July 12, 1949. K. W. MacKENZIE 2,476,247

ELECTRICAL PRECIPITATOR

Filed Aug. 24, 1946 3 Sheets-Sheet 1

FIG. 2.

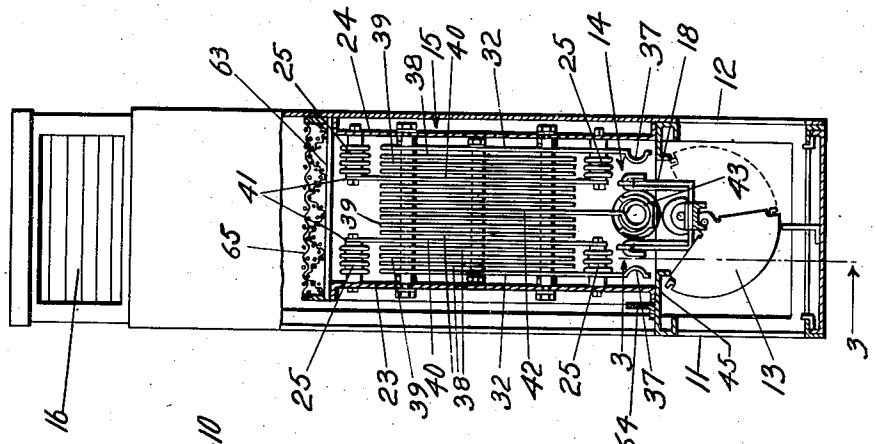
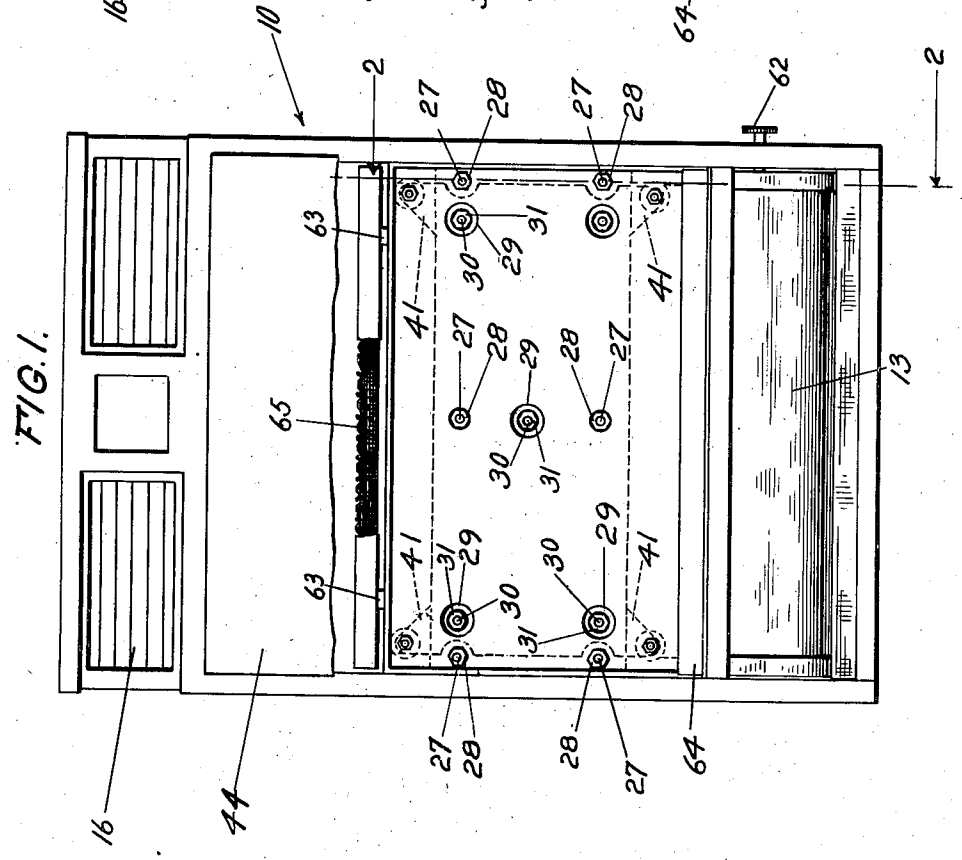


FIG. 1.



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FIG. 4

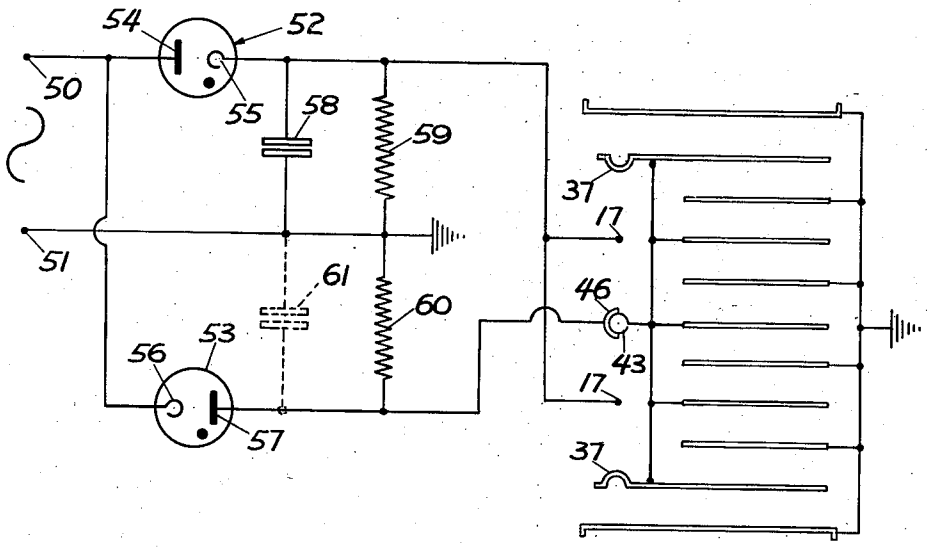
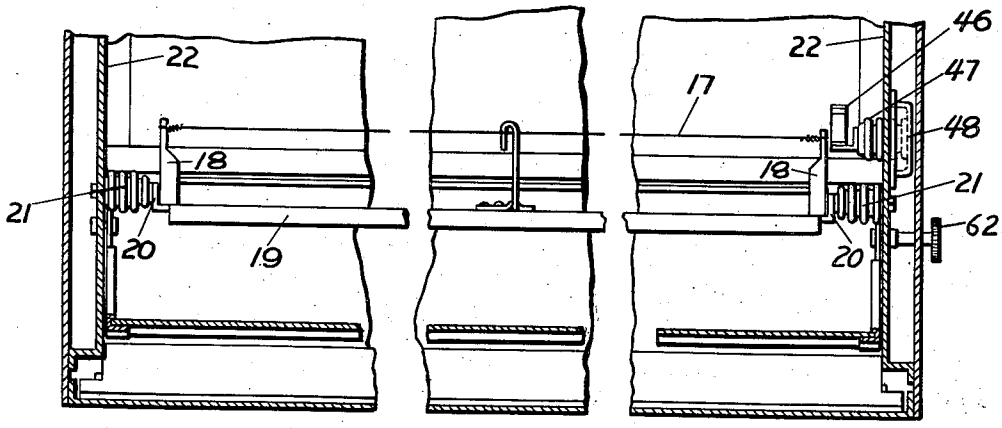


FIG. 3



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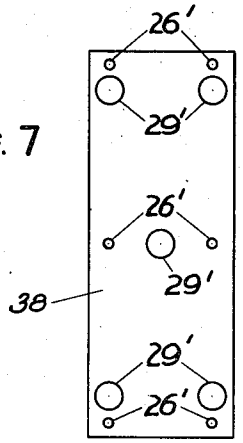


FIG. 7

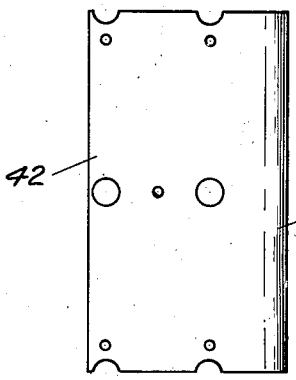


FIG. 10

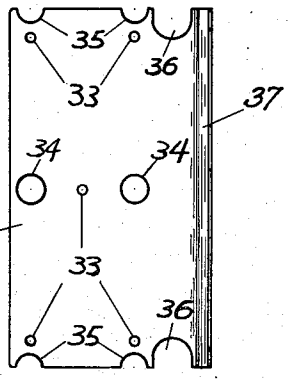


FIG. 6

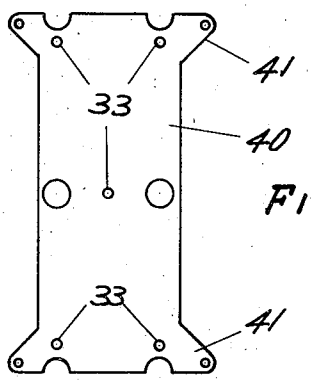


FIG. 9

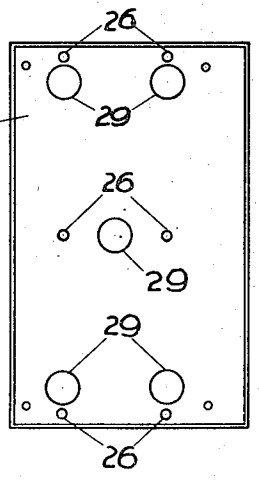


FIG. 5

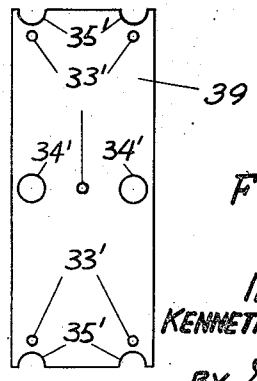


FIG. 8

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2,476,247

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ELECTRICAL PRECIPITATOR

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Application August 24, 1946, Serial No. 692,893

14 Claims. (Cl. 183—7)

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This invention relates to electrical precipitators for electrically separating dust or smoke from atmospheric air or other gases. More particularly, the invention relates to precipitators of the type in which the air or gas to be cleaned is first ionized by an ionizing device and thereafter passed through a precipitating device comprising a plurality of parallel collector plates, alternate plates being charged in one polarity and the intervening plates being charged in the opposite polarity or grounded.

It is among the objects of the present invention to provide a precipitator of the type described which is relatively small and compact, and which may be conveniently housed in a single unit for domestic use, for example, for cleaning air in a room or office.

It is a further object of the invention to provide a precipitator of the type described in which the collector plates may be readily removed for the purpose of cleaning.

A further object of the invention resides in the provision of a collector plate assembly which carries integrally therewith one set of the ionizing electrodes of the ionizing means.

A further object of the invention resides in the provision of a construction in which one set of ionizing electrodes is maintained at a given positive potential relative to ground, while the other set of ionizing electrodes is maintained at a negative potential relative to ground, and wherein the two sets of electrodes are separately supported so that the required insulation may be only that necessary to insulate each set of electrodes relative to ground rather than that required to insulate the two sets from each other.

The above and other objects and features of the invention will be made fully apparent to those skilled in the art from a consideration of the following detailed description taken in conjunction with the accompanying drawings, in which:

Fig. 1 shows in front elevation, with parts removed to show internal construction, a precipitator constructed in accordance with the present invention;

Fig. 2 shows the precipitator in side elevation with parts removed to show internal construction;

Fig. 3 shows a section taken on the line 3—3 of Fig. 2 with parts removed for the sake of clarity;

Fig. 4 shows a wiring diagram for the power supply of the precipitator; and

Figs. 5, 6, 7, 8, 9 and 10 are details showing the form of the side walls and various collector plates of the collector plate assembly.

Referring to the drawings, reference numeral 10 indicates a cabinet for housing all of the elements of the precipitator unit. The cabinet 10 is provided with screened openings 11 and 12 in the lower portion thereof for the entrance of air to be cleaned. A damper 13 permits the air

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cleaned to be drawn in through either the opening 11 or the opening 12 to the end that air from the outside of the room or air from within the room may be passed through the precipitator. An ionizing device indicated generally at 14 is provided in the lower portion of the housing 10 for ionizing the air prior to its passage through a collector plate assembly indicated generally at 15. The collector plate assembly may be removed as a unit from the housing 10 to permit the cleaning of accumulated dust and smoke therefrom. It will be understood that the upper portion of the housing above the collector plate assembly 15 may house the power supply assembly and fans for drawing the air to be cleaned through the precipitator. The cleaned air is forced out of the unit through screened openings 16 in the upper portion of the housing 10.

The ionizing device 14, as shown in Fig. 3, includes a pair of fine wire electrodes 17 supported by the upwardly projecting arms of a pair of yokes 18. The yokes 18 are mounted on the outer ends of a channel iron 19 having upwardly projecting end tabs 20 for securing the supporting structure of the fine wire electrodes 17 to a pair of insulators 21. In order to provide a smooth external housing free from projecting bolts and the like, a double end wall is provided and the insulators 21 are secured by suitable nuts to the innermost wall 22.

The collector plate assembly 15, as shown in Fig. 2, comprises a pair of side walls 23 and 24 which support therebetween a plurality of spaced parallel precipitator plates. Alternate of said precipitator plates are directly supported by and electrically connected to said side walls. The intervening of said plates are insulated from said side walls and from said alternate plates and supported from said side walls by insulators 25 in a manner which is more particularly described and claimed in my copending application, Serial No. 678,146, filed June 20, 1946, now Patent No. 2,470,356 dated May 17, 1949. The side walls 23 and 24, and accordingly said alternate plates, are grounded and for convenience will be called ground plates. The plates which intervene between said ground plates and between said ground plates and said side walls are adapted to be connected to a suitable source of potential, in a manner hereinafter described, and will be called charge plates.

The side walls 23 and 24, one of which 23 is shown in Fig. 5, are provided with a plurality of small openings 26 of approximately the same diameter as the external diameter of a corresponding number of rods 27. The rods 27 extend between said side walls and project through said openings. The ends of said rods are threaded to receive nuts 28 on each side of said side walls to the end that the walls are rigidly

secured in spaced relation and electrically connected. The rods 27 pass through all of the collector plates, directly supporting the ground plates and in electrical contact therewith. They are, however, free from contact with the charge plates in a manner to be described. The side walls 23 and 24 are also provided with openings 29 of larger diameter than the openings 26 to provide a clearance space between said side walls and the ends of a plurality of rods 30. The rods 30 support and electrically connect the charge plates but are free from electrical contact with side walls 23 and 24 due to the clearance provided by the openings 29. The ends of the rods 30 are threaded to receive nuts 31 on the ends thereof adjacent the side walls 23 and 24.

The collector plates 32, shown in Fig. 6, are positioned next adjacent to the side walls 23 and 24, and constitute a portion of the charge plates. These plates are provided with small openings 33 of approximately the same diameter as the external diameter of the rods 30 and are secured thereto and in good electrical contact therewith by the nuts 31. A pair of openings 34 of substantially larger diameter than the openings 33, together with cut-out portions 35, permit the supporting rods 27 to pass freely through the plates 32 with an insulating clearance therebetween. The plates 32 are also provided with cut-out portions 36 to permit the insulators 25 to pass therethrough with a suitable clearance. The plates 32 are provided with inwardly curved portions 37 to provide semi-cylindrical surfaces adjacent the fine wire electrodes 17 functioning as electrodes having a polarity opposite to that of said fine wire electrodes. The plates 38 next adjacent to the collector plates 32 are shown in Fig. 7. These plates constitute a portion of the ground plates, are of substantially less width than the plates 32, and are provided with openings 26' corresponding to the openings 26 in the side walls 23 and 24. The rods 27 pass through these openings and suitable washers or bushings on the rods secure the plates 38 in spaced relation to the side walls 23 and 24 and to the next succeeding ground plates. The plates 38 are also provided with openings 29' corresponding to the openings 29 to permit the rods 30 to pass freely through the plates 38, and provide an insulating clearance therebetween.

The plates 39 next adjacent to the plates 38, shown in Fig. 8, constitute charge plates and are similar in construction to the plates 32 except that they are narrower being of substantially the same width as the plates 38 and having no electrode corresponding to the electrodes 37. The openings 33' in the plates 39 correspond in function to the openings 33 of the plates 32, and the openings 34' and the cut-out portions 35' correspond to the position and function of the openings 34 and cut-out portions 35 of the plates 32.

Any desired number of ground plates 38 alternating with charge plates 39 may be provided. Two of the charge plates, one of which is indicated at 40 in Fig. 9, are provided with projecting tabs 41 for securing said plates to the insulators 25. The insulators 25 thus support the plates 40 which in turn support the rods 30 which pass through the openings 33, and the rods 30 in turn support the remainder of the charge plates.

As shown in Fig. 10, one of the charge plates 42 which in this instance is the center plate in the collector plate assembly is provided with an extended portion terminating in a tubular member 43. The tubular member 43 provides a cylindrical electrode extending parallel with the semi-cylindrical surfaces 37 and is adapted when the collector plate assembly is in position to rest between the two fine wire electrodes 17.

When the collector plate unit has been assembled, a rigid unitary structure is provided which may be inserted into or lifted from the housing 10 upon the removal of a front panel 44. The collector plate assembly rests upon a partition 45, with the semi-cylindrical electrodes 37 and the cylindrical electrode 43 lying in the same horizontal plane as the fine wire electrodes 17. In this position while the weight of the collector plate assembly rests upon the partition 45, the cylindrical electrode 43 is engaged with a resilient clamp 46, which clamp is supported by an insulator 47 secured to the inner wall housing 22 through a retaining cap 48. Resilient clamp 46 is connected to a suitable lead-in conductor for supplying a desired potential to the charge plates of the collector plate assembly. The semi-cylindrical electrodes 37 and the cylindrical electrode 43 are thus at the same potential as the charge plates of the collector plate assembly.

The collector plate assembly and the ionizing means may be energized in the manner disclosed in Fig. 4. Referring to this figure, alternating current from a suitable source is supplied at the terminals 50 and 51. A pair of gaseous discharge devices 52 and 53 are connected in inverse relation to the terminal 50. The anode 54 of the tube 52 is connected to the terminal 50 and its cathode 55 is connected directly to the fine wire electrodes 17. The tube 53 has its cathode 56 connected to terminal 50 and its anode 57 connected to the resilient clamp 46, and hence to the tubular electrode 43, and through this electrode to the charge plates of the collector plate assembly. The other terminal 51 of the alternating current source is connected to ground. Between the ground connection of the terminal 51 and the cathode lead of the tube 52, a condenser 58 and a resistor 59 are connected in parallel. Between the anode lead of the tube 53 and ground is a resistor 60. It will be seen that the collector plate assembly functions as a condenser connected between the anode lead of the tube 53 and ground. The capacitance of the condenser provided by the collector plate assembly corresponds to the capacitance of the condenser 58, its electrical equivalent being shown in dotted lines at 61.

The circuit just described constitutes a voltage doubler circuit and it will be seen that a positive potential will be applied to the fine wire electrodes 17. A numerically equal potential of opposite polarity will be applied to the cylindrical electrode 43 and the semi-cylindrical electrodes 37. Thus if the potential applied to the fine wire electrodes is 6 kv. positive relative to ground and the potential applied to the cylindrical electrode 43 and the semi-cylindrical electrodes 37 is 6 kv. negative relative to ground, the ionizing potential applied between the fine wire electrodes and the cylindrical surfaces will be 12 kv. The potential applied to the charge plates of the collector plate assembly is the same as that applied to the cylindrical electrode 43, and since this is 6 kv. negative relative to ground, the potential applied to the charge plates of the collector plate assembly will be 6 kv. negative relative to the ground plates.

In operation air is drawn in through either one or both of the openings 11 and 12 depending upon the setting of the damper 13, the position of which may be adjusted from the exterior of the

housing 10 by means of a knob 62. Thus, fresh air from the outside, or air from within the room, or both in any desired proportion, may be passed through the precipitator for purification. The air passes upwardly between the ionizing electrodes provided by the fine wires 17 and the cylindrical surfaces 37 and 43 where it is ionized, and thence through the narrow spaces between the collector plates where the dust particles and other solid impurities are collected. The purified air is then drawn upwardly through the housing 10 and forced out through the openings 16.

It will be understood that suitable fans, not shown, are disposed in the upper portions of the housing 10, as is also the power supply unit for energizing the ionizing electrodes and the collector plates. If desired a screen filter 65 may be disposed above the collector plate assembly for preventing any agglomerated dust particles from being blown out into the room. Although such screen filters are not capable of separating fine dust and smoke particles from air, it may happen that such particles agglomerated on the collector plates will be blown upwardly. These agglomerations are sufficiently large to be retained by a screen filter.

Most of the dust and smoke particles adhere to the collector plates and occasionally these must be removed for cleaning. To this end the entire collector plate assembly is readily removable by opening the front panel 44, removing the filter 65, which rests upon the assembly, and lifting the collector plate assembly from the housing by means of straps 63. In order to insure that the collector plate assembly will be lifted clear of the fine wire electrodes 17 while being removed from the housing 10, an upwardly projecting strip 64 is provided upon the partition 45, so that the assembly must be lifted upwardly for a sufficient distance to clear the strip and thus clear the fine wire electrodes before it can be withdrawn laterally from the housing 10. It will be observed that the only electrical connection to the collector plate assembly is through the clamp 46 and this connection is automatically made or broken upon the insertion or the removal of the assembly. Thus the user is not required to concern himself with making proper electrical connections or disconnections for the collector plate assembly when removing or replacing the same.

While there has been herein described a preferred embodiment of the invention, other embodiments within the scope of the appended claims will be obvious to those skilled in the art from a consideration of the form shown and the teachings hereof.

What is claimed is:

1. An electrical precipitator for separating impurities from air and other gases including in combination a plurality of spaced, parallel collector plates comprising charge and ground plates, a fine wire electrode positioned in the gas stream ahead of said plates, at least one of said charge plates having a projecting portion extending beyond other of said plates in the direction of the incoming air, said projecting portion having a curved surface providing an electrode coacting with said fine wire electrode, means for applying a potential of a predetermined polarity relative to ground to said charge plates, and means for applying a potential of the opposite polarity relative to ground to said fine wire electrode.

2. An electrical precipitator for separating impurities from air and other gases comprising a

plurality of spaced, parallel collector plates, means for applying a potential difference between adjacent of said plates, means supporting a fine wire electrode independently of said collector plates in the gas stream ahead of said plates, at least one of said plates having a projecting portion extending beyond other of said plates in the direction of the incoming air, said projecting portion having a curved surface providing an electrode element coacting with said fine wire electrode, and between which coacting electrodes an ionizing discharge is adapted to occur.

3. An electrical precipitator for separating impurities from air and other gases including in combination a plurality of spaced, parallel collector plates comprising charge and ground plates, means for applying a potential difference between said charge and ground plates, means supporting a fine wire electrode independently of said collector plates in the gas stream ahead of said plates, at least one of said charge plates having a projecting portion extending beyond other of said plates in the direction of the incoming air, said projecting portion having a curved surface providing an electrode element coacting with said fine wire electrode, and between which coacting electrodes an ionizing discharge is adapted to occur.

4. An electrical precipitator for separating impurities from air and other gases including in combination a plurality of spaced, parallel collector plates comprising charge and ground plates, means supporting a fine wire electrode independently of said collector plates in the gas stream ahead of said plates, at least one of said charge plates having a projecting portion extending beyond other of said plates in the direction of the incoming air, said projecting portion having a curved surface providing an electrode element coacting with said fine wire electrode, means for applying a potential of a predetermined polarity relative to ground to said charge plates, and means for applying a potential of the opposite polarity relative to ground to said fine wire electrode.

5. An electrical precipitator for separating impurities from air and other gases comprising a plurality of spaced, parallel collector plates, means for applying a potential difference between adjacent of said plates, means supporting a pair of fine wire electrodes independently of said collector plates in the gas stream ahead of said plates, three of said plates having projecting portions extending beyond other of said plates in the direction of the incoming air, said projecting portions having curved surfaces providing electrode elements coacting with said fine wire electrodes, and between which coacting electrodes an ionizing discharge is adapted to occur.

6. An electrical precipitator for separating impurities from air and other gases comprising a plurality of spaced, parallel collector plates, means for applying a potential difference between adjacent of said plates, means supporting a pair of fine wire electrodes independently of said collector plates in the gas stream ahead of said plates, three of said plates having projecting portions extending beyond other of said plates in the direction of the incoming air, one of said projecting portions terminating in a tubular member providing a cylindrical electrode element lying between and coacting with both of said fine wire electrodes, and the other two of said projecting portions each having a curved surface lying adjacent one of said fine wire electrodes on the side

thereof opposite said cylindrical electrode, and coacting therewith to provide an ionizing discharge therebetween.

7. An electrical precipitator for separating impurities from air and other gases comprising a plurality of spaced, parallel collector plates, means for applying a potential difference between adjacent of said plates, means supporting a fine wire electrode in the gas stream ahead of said plates, one of said plates adjacent an end plate having a projecting portion extending beyond other of said plates in the direction of the incoming air, said projecting portion having a curved surface providing an electrode element coacting with said fine wire electrode, and between which coacting electrodes an ionizing discharge is adapted to occur, said curved surface being in the form of a laterally deflected portion of said projecting portion having its convex side toward said fine wire and baffle means positioned to direct said incoming air away from the space between said end plate and said one plate and between said fine wire and said convex side.

8. In a dust precipitator, a cabinet, a first ionizer element in said cabinet insulatedly mounted therein, electrical contact making means in said cabinet insulatedly mounted therein and adapted to receive a second ionizer element, a unitary collector plate assembly adapted to be removably supported in said cabinet, said second ionizer element being conductively supported on a plate of said assembly and arranged to fit into said contact making means in electrical contact making relation therewith when said assembly is disposed in said cabinet, means to support said unit in said cabinet in such a position that said second ionizer element establishes said relation with said contact making means and individual electrical connection means at said first ionizer element and said contact making means.

9. In a dust precipitator, a cabinet, a first ionizer element in said cabinet insulatedly mounted therein, electrical contact making means in said cabinet insulatedly mounted therein and adapted to receive a second ionizer element, a unitary collector plate assembly comprising first and second sets of interleaved plates, the plates of one set being insulatedly affixed to the plates of the other set, said assembly adapted to be removably supported by at least one plate of said first set in said cabinet, said second ionizer element being conductively supported on a plate of said second set and arranged to fit into said electrical contact making means in electrical contact making relation therewith when said assembly is disposed in said cabinet, support means disposed in said cabinet to engage said plate of said first set and support said assembly with said second ionizer element in said relation, and individual electrical connection means at said first ionizer element, said electrical contact making means and said plate of said first set.

10. The arrangement of claim 9 wherein said support means is electrically conductive and electrical connection to said plate of said first set is made therethrough.

11. The arrangement of claim 9 wherein the connection to said plate of said first set is grounded, and means are provided for furnishing to said first ionizer element a potential on one side of ground and to said electrical contact making means a potential on the opposite side of ground.

12. In a dust precipitator, a cabinet, a first ionizer element insulatedly mounted in said cabinet, a unitary collector plate assmbly comprising first and second sets of interleaved plates, the plates of one set being insulatedly affixed to the plates of the other set, said assembly adapted to be removably supported by at least one plate of said first set in said cabinet, a plate of said second set comprising an extension shaped to provide a second ionizer element which is disposed between said first ionizer element and said one plate when said assembly is disposed in said cabinet, support means disposed in said cabinet to engage said one plate and support said assembly with said ionizer elements in ionizing relation, and individual electrical connection means at said first ionizer element, said plates of said first set and said plates of said second set.

13. In a dust preciptator, a cabinet, a first ionizer element insulatedly mounted in said cabinet, a unitary collector plate assembly comprising first and second sets of interleaved plates, the plates of one set being insulatedly affixed to the plates of the other set, said assembly adapted to be removably supported by at least one plate of said first set in said cabinet, a plate of said second set comprising an extension shaped to provide a second ionizer element which is disposed between said first ionizer element and said one plate when said assembly is disposed in said cabinet, support means disposed in said cabinet to engage said one plate and support said assembly with said ionizer elements in ionizing relation, said support means extending into the path of the gas being cleaned on the upstream side thereof sufficiently far to deflect said gas away from the space between said one plate and said second ionizer element and into the space between said ionizer elements, and individual electrical connection means at said first ionizer element, said plates of said first set, and said plates of said second set.

14. An electrostatic precipitator comprising a casing, collector electrodes in said casing, means including means insulated from said casing for supporting said electrodes therefrom, relatively large ionizer electrodes supported from and in electrical contact with said collector electrodes, wire ionizer electrodes between said relatively large electrodes, means including means insulated from said casing for supporting said wire ionizer electrodes therefrom, means for charging said wire electrodes to a potential having one polarity with respect to said casing, and means for charging said collector and said relatively large ionizer electrodes to a potential having the opposite polarity with respect to said casing.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,343,285	Schmidt	June 15, 1920
2,129,783	Penney	Sept. 13, 1938
2,214,585	Hildebrand	Sept. 10, 1940
2,347,709	Penney	May 2, 1944