Feb. 10, 1959 L. S. ELAM 2,873,000

ELECTROSTATIC PRECIPITATOR

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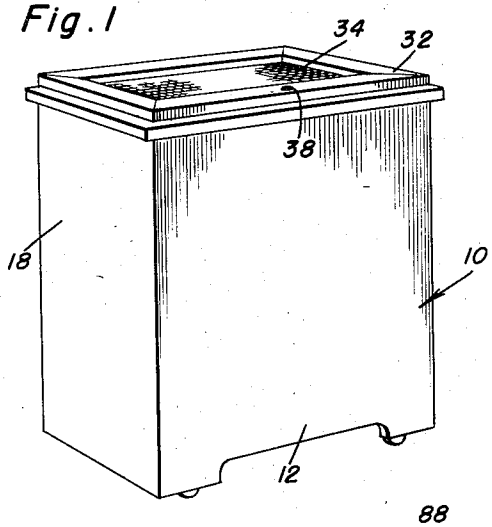
Fig. 1



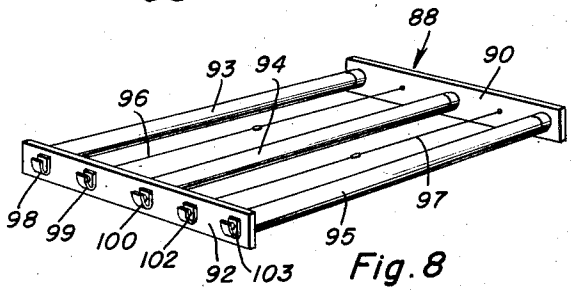
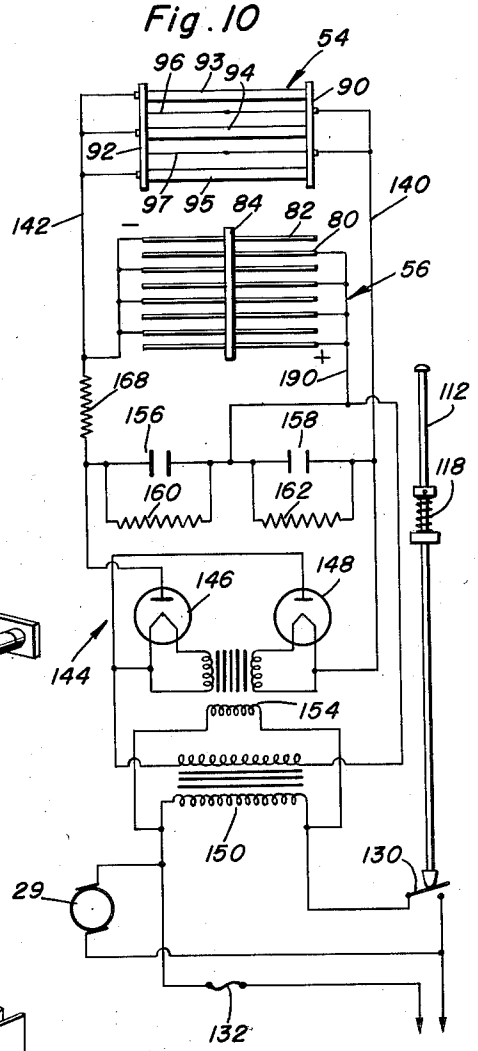


Fig. 8

Fig. 10



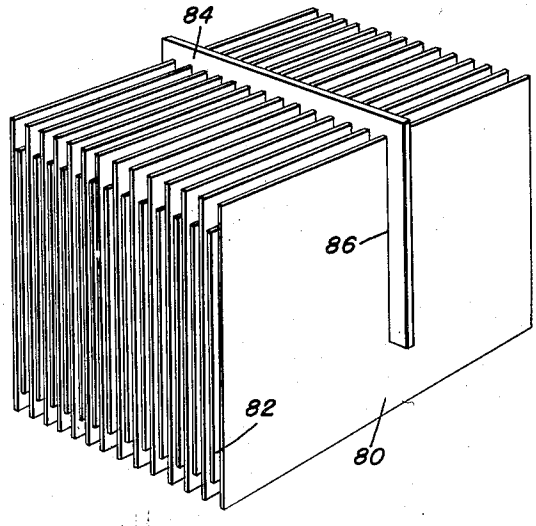


Fig. 9

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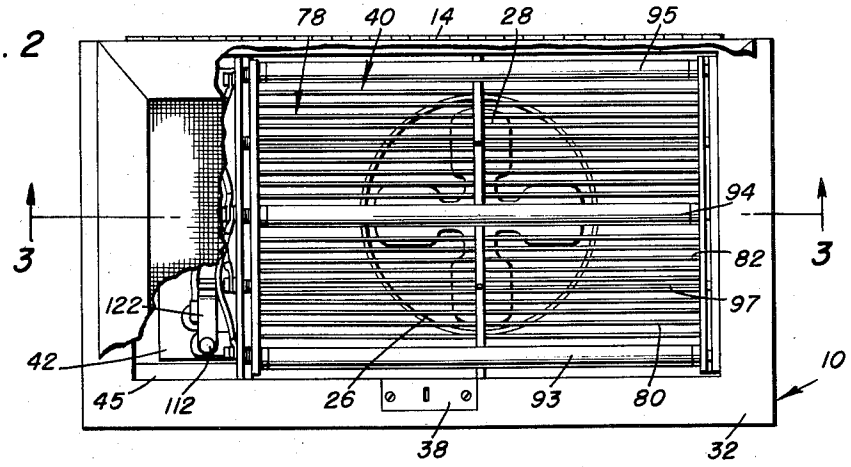
Fig. 2



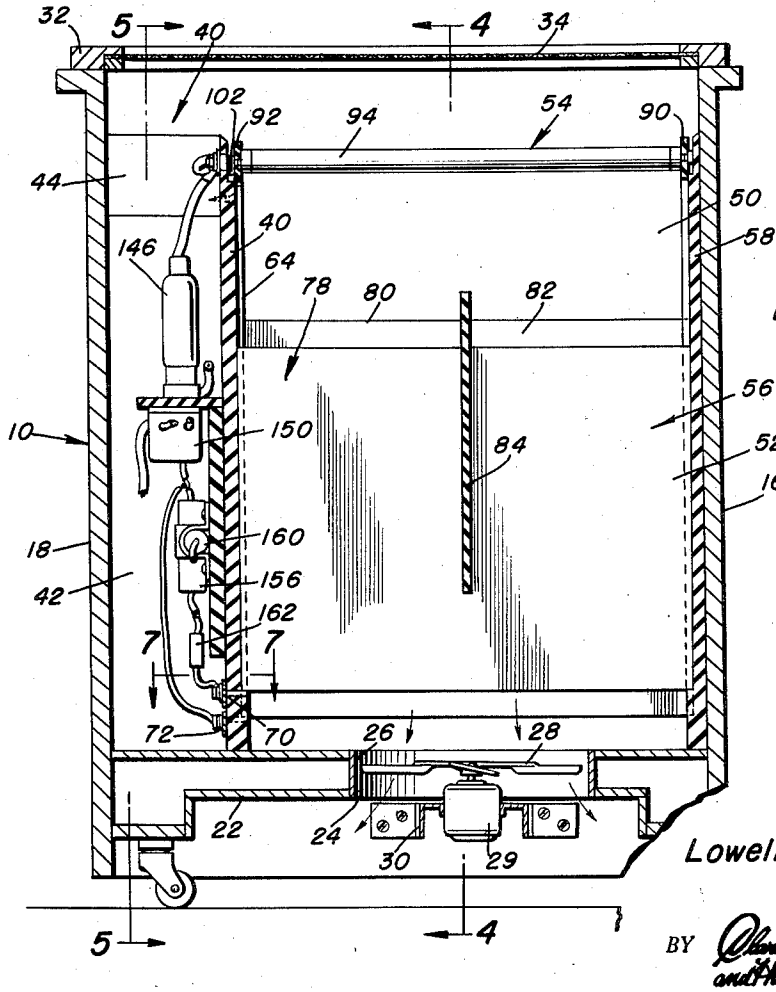


Fig. 3

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Fig. 4

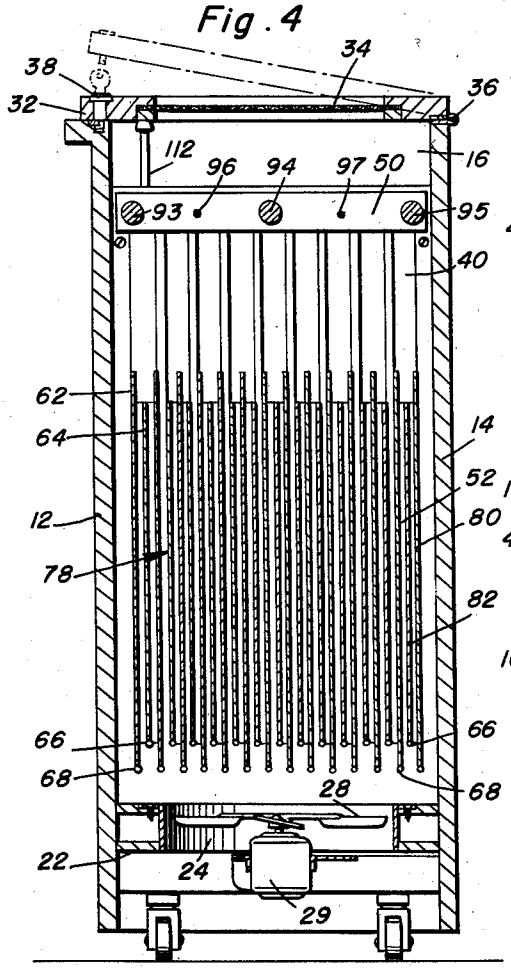


Fig. 5

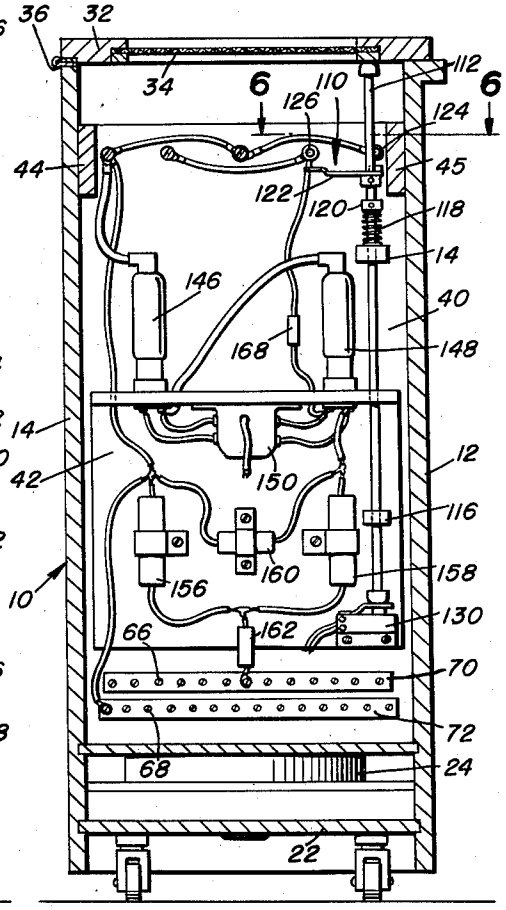


Fig. 6

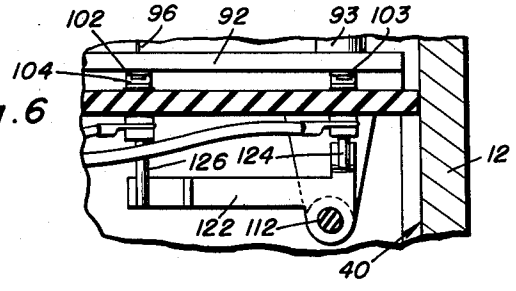
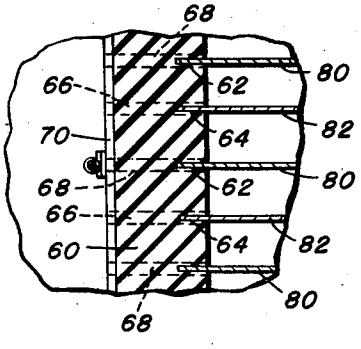


Fig. 7



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ELECTROSTATIC PRECIPITATOR

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Application May 8, 1956, Serial No. 583,435

6 Claims. (Cl. 183—7)

This invention relates to electrostatic precipitators and particularly to the ionizing and impurities collection plate assembly in their ionizing and collection chambers.

In electrostatic precipitators of the type which have an airstream passing through an ionizing and collection chamber, there is generally a group of plates arranged parallel and interleaved with a second group, these plates being alternately charged with positive and negative potential so that the air that is drawn through the ionizing chamber has its foreign particles propelled by both attraction and repulsion toward one group of the plates. In this way they bombard and adhere to one group of plates, whereby the air is materially purified. After a short time a film of oils, tars and resins accumulate on the plates, and they require cleaning. This film is insoluble in water and soap or detergent and is difficult to remove because of the closeness of the plates. One of the principal objects of the present invention is to provide a collector plate assembly whose plates are individually separable from the collection chamber, greatly simplifying the cleaning operation. With currently available collector plate units the only satisfactory way of cleaning is by steam. This is not only expensive and bothersome, but if not done after several months the film builds up to a point where the efficiency of the precipitator is impaired.

A further object of the invention is to provide an electrostatic precipitator whose power pack is made from readily available parts that are now very common in the radio and television fields. In view of this the cost of the parts is much smaller than the cost involved in using those which are not so high in production quantities.

A further object of the invention is to provide an electrostatic precipitator that has an inlet and an outlet for the ambient air, the air being propelled therethrough and intermediate the inlet and outlet there being an ionizing and collection chamber with an improved ionizer and an improved collection unit for particles that are suspended in the air.

A still further object of the invention is to provide an electrostatic precipitator which is constructed in a practical way so that it may be easily serviced and yet, which is more inexpensive to construct than presently available precipitators of comparable capacity.

These together with other objects and advantages which will become subsequently apparent reside in the details of construction and operation as more fully hereinafter described and claimed, reference being had to the accompanying drawings forming a part hereof, wherein like numerals refer to like parts throughout, and in which:

Figure 1 is a perspective view of the precipitator in one form of cabinet;

Figure 2 is a plan view of the cabinet in Figure 1 with parts broken away to show detail of construction;

Figure 3 is a sectional view approximately on the line 3—3 of Figure 2;

Figure 4 is a sectional view taken approximately on the line 4—4 of Figure 3;

Figure 5 is a sectional view taken on the line 5—5 of Figure 3;

Figure 6 is a fragmentary sectional view on enlarged scale and taken approximately on the line 6—6 of Figure 5;

Figure 7 is an enlarged sectional view taken on the line 7—7 of Figure 3;

Figure 8 is a perspective view of the ionizer unit that constitutes part of the invention;

Figure 9 is a perspective view of the collector unit that forms another portion of the invention; and

Figure 10 is a schematic wiring diagram of the power pack and other electrical parts of the system.

Although the cabinet may assume various configurations such as to blend well with various furniture motifs and styles, a practical form of the cabinet is seen in Figure 1. Here the casing **10** has a front wall **12**, a back wall **14** and end walls **16** and **18**. The front and back walls **12** and **14** have openings at the bottoms thereof through which air is adapted to pass. A bottom **22** extends across and is secured to, as by being rabbeted in or otherwise joined, the walls of the casing. Bottom **22** is of built-up frame construction and has an air outlet **24** in approximately the center thereof. This air outlet is framed by an annular collar **26** in which the fan blade **28** is rotatable. This blade is driven by an electric motor **29**, the latter being carried by a mounting bracket **30** which is screwed or otherwise fastened to opposite walls of the casing.

The upper end of the casing is open and has a hinged closure **32** covering it. The closure is in the form of a frame with a grill or screen **34** as the center panel thereof. Hinge **36** connects the closure to the back wall of the casing so that it is capable of being opened in order to service the precipitator. Latch **38** carried by closure **32** is preferably of the type which may be locked with a key in order to prevent unauthorized entry into the precipitator casing. In order to have an initial separation of particles from the air as they pass through the precipitator, a standard filter of the type used in air conditioning and hot air heating systems may be attached by mounting brackets on the inside surface of the lid **32** and in registry with the screen **34**. In this way when the lid is opened the filter is easily accessible for removal, servicing and replacement.

Casing **10** is divided by a vertical wall or panel **40** into a component space **42** on one side of it and ionizing chamber **50** together with collection chamber **52** on the other side of it. Panel **40** is mounted in casing **10** by being secured to blocks **44** and **45** carried by the sides of the casing. The power pack is in space **40** and is serviced by removing panel **40**. Ionizer unit **54** is at the upper part of casing **10** and in chamber **50**, while the particle collection unit **56** is at the lower part of casing **10** and in chamber **52**. An insulating wall or panel **58** is attached to the inner surface of front wall **16**, and with panel **40** and walls **12** and **14** define the ionization and collection chambers, with the opposite walls **40** and **58** functioning as supports for the ionizer and the particle collection unit **56**. Walls **40** and **58** are provided with vertical slots that open through the upper edges thereof. There are longer slots **62** and shorter slots **64**, all of these slots being parallel. There are two groups **66** and **68** respective of contacts that are at the lower ends of slots **64** and **62**. The contacts in the group **66** are each attached to a bus **70** that is on the exterior of wall **40**, while contacts **68** are secured to a bus **72** that is located adjacent to the bus **70**. Contacts **66** and **68** may assume several configurations, one being short rods which constitute the bottoms of the slots.

Attention is now invited to Figures 8 and 9. The

particle collection unit **78** is shown separated from its chamber (Figure 9), and its consists of a first group of electrically conductive electrodes in the form of plates **80** together with a second group of electrodes in the form of plates **82**. These groups of plates are interleaved with the plates **82** being shorter than plates **80**. Each of the plates is adapted to be fitted in the slots of supports formed in walls **58** and **40** by having the opposite edges thereof slidably disposed therein. Plates **89** and **82** are very thin and may be cut from sheet aluminum or other material possessing the necessary electrical conductivity qualities. The groups of plates **80** and **82** are held supported with proper spacing in chamber **52** by a member which is in the form of an insulating comb **84**. It has a number of slots **86**, one slot being reserved for each plate. By having this type of construction the plates **80** and **82** of the collection unit are separately removable from chamber **52** after comb **84** is lifted from the plates. When inserting the plates, the opposite edges of the plates slide in the slots in walls **58** and **40**, and the lower edges of these plates come to rest on the contacts **68** and **66** so that the plates of one group may be charged from bus **72** while the plates of the other group may be charged from bus **70**. These buses have electrical energy of opposite polarity so that the collection plates **80** and **82** are oppositely charged.

Ionizer unit **88** comprises a pair of insulating strips **90** and **92** that are held spaced apart by means of bars **93**, **94** and **95**. Between the bars there are filament wires **96** and **97**, these wires being of very small diameter in comparison to the diameter of the conductive bars **93**, **94** and **95**. Each of the bars and filament wires is connected for electrical conductivity to its spring connector **98**, **99**, **100**, **102** and **103**. These connectors are on strip **92** and are arranged to be used for establishing electrical continuity in the circuit of Figure 10. When ionizer unit **88** is inserted in the top part of casing **10**, the connectors come to bear against five similar connectors **104** (Figure 6) secured to the inner face of the support walls **40** and **58** respectively.

A safety device is included in the precipitator. It comprises a switch **110** used to discharge the ionizer unit automatically in response to opening the closure **32**. In addition it automatically opens the circuit which includes the power pack. Switch **110** comprises a plastic rod **112** that is slidable in guides **114** and **116** on one wall of casing **10**. The upper end of the rod is in contact with the closure **32** and is biased upwardly by spring **118** that rests on one of the supports for rod **112** and on a collar **120** or an equivalent mechanical stop on plastic rod **112**. When the closure is lifted spring **118** pushes the rod upwardly thereby moving the switch arm **122** that is carried by rod **112** into bridging relationship with terminals **124** and **126** which, through the wiring shown in Figure 5, are interconnected with the bars and wires of the ionizer unit and from Figure 10, it is seen that they are ultimately connected with the voltage doubler circuit and the collector plates. The lower end of rod **112** is arranged to operate a microswitch **130** which is in the line of the power pack circuit. This circuit is also fused as at **132** for the protection of the equipment.

In Figure 10 a schematic representation of a typical circuit, utilizing very readily available components is shown. The ionizer unit **54** is illustrated as being wired by means of conductors **140** and **142** to a standard voltage doubler circuit **144** having two half-wave rectifiers **146** and **148** connected to the output of transformer **159** and to filament transformers **154**. These tubes pass the negative phase of the output of the transformer to one of the capacitors **156** and the positive phase to the other capacitor **158**. Accordingly, they charge one of the capacitors to a positive potential, say 6,000 volts and the other to a negative potential, say 6,000 volts. This provides a voltage difference of 12,000 volts D. C. Resistors **160** and **162** are wired across the capacitors **156** and **158** in order to discharge the capacitor when the power is turned off. This cooperates with switch **110** as a safety feature.

The line from the minus 6,000 volt terminal on one capacitor is passed through a limiting resistor **168** in order that the current which can pass through the tubes in the case of a direct short in the ionizer or collector plates may be limited. This line **142** then goes directly to the ionizer bars and to the negative plates **80**. The positive collector plates **82** are connected to the center junction of the two capacitors, as by wire **190**, as is the other leg of the 6,000 volt transformer **150**. The filament of the ionizer unit is then connected to the positive 6,000 volt terminal on the other capacitor.

In practical use and operation, the ionizer unit discharges a controlled corona and the fan **28** propels an air stream through the ionization chamber. This charges the foreign particles in the air. The ionizer unit operates at a high potential, for example 12,000 volts D. C. The particles in the air pass between the interleaved plates of the collector unit **78**, the plates of one group being charged at a lower voltage, say 6,000 volts while the plates of the other group are charged with a similar voltage but of opposite polarity. Therefore the air as it passes through the collector unit has its charged particles propelled by both attraction and repulsion so that they bombard one group of plates and adhere thereto. The then purified air passes through the outlet in the precipitator for distribution in the room or other enclosure where the electrostatic precipitator is located. To enhance the filtering of the unit, the described standard filter may be attached in place on the closure **32**.

In actual practice when the machine is to be cleaned it is first unplugged and wheeled to a wash basin or sink. The lid is unlocked and opened. The ionizer unit is grasped by the center bar and lifted out, after which it is placed in the sink and washed. Then the center spacer **84** is grasped by its top edge and removed after which it is laid aside. Then one of the larger plates is grasped by the top edge and lifted out, after which it is placed in the sink. This operation is repeated successively until all of the large plates have been removed and placed in the sink, leaving the smaller plates now readily accessible to be removed in the same way. This operation takes in the neighborhood of a half a minute. After the plates have been cleaned and rinsed they are placed in a rack and allowed to drain and air dry. After the plates are dry a small plate is held by its top edge and the lower side edges are inserted into the top of the two corresponding slots or panels **58** and **40**. The top edges of the fingers that form these slots are marked and cut in such a way as to facilitate this and also to show which slots accept the small plates and which ones accept the larger plates. After the plate has been inserted a short distance into the top of the slot it is released and gravity pulls the plate down into position at which time it rests on its individual contact at the bottom of the slot. This operation is repeated until all of the small plates have been returned to the cabinet, at which time the large plates are then inserted in the same manner. When all of the plates have been returned to their respective position in the cabinet, the comb or spacer **84** is again held by its top edge and with the other hand the fingers of this spacer are positioned between corresponding plates whereupon it is pressed down into position. The ionizer unit is then grasped again by the center bar and placed in its position coming to rest on top of the fingers on panels **58** and **40** which extend several inches beyond the tops of the plates. After this is completed the unit is again wheeled back to its operating position and plugged in at which time the fan begins operation, and upon then closing and locking the lid, the precipitator is back in operation.

The foregoing is considered as illustrative only of the principles of the invention. Further, since numerous

modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation shown and described, and accordingly, all suitable modifications and equivalents may be resorted to, falling within the scope of the invention as claimed.

What is claimed as new is as follows:

1. An electrostatic precipitator comprising a casing having an air inlet and an air outlet, electrically insulating side walls defining communicating ionizing and collection chambers in said casing and in registry with said inlet and outlet, a power pack which includes a transformer, and a voltage doubler circuit connected therewith, an ionizer unit which includes small diameter wires and larger diameter bars, strips to which said bars and wires are secured, connectors in the high voltage side of said circuit and carried by one of said walls, flexible connectors on the outer edge of one of said strips and electrically connected with said wires and bars, said connectors frictionally holding said strips fastened to said walls and establishing electrical continuity between said circuit and said wires and bars.

2. An electrostatic percipitator comprising a casing having an air inlet and an air outlet, electrically insulating side walls defining communicating ionizing and collection chambers in said casing and in registry with said inlet and outlet, a power pack which includes a transformer, and a voltage doubler circuit connected therewith, an ionizer unit which includes small diameter wires and larger diameter bars, strips to which said bars and wires are secured, connectors in the high voltage side of said circuit and carried by one of said walls, flexible connectors on the outer edge of one of said strips and electrically connected with said wires and bars, said connectors frictionally holding said strips fastened to said walls and establishing electrical continuity between said circuit and said wires and bars, a collector unit which has two groups of plates interleaved with each other, an insulating member holding said plates separably arranged in parallel relation, means including two groups of contacts touching individual plates and connected with the low voltage side of said circuit for energizing said groups of contacts and plates with voltage charges of opposite polarity, two of said insulating side walls having opposed confronting slots in which the side edges of said plates are separably supported, and said groups of contacts being at the bottoms of said slots.

3. An electrostatic precipitator comprising a casing having an air inlet and an air outlet, electrically insulating side walls defining communicating ionizing and collection chambers in said casing and in registry with said inlet and outlet, a power pack which includes a transformer, and a voltage doubler circuit connected therewith, an ionizer unit which includes small diameter wires and larger diameter bars, strips to which said bars and wires are secured, connectors in the high voltage side of said circuit and carried by one of said walls, flexible connectors on the outer edge of one of said strips and electrically connected with said wires and bars, said connectors frictionally holding said strips fastened to said walls and establishing electrical continuity between said circuit and said wires and bars, a collector unit which has two groups of plates interleaved with each other, an insulating member holding the center portions of said plates separably arranged in parallel relation, means including two groups of contacts touching individual plates and connected with the low voltage side of said circuit for energizing said groups of contacts and plates with voltage charges of opposite polarity, said walls having slots in which the edges of said plates are fitted so as to slidably accept the edges of said plates.

4. An electrostatic precipitator comprising a casing having an air inlet and an air outlet, walls defining communicating ionizing and collection chambers in said casing and in registry with said inlet and outlet, a power pack which includes a transformer, and a voltage doubler circuit connected therewith, an ionizer unit which includes small diameter wires and larger diameter bars, strips to which said bars and wires are secured, flexible connectors in the high voltage side of said circuit and carried by the outer edges of said strips, said connectors being electrically connected with said wires and bars, said connectors frictionally holding said strips fastened to said walls, a collector unit which has two groups of plates interleaved with each other, an insulating member holding said plates separably arranged in parallel relation, means including two groups of contacts touching individual plates and connected with the low voltage side of said circuit for energizing said groups of contacts and plates with voltage charges of opposite polarity, said walls having slots in which the edges of said plates are fitted so as to slidably accept the side edges of said plates, a closure for said air inlet, and means responsive to the opening of said closure for automatically discharging the electrical energy stored in the circuit.

5. An electrostatic precipitator comprising a casing, a unit to ionize particles that are suspended in the air as they are drawn through said inner and outer casings, a unit to collect the particles as they pass through said ionizer unit, the collecting unit comprising a plurality of plates that are parallel, insulating means holding said plates grouped as a unit and individually separable and in parallel relationship to each other, slotted means in said casing to support said plates at the side edges thereof and to hold them arranged in a manner to prevent voltage breakdown therebetween, said ionizer unit including a pair of strips, filaments, and conductive bars extending across and secured to said strips, connectors carried by one of said strips, said connectors constituting means for connection of said bars and filaments in a power pack circuit, said strips mounted at the ends of said slots.

6. In an electrostatic precipitator, the improvement comprising a collector unit and support for the unit, said support comprising a pair of electrically insulating side walls that have inwardly opening slots, alternate slots in one side wall having electrical conducting contacts at the lower ends thereof and constituting the bottoms of said slots, alternate contacts vertically staggered to increase the distance between alternate contacts, said unit having a plurality of flat plates provided with planar surfaces and of electrically conductive material, said plates individually and separably disposed in said slots with the lower edges at the corners thereof disposed upon said contacts in said slots and the side edges of said plates embraced within said slots, said slots opening upwardly to provide entrances for individual plates of said unit, means located between said walls and contacting individual plates for cooperating with said slots in maintaining said plates equally spaced from each other, said walls having elastic electrical connectors at the upper ends thereof, a precipitator ionizing unit having electrical connectors, said ionizer unit disposed on the upper portions of said walls and the connectors of said walls and said ionizer unit separably holding said unit assembled in alignment with said collector unit within said walls.

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