets of metal, wholly or partly inclosing another sheet of metal, wire mesh, or a parallel grouping of wires. Between these forms of conducting surfaces, the electromagnetic wave moves along, and is prevented from spreading out, that is, it is confined in much the same manner as a sound wave is confined within a speaking tube through which it passes.

One of the objects of the present invention is to utilize one or more of the well known phenomena associated with electromagnetic waves, when these waves are so controlled as to give rise to more or less faint nodes and loops on the conductors constituting the electrode system, as well as in the dielectric medium through which the electromagnetic wave is passing. A further object is to provide an electrode system equally well adapted to operate at high efficiency, for electromagnetic waves of high or low frequency, and of large or small amplitude. A further object is to provide an apparatus which is applicable where electromagnetic waves may be controlled so

that either their electrostatic or magnetic components may be made, at will, the dominating ones. A further object is to provide an apparatus which shall be adapted to electric potentials of low or high frequencies, and producing electrical discharges which may be steady, disruptive, alternating, pulsating or oscillating in character.

The invention will be hereinafter fully set forth and particularly pointed out in the claims.

In the accompanying drawings:—

Figure 1 is a vertical sectional view illustrating a precipitating apparatus constructed in accordance with my invention. Fig. 2 is a horizontal sectional view on the line 2—2, Fig. 1. Fig. 3 is a vertical sectional view taken at right angles to Fig. 1. Fig. 4 is a similar view illustrating a slight modification. Fig. 5 is an enlarged detail view illustrating the arrangement of the electrodes when the grounded plates 20 are slightly corrugated in form. Fig. 6 is a diagrammatic view illustrating the electric circuits.

Referring to the drawings, 10 designates a supporting framework, provided with beams 11 which serve to support insulators 12 of any suitable or preferred construction. Extending through a casing 13, are bars 14 of suitable metal, the ends of which rest upon and are secured to the insulators 12, said bars serving to support the framework which carries the active electrode wires 15. Said electrode frame work comprises bars 16 connected with the bars 14 and connected by vertical bars 17, the wires 15 being strung under tension between the bars 17. When the weight of the bars 16 and the wires 15 is sufficient to give a fairly rigid structure that will hang vertically, then the entire active electrode system may be suspended from the top only, by bars 14, the lower end of the frame hanging free. It is also obvious that the frame may be supported from the bottom alone. The weight of the active electrode frame employed will depend upon the tension to which the wires 15 are stretched between the end bars 17, as the greater the tension the heavier the frame must be. I prefer, however to support the frame both at the top and the bottom, as illustrated in the drawings, and to connect the horizontal bars of the frame by means of a tie strip 18 through which the wires 15 are passed, said tie strip also serving to prevent or at least damp the vibrations of the wires 15. Any number of such damping strips may be employed, the number required being dependent upon the length of the wires 15 and the manner in which they are strung between the bars 17. The bars 16 are also connected by a tie rod 19, the high voltage wires for supplying current to the electrode system being attached to said bar in any suitable manner.

The grounded electrode comprises the walls 13 of the casing and a plurality of metal plates 20 which may be slightly corrugated, smooth, perforated or uniformly roughened, fine meshed wire netting, or gauze. It will be understood from the drawings that said plates 20 alternate with the frames carrying the active electrode wires 15. The plates 20 are supported by T-bars 21, one arm of each T-bar being slotted to permit of the plates to be shoved into place, and also to allow of a lateral adjustment for alinement with the active electrodes. The frames of the active electrodes are supported by brackets 22 which are free to slide along the bars 14 and when adjusted to proper position are held against displacement in any preferred manner, as for instance by set screws. In Fig. 1 the plates 20 are illustrated as not as long vertically as are the end bars 17 of the active electrodes. In Fig. 2, however, said plates 20 are shown as longer horizontally than the upper and lower bars 16.

The casing 13 is provided with an inlet conduit 25 for conducting the gaseous or fluid bodies, containing suspended matter, into said casing, suitable deflecting dampers 26 being provided to aid in distributing the incoming gases or fluid bodies as they are deflected upward. Said dampers are mounted in a distributing chamber 27, and below said chamber is a suitable hopper 28 to receive the precipitate. The chamber 27 is provided with an extended side apartment 28' in alinement with the conduit 25 for the purpose of insuring that the incoming gases or fluid will travel more or less completely across said chamber, whereby a more uniform distribution of the gases or fluids between the electrodes is assomplished. Above the distributing chamber 27 the casing is provided with extension spaces 29 having openings in their outer walls to receive suitable insulating bushings 30 through which the bars 14 extend. The extension spaces 29 very largely prevent the deposition of solid matter on the bushings 30, or those portions of the bars 14 which extend beyond the side and end walls of the casing, and which are not in the direct path of the gaseous or fluid streams which contain the matter to be deposited. The openings between the walls of the bushings and the bars 14 permit the suction action, produced by natural or forced draft through the casing, to draw air into the spaces 29, thereby aiding in keeping said spaces free from the precipitated materials.

In Figs. 1, 2 and 3, the wires 15 are shown as extending horizontally. In Fig. 4 I have

shown a modification which consists in arranging the active electrode wires 15′ to run diagonally. The operation is much more efficient with this diagonal grouping of the active electrodes.

In the structure illustrated in the drawings, the flow of the gaseous or fluid media is vertical. It is obvious, however, that the direction of flow may be changed without departing from the spirit of my invention, but no matter what the direction of flow may be it is at all times preferable to keep the plane of the plates 20 vertical in order that they may more easily be kept free from and clean of deposited matter. It will also be understood that whatever may be the direction of flow of the gaseous and fluid streams through the apparatus, it is preferable that the high voltage wires be connected to the active electrodes at the upper ends through the tie strip 19. This method of connecting the high voltage supply circuit to the active electrode system especially with the diagonal grouping of the wires makes the lower end of the active electrode frame the same in its action toward the grounded electrode plates 20 and the walls of the casing, as the upper end of the fan parallel type of antenna in a wireless telegraph apparatus. The wires 15 are bare and preferably cylindrical in cross section, being as smooth as practicable, and they may or may not be under tension. All parts of the active and grounded electrodes are as free as possible from sharp points or corners which would tend to localize the electrical discharge. For the purposes of this invention it is immaterial whether the active electrode is of negative or positive sign, it being understood that the coöperating electrode is of the opposite sign.

With the type of electric current, which is unidirectional, yet intermittent, oscillating, or pulsating in character, and of electrical circuits similar to those herein specified, there is a tendency for the electromagnetic waves, as they approach the lower end of the active electrode system in this apparatus, to set up violent whirls or vortices in the gaseous or fluid media, even before the entrance of such media to or passage through the precipitating elements. The greater the dielectric capacity of the gaseous or fluid media, the greater will be the electromagnetic radiations, and these same radiations are made more intense in the very direction which will enable a much higher rate of producing nuclei to be obtained, and consequently a more efficient precipitation of suspended matter.

In Fig. 6 I have illustrated the general type of electric circuit preferably employed with the above described apparatus. Referring to said figure, the low voltage alternating current supply is represented by the wires 35, 36 which receive current from a suitable generator. The transformer with its primary coil 37 and secondary coil 38, is shown with a middle tap 39 connected to the center of a double spark gap 40, 41. The condensers 42, 43 are connected across the terminals 44, 45. Asymmetrical spark gap rectifiers 46, 47 are connected by wires 48, 49 with the secondary coil 38, as shown. The active electrode members containing the wires 15 are connected by a wire 50 with the branch 39, as indicated at 51. The casing and negative electrodes 20 are connected at 57 by a wire 52 with the inductances 53 and 54 leading from the spark gap rectifiers 46, 47, through a wire 55, an inductance 56 being interposed between said wire and the first mentioned inductances. The casing 10 is grounded, as indicated at 58. The inductances 53, 54 and 56 are for the purpose of sustaining the current during the interval when the voltage wave is falling off and is too small to be maintained without their use, or the use of condensers elsewhere provided.

Should the electrical precipitation apparatus containing active and grounded electrodes be omitted, the secondary voltage may become of sufficient value to cause intense ionic streams across the gaps of the rectifiers 46 and 47, and the hissing, which at first would be rather faint, becomes much more audible. When this condition has been attained, either a slight rise in the secondary voltage, or a very small decrease in the length of the gaps, causes the electrical discharge to take the form of an arc across the gaps. Simultaneously with the formation of these arcs, the secondary voltage must either be very materially lowered, or the gaps lengthened to maintain the voltage across the gaps approximately constant for working conditions. The presence, however, of the active and grounded electrodes of the precipitation apparatus, as shown across the circuit terminals 51 and 57, eliminates the necessity of the same rapidity and nicety of adjustment of secondary voltage or lengthening of the gaps, because a larger part of the total line voltage between the outside terminals 44 and 45 and the neutral point 39 now falls across the terminals 51 and 57. In other words the gaps 46 and 47 may be made quite short before an arc forms, and also before there will simultaneously occur, between the active and grounded electrodes, a corona discharge sufficient in magnitude to maintain a quiet or slightly humming arc.

A large number of possible electric circuits are admissible in the operation of my precipitating apparatus, and also groupings of resistances, inductances, capacities, and spherical spark gaps, and I accordingly do

not desire to limit myself to the precise arrangement of these elements shown and described. Furthermore, any form of rectifier may be employed, and the general make up of the electric circuit will vary accordingly, the rectifiers shown and described, and the circuits in connection therewith being employed for illustrative purposes only, and I therefore do not limit myself in this particular.

Having thus explained the nature of my invention and described an operative manner of constructing and using the same, although without attempting to set forth all of the forms in which it may be made, or all of the forms of its use, what I claim is:—

1. An improvement in means for removing suspended particles from gaseous and fluid bodies comprising a plurality of spaced apart plate-like grounded electrodes, and a plurality of active electrodes alternating with said grounded electrodes, each active electrode being provided with a plurality of electrode members located on a common plane extending parallel with the faces of said grounded electrodes and in the direction of flow of the stream, said members extending angularly to the direction of flow of the gaseous or fluid streams.

2. An improvement in means for removing suspended particles from gaseous and fluid bodies comprising an active electrode formed of a rectangular frame having a plurality of parallel wires supported by opposite side bars of said frame, and extending angularly to the direction of flow of the gaseous or fluid streams, and a grounded electrode having one face opposite said wires.

3. Apparatus for electrical precipitation of suspended particles from gases, comprising a plurality of spaced plate-like receiving electrodes forming a gas-passage between them, an electrode frame between said receiving electrodes and in a plane parallel thereto and a series of parallel discharge electrodes in said frame angularly disposed with respect to the direction of gas-flow.

4. Apparatus for electrical precipitation of suspended particles from gases, comprising a plurality of spaced plate-like receiving electrodes forming a gas-passage between them, an electrode frame between said receiving electrodes and in a plane parallel thereto and a series of parallel filamentary discharge electrodes in said frame angularly disposed with respect to the direction of gas-flow.

5. Apparatus for electrical precipitation of suspended particles from gases, comprising a plurality of spaced plate-like receiving electrodes forming a gas-passage between them, an electrode frame between said receiving electrodes and in a plane parallel thereto and a series of parallel filamentary discharge electrodes held by said frame under tension at an angle to the direction of gas-flow.

6. Apparatus for electrical precipitation of suspended particles from gases, comprising spaced plate-like receiving electrodes forming a gas-passage between them, an electrode frame between said receiving electrodes and in a plane parallel thereto and a series of parallel discharge electrodes held by said frame under tension.

7. Apparatus for electrical precipitation of suspended particles from gases, comprising a plurailty of spaced, vertical, plate-like receiving electrodes forming a vertical gas-passage between them, a vertical electrode frame between said receiving electrodes and a series of parallel discharge electrodes in said frame at an angle to the vertical.

8. Apparatus for electrical precipitation of suspended particles from gases, comprising a plurality of spaced, vertical, plate-like receiving electrodes forming a vertical gas-passage between them, a vertical electrode frame between said receiving electrodes and a series of parallel discharge electrodes held in said frame under tension.

9. Apparatus for electrical precipitation of suspended particles from gases, comprising a plurality of spaced, vertical, plate-like receiving electrodes forming a vertical gas-passage between them, a vertical electrode frame between said receiving electrodes and a series of parallel filamentary discharge electrodes held by said frame under tension, said discharge electrodes being inclined to the line of flow of the gas.

10. Apparatus for electrical precipitation of suspended particles from gases, comprising a plurality of spaced, vertical, plate-like receiving electrodes forming a vertical gas-passage between them, a vertical electrode frame between said reciving electrodes having a vertical cross-bar intermediate its ends, a series of parallel discharge electrodes in said frame between one of its ends and said cross-bar, said discharge electrodes being inclined to the line of flow of the gas and a second series of parallel discharge electrodes in said frame between its other end and said cross-bar, the discharge electrodes of said second series being inclined to the line of flow of the gas and substantially at right angles to the discharge electrodes of the first series.

11. Apparatus for electrical precipitation of suspended particles from gases, comprising a plurality of spaced, vertical, plate-like receiving electrodes forming a series of parallel, vertical gas-passages, a vertical electrode frame in each of said passages and a series of parallel discharge electrodes carried rigidly in each of said frames at an angle to the vertical.

12. Apparatus for electrical precipitation of suspended particles from gases, compris-

ing spaced plate-like receiving electrodes forming a gas-passage between them, an electrode frame between said receiving electrodes and a series of parallel flexible linearly extending discharge members held rigidly in said frame.

13. Apparatus for electrical precipitation comprising opposing electrode systems, the discharge system comprising a frame carrying rigidly a plurality of flexible linearly extending discharge members extending in parallelism with each other.

14. Apparatus for electrical precipitation comprising opposing electrode systems, the discharge system comprising a frame carrying rigidly a plurality of flexible linearly extending discharge producing elements extending in parallelism with each other, said elements intersecting the direction of flow of the stream.

15. Apparatus for electrical precipitation comprising opposing electrode systems, the discharge system comprising a rigid frame, a support therefor, and a plurality of flexible linearly extending discharge producing elements rigidly carried by the frame and extending in parallelism with each other on a common plane corresponding to the direction of flow of the stream.

16. Apparatus for electrical precipitation comprising opposing electrode systems, the discharge system comprising a rigid frame, a support therefor, and a plurality of flexible linearly extending discharge producing elements rigidly carried by the frame and extending in parallelism with each other on a common plane, said frame and elements constituting a unit of single charge sign.

17. Apparatus for electrical precipitation comprising opposing electrode systems, the discharge system comprising a plurality of flexible linearly extending discharge producing elements parallel with each other and held substantially rigid.

18. Apparatus for electrical precipitation comprising a discharge electrode system consisting of a frame carrying parallel flexible linearly extending electrode elements, a support for said frame, and means for adjustably holding the frame on said support.

19. Apparatus for electrical precipitation comprising opposing electrode systems, means for passing a gas stream therebetween, the discharge electrode system comprising a series of parallel electrode elements inclined to the direction of gas flow, and means for connecting the discharge electrode systems with a source of electrical energy at that end farthest from the gas entrance.

20. Apparatus for electrical precipitation comprising opposing electrode systems, the discharge system comprising a frame carrying rigidly a plurality of electrode elements extending in parallelism with each other and inclined to one side of the frame.

21. Apparatus for electrical precipitation comprising opposing electrode systems, the discharge system comprising a rigid frame carrying rigidly a plurality of electrode elements extending in parallelism with each other and inclined to one side of the frame.

In testimony whereof I have hereunto set my hand in presence of two subscribing witnesses.

ARTHUR F. NESBIT.

Witnesses:
ALBERT H. KOTSCH,
W. J. MOORE.