March 4, 1941. E. H. R. PEGG 2,233,639

ELECTRICAL PRECIPITATOR

Filed Jan. 10, 1940 3 Sheets-Sheet 1

Fig. 1.

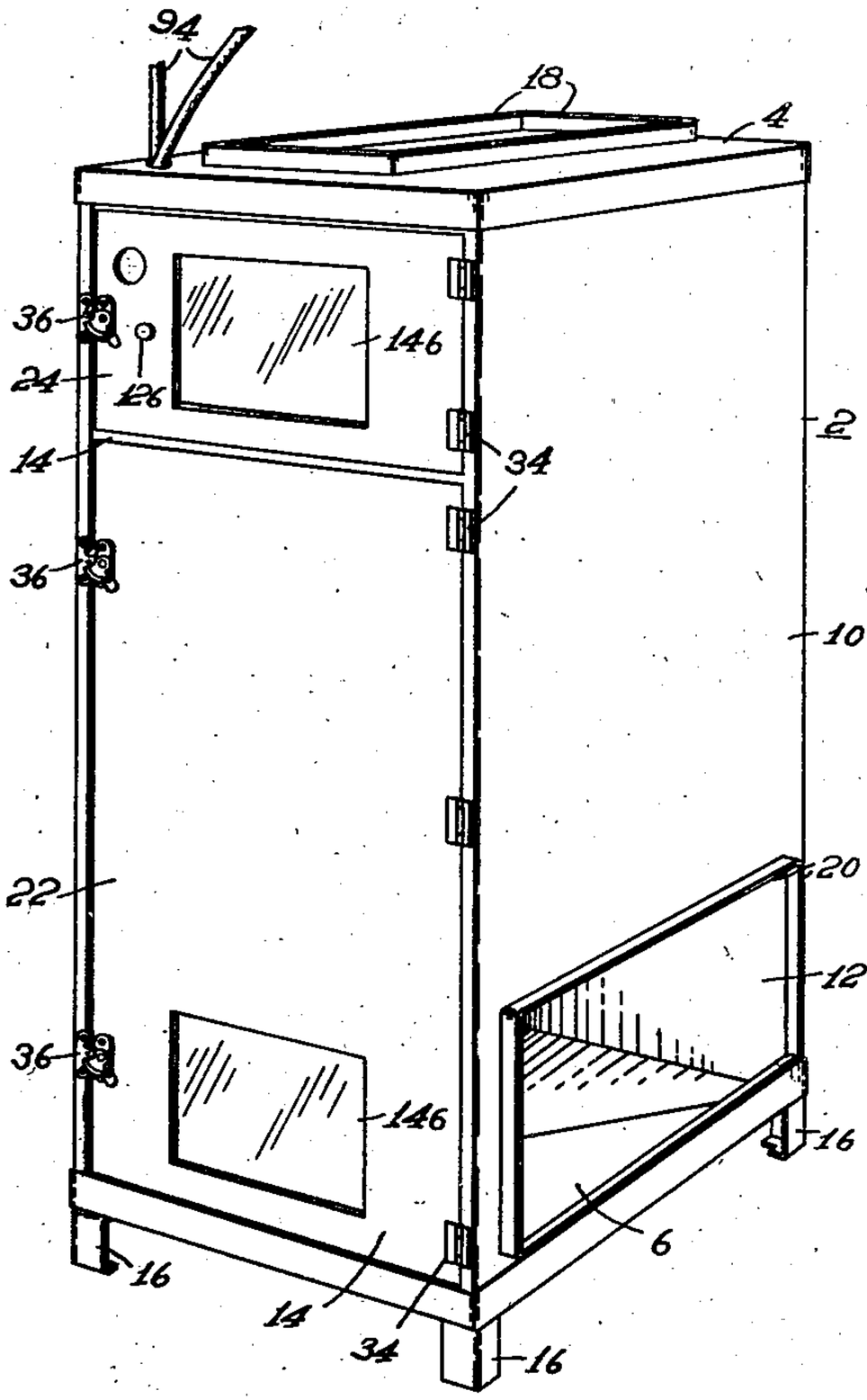

Fig. 2.

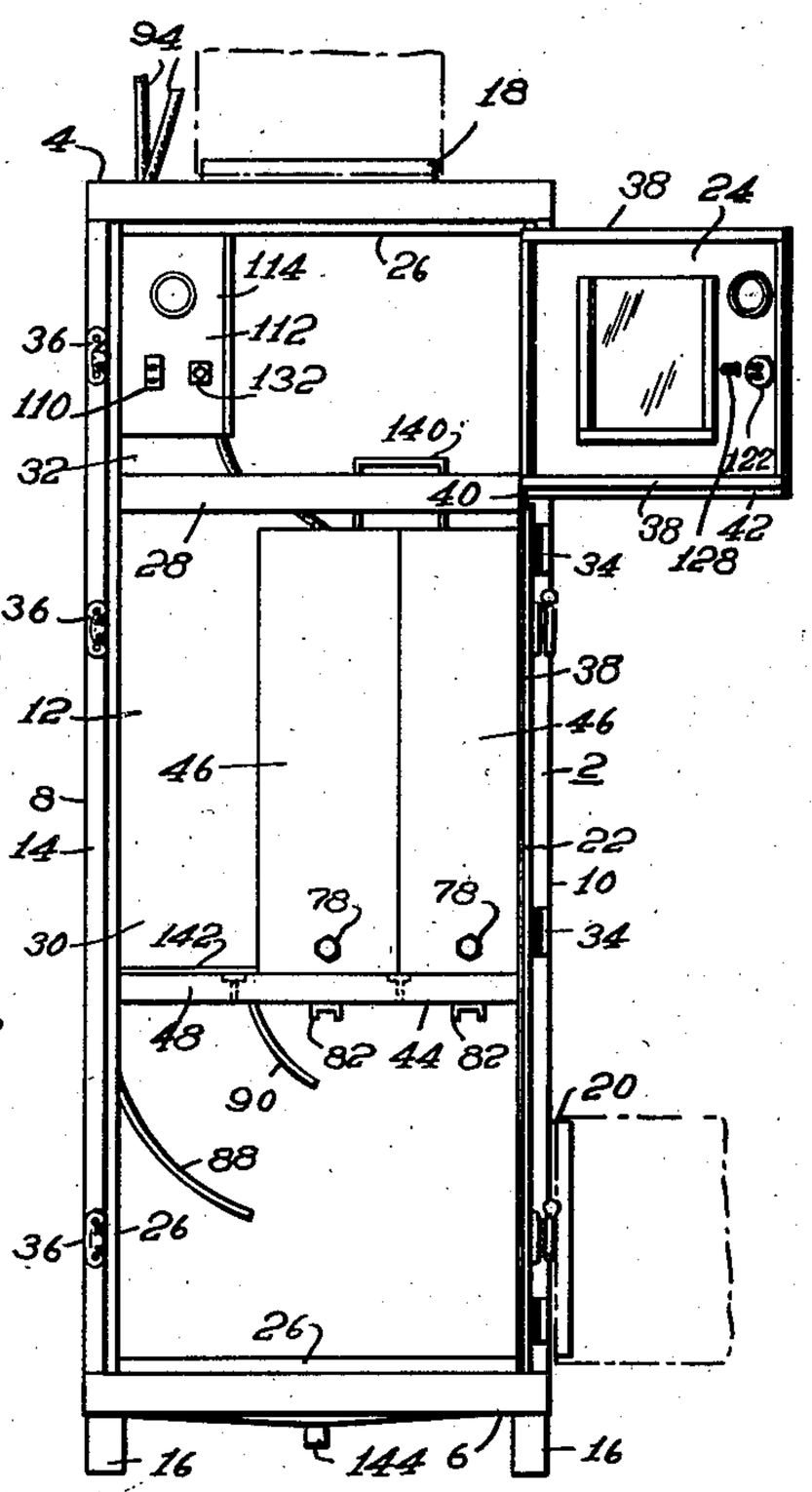

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Fig. 3.

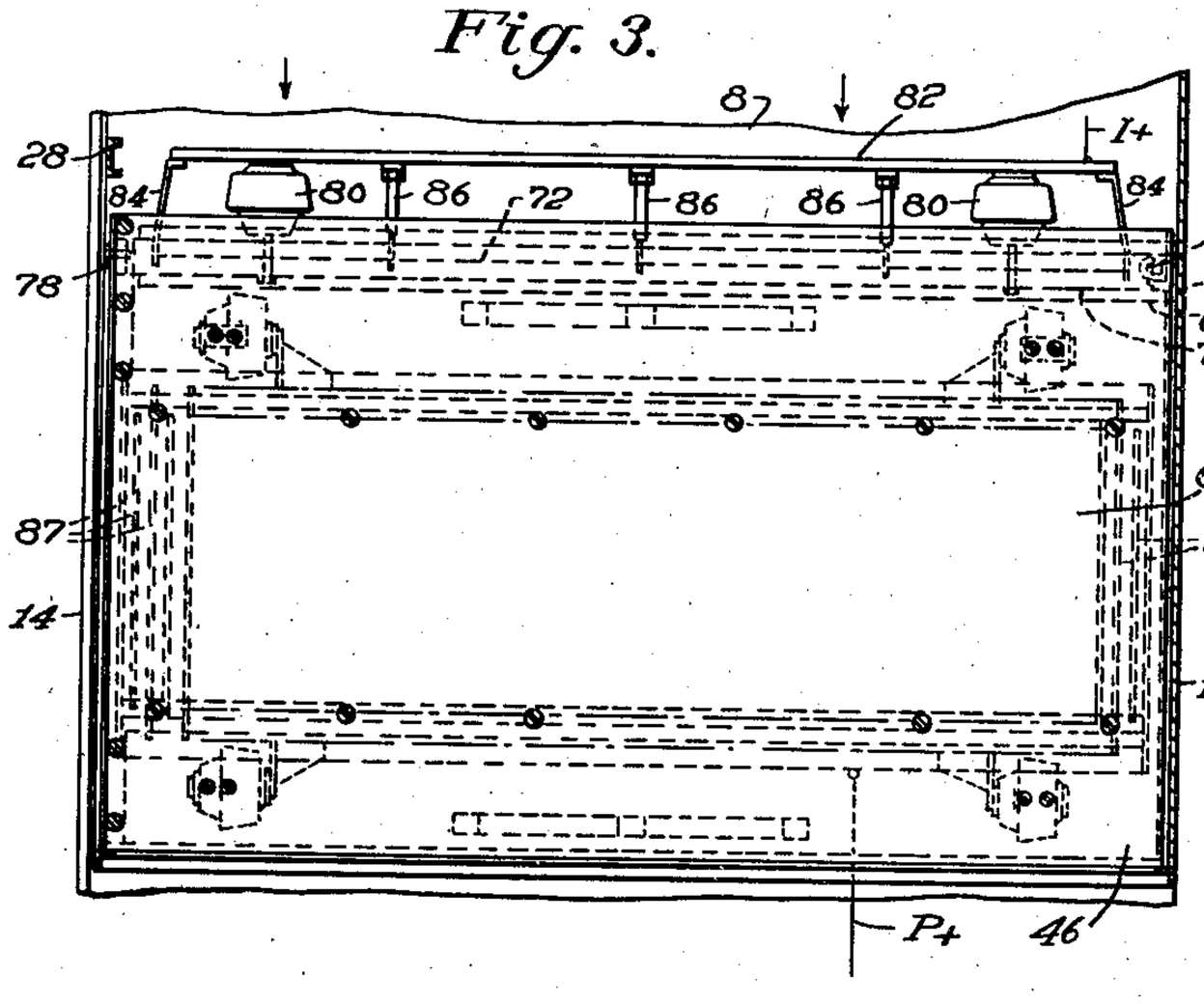

Fig. 5.

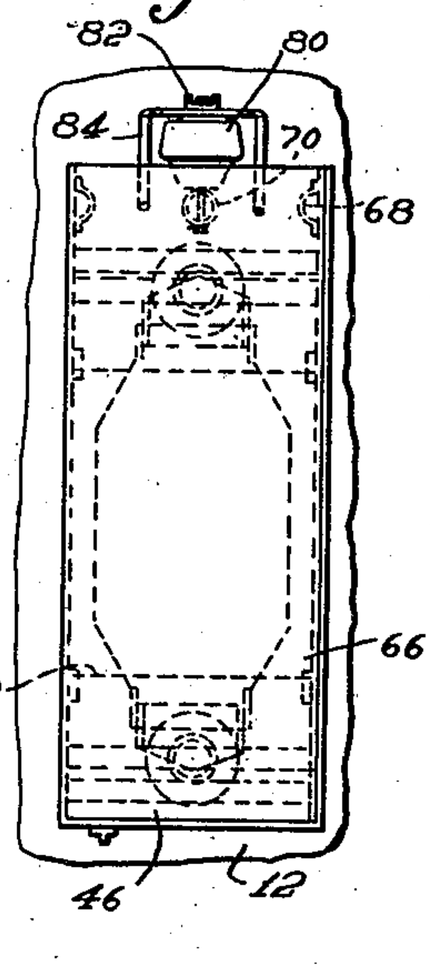

Fig. 4.

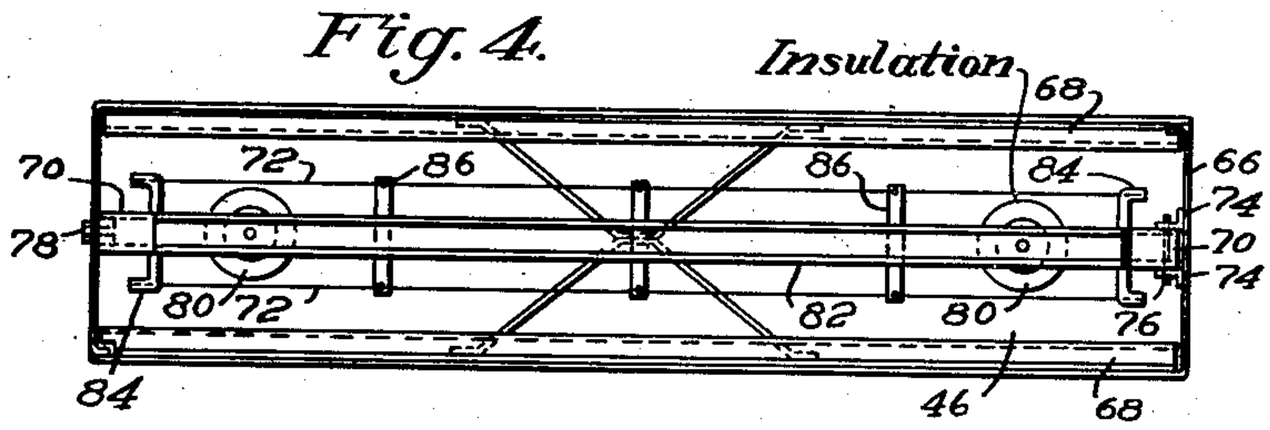

Fig. 6.

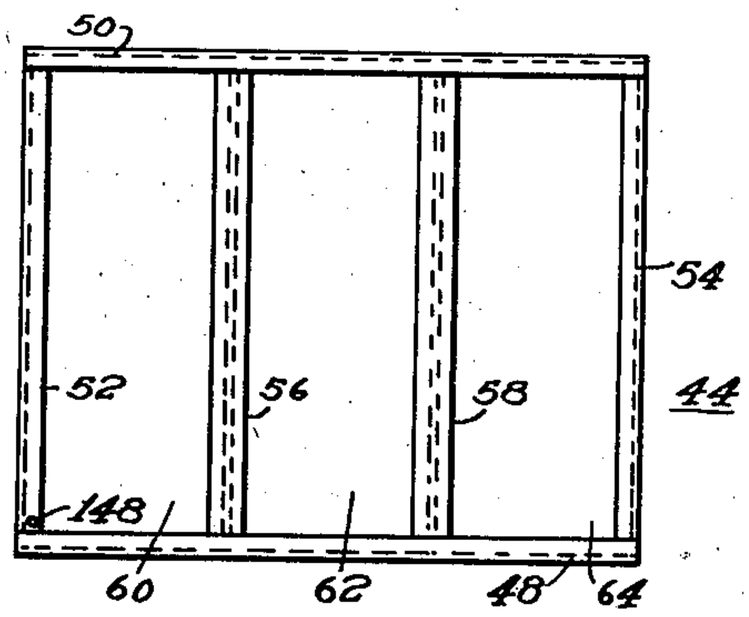

Fig. 7.

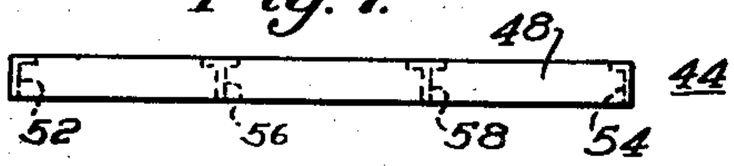

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Fig. 9.

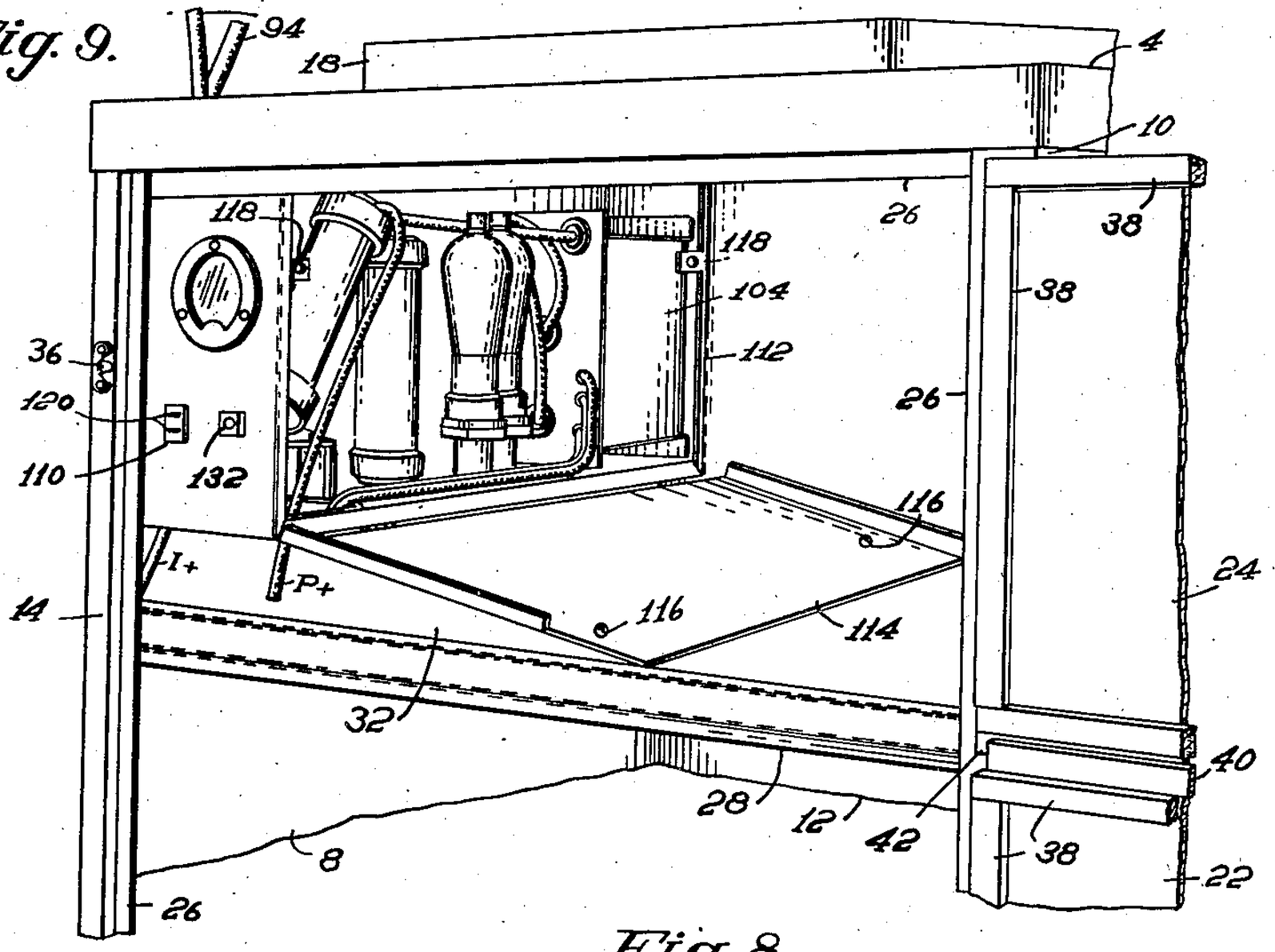


Fig. 8.

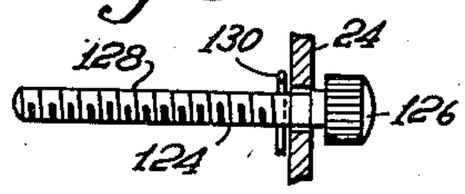
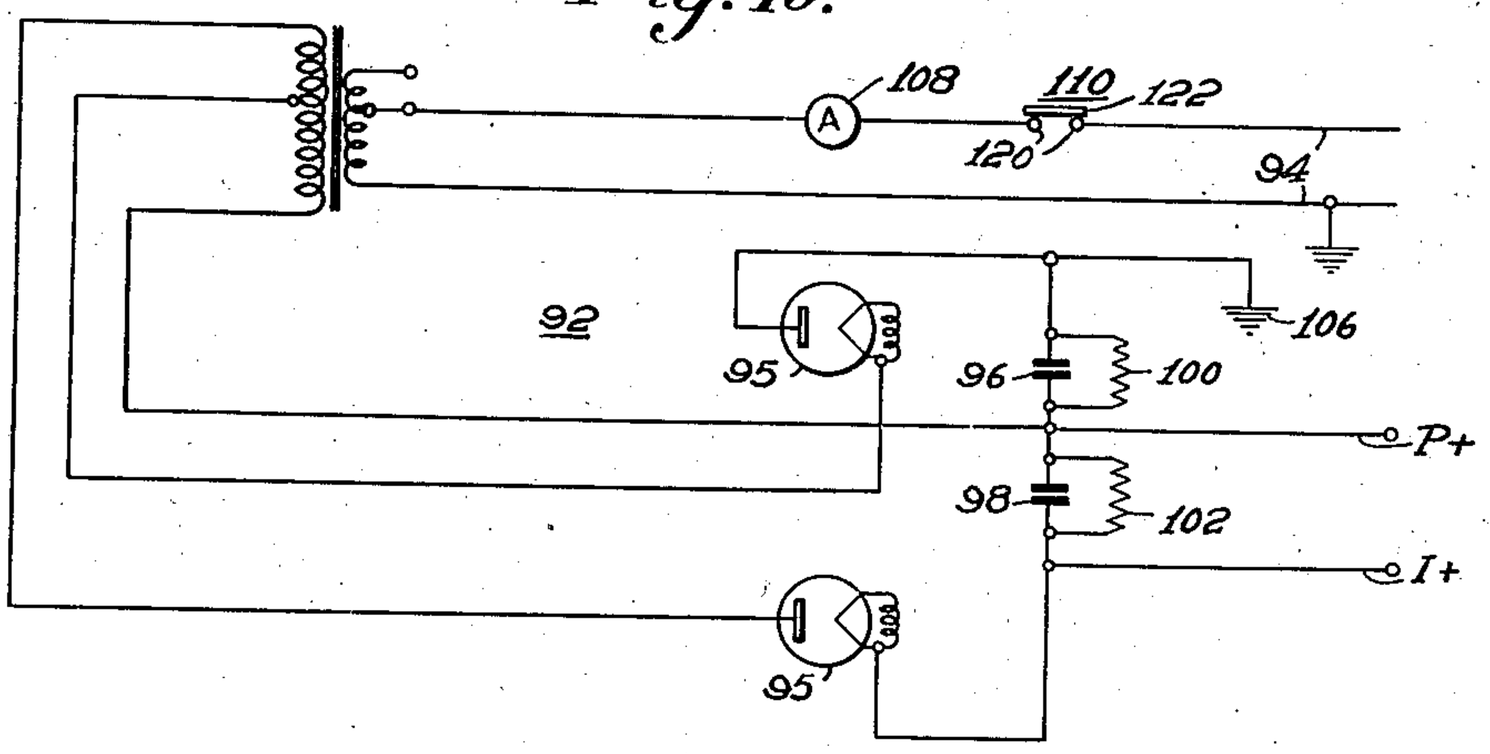


Fig. 10.



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Patented Mar. 4, 1941 2,233,639

UNITED STATES PATENT OFFICE

2,233,639

ELECTRICAL PRECIPITATOR

Edward H. R. Pegg, Lakewood, Ohio, assignor to Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., a corporation of Pennsylvania

Application January 10, 1940, Serial No. 313,243

6 Claims. (Cl. 183—7)

My invention generally relates to electrical precipitators for removing dust from a gaseous stream by electrically charging and precipitating the dust, but more particularly, relates to the creation of a precipitator in the form of a unit which can be readily and easily installed and incorporated into new, or existing, moderately-sized, ventilating systems, or air-conditioning systems, or the like, such as, for example, central air-heating systems for private homes or residences, for cleaning air to be breathed.

A precipitator of the type to which my invention relates usually comprises an ionizing zone for ionizing or charging the dust particles in the gas-flow, and a precipitating zone for precipitating the ionized or charged dust upon dust-precipitating or dust-collecting means, and it is an object of my invention to provide such a precipitator in the form of a unit which will have a low initial cost, which will be rugged in use, which will have a low up-keep expense, and which will require but little, if any attention over long periods of time, except for occasional washing of the dirt accumulated on the collecting means of the precipitator.

It is a further object of my invention to provide an electrical dust-precipitator unit which comprises an outer sheet metal cabinet or casing for encasing the primary working parts of the unit, which are usually operated at high potentials, but the casing, nevertheless, having provisions in the form of closure means for permitting ready access to these parts, and provided with safety features which will remove any high potentials on the parts before permitting such access.

In the preferred form of my invention, the casing is provided with an opening in its top and an opening near the bottom in one of its sides, the openings being defined by flanges for connection to ducts or conduits of the particular system of which my unit is to be part. For precipitating the dust a plurality of precipitator cells are disposed in the casing intermediate the openings, spaced from the top and bottom of the casing. The cells are preferably of the type described and claimed in my copending application, Serial No. 286,577, filed July 26, 1939, and assigned to the Westinghouse Electric & Manufacturing Company. The construction of the casing and the cells is such that the gas-flow through the casing from one of the aforesaid openings to the other may be in either direction, it being only necessary to turn or invert the cells on their supports for a reversed gas-flow. Consequently, my unit can be adapted to an air-treating system regardless of the direction of flow in the system.

An important feature of my precipitator unit lies in the simple provisions by means of which its precipitating means can be washed without the need of removing them from the casing or disturbing them in any way. To this end the hereinbefore-mentioned closure means includes a door for an opening in a side of the casing, which is above the dust-precipitating means and through which a water hose may be inserted for playing a stream of water completely over the dust-precipitating means. The part of the casing below this last opening is made water-tight, and this applies also to any further closure means below the cell opening so that the washing water will flow to the casing bottom which is sloped downwardly to a drain. The drain is preferably relatively small compared to the cross-section of the air-flow conduits and openings, and when connected to a waste pipe affords sufficient air-flow resistance to prevent the flow of any appreciable amount of air through the drain during the operation of the unit. However, a separate valve, or other suitable air-flow-restricting means, may be employed, if desired, to close or restrict the drain when the unit is being used for cleaning air.

My invention also utilizes a power-pack of any known type to convert the conventional house voltage supplies to the necessary higher values of unidirectional voltages required by the electrical precipitator unit. In my preferred construction, a power-pack is mounted in the top of the casing above the dust-precipitating means in such a manner as to interfere only slightly, if at all, with the gas flow; and it is fully encased so that water cannot spray or contact any of the electrical elements of the power-pack during washing of the dust-precipitating parts of the precipitator unit.

Further features, advantages, arrangements, and objects of my invention will be apparent from the following description thereof, which should be taken in conjunction with the drawings, drawn on varying scales, in which:

Figure 1 is a perspective view of my precipitator unit;

Fig. 2 is a front elevational view thereof with the closure means shown in open position to expose the working parts inside the unit;

Figs. 3, 4 and 5 are, respectively, side elevational, top plan, and front elevational, somewhat schematic and enlarged, views of a precipitator cell built in accordance with the disclosure in my

aforesaid application. Figs. 3 and 5 show the cell inverted with respect to the cells shown in Fig. 2, with Fig. 3 diagrammatically indicating the position of the inverted cell in the unit.

Figs. 6 and 7 are, respectively, top plan, and front views, somewhat enlarged, of an open framework secured inside the casing for supporting from one to three precipitator cells, such as shown in Figs. 3–5.

Fig. 8 is an enlarged view of a safety provision for delaying the opening of the top door of the unit;

Fig. 9 is an enlarged perspective view of the upper interior of my unit, showing the disposition and arrangement of the parts of the powerpack; and

Fig. 10 is a wiring diagram of a circuit which may be employed for energizing my precipitator unit.

Referring more particularly to the drawings, the form of my invention now preferred comprises an outer metallic casing **2** having a top **4**, a bottom floor **6**, lateral sides **8** and **10**, a rear side **12**, and a front side **14**. The unit is preferably adapted for a vertical gas-flow and, consequently, the side walls are elongated vertically. A plurality of supporting legs **16** are provided at each of the bottom corners of the casing which permits the bottom floor to be sloped for draining.

The top side **4** of the casing has an opening defined by upright flanges **18**, and a second opening is provided at the bottom of one of the lateral sides **10**, the opening being defined by protruding flanges **20**. The openings are sufficiently large to accommodate the required gas-flow through the unit.

The front side **14** of the unit comprises closure means in the form of a lower door **22**, and an upper door **24**. The doors cover substantially the full area of the front side of the casing which is provided with ledges **26**, in line with the outer edges of the doors, to provide part of door frames for the doors **22** and **24**. The remaining parts of the door frames are obtained by means of a cross bar or channel **28** secured in the casing laterally across the front side of the unit at the dividing line between the upper and lower doors. The ledges **26** and cross bar **28** define a lower opening **30** and an upper opening **32** in the front side of the casing.

The doors are hinged to a vertical edge of side **14** by means of hinges **34**, and window locks **36**, or other suitable latches are provided on the opposite edge of the front side by means of which the doors can be tightly closed. In order to further assure a gas-tight and water-tight closure means, compressible strips **38**, such as felt, sponge rubber or asbestos, or other suitable gasketing material, are secured to the four edges of each of the doors **22** and **24**, these strips being compressed against the ledges **26** and cross bar **28** when the doors are latched closed. For reasons which will later become apparent, the lower door is provided with an interlocking means in the form of an upwardly-projecting bar **40** in the path of a lower edge **42** of the upper door so that the lower door cannot be opened until after the upper door is opened and, conversely, the upper door cannot be closed until after the lower door is closed. This bar **40** is adapted to contact and abut the bottom edge **42** of the upper door, which is formed by securing the bottom compressible strip on the upper door somewhat above its bottom extremity.

Secured inside the casing is an open, metal framework **44** disposed below the cross bar **28** a distance which is slightly larger than the height of the cells **46** of the precipitating means, which are supported or rest on the framework. The framework substantially fits the interior cross section of the unit and comprises a front angle bar **48**, a rear angle bar **50**, side angles **52** and **54**, and spaced intermediate T-members parallel to the side members **52** and **54**.

The open distance between front and rear bars **48** and **50** is slightly less than the length of the cells **46**; and the open distance between the side angles **52** and **54** is, preferably, slightly less than a multiple of the width of one of the cells.

The unit of the particular embodiment shown is adapted to contain as many as three cells, and, consequently, two intermediate T-members **56** and **58** are provided equally spaced to provide three substantially equal spaces **60**, **62** and **64** in the framework. As more particularly shown in Fig. 2, the cells **46** are adapted to rest on the top surfaces of the framework **44**. Consequently, the members comprising the framework have top legs with outer surfaces lying in a plane, and of some width so that the side and end walls of the cells **46** may rest thereon.

Each of the precipitating cells comprises, generally, an open-ended, outer, metallic casing **66**, whose side and end walls define a rectangular section slightly greater in size, but geometrically similar, to the spaces **60**, **62** and **64**. Within this casing is disposed an ionizing means and precipitating means successively in the direction of the gas-flow. The ionizing means comprises a plurality of curved grounded electrodes **68** and **70** secured in spaced relation in the casing, with ionizing wires **72** disposed substantially centrally between the electrodes. I prefer to employ the construction for an ionizing means such as shown in my aforementioned application, one of the features of which includes detachably mounting the electrode **70** to the casing by means of a hook member **74** secured to the casing and engaging a pin **76** attached to the electrode **70**. The other end of the electrode is provided with a threaded plug into which may be screwed a bolt **78** for securing the ground electrode in place by first hooking the pin **76** over the hook member **74** and then threading the bolt **78** into the plug at the end of the ground electrode, the bolt extending through a suitable aperture in an end side of the casing.

The ionizing wires are supported by this ground electrode through the medium of a plurality of insulators **80** having one end bolted to the electrode and supporting a metallic bar **82** shorter than, and parallel to, the ground electrode. Suitable ionizing-wire supporting arms, such as end supports **84** and intermediate supports **86**, depend from this bar **82** and support the ionizing wires. Across the full length of the interior of the cell are a plurality of spaced parallel plates **87** alternate ones of which are grounded with the remaining plates electrically insulated from the casing and the grounded plates. It should be observed that the bar **82** projects above the top of the cell casing **66** and the overall height of the cell is somewhat greater than the distance between the cross bar **28** and the framework **44**.

In the operation of the cell, a gas-flow in the direction shown by the arrows in Fig. 3 first passes through the ionizing zone, comprising the ground electrodes and the ionizing wires, where

the dust in the gas stream is suitably charged. The gas including the charged dust then passes between the spaced dust-collecting plates of the precipitating zone where the dust is precipitated while the clean gas flows out through the other open end of the casing. Any suitable air-propelling means may be employed for forcing the air through the cells, such air-propelling means being usually part of the system into which the unit is incorporated. In mounting the cells in the casing the ionizing portion is placed forwardly in the gas stream so that the gas will pass through it before it passes through the dust-collecting means comprising the alternately insulated and uninsulated spaced plates.

In the construction I employ each cell is placed in the casing with the ionizing portion either toward the top or toward the bottom, depending on the direction of gas-flow through the unit. In Fig. 2 the ionizing portion is shown at the bottom of the cells and is so indicated by the bars **82** below the framework **44**; while in Fig. 3 the cell is shown with the ionizing means toward the top of the unit. In Fig. 2, of course, the gas-flow would be in a direction from the lower opening to the upper opening, while in the embodiment of Fig. 3, the gas-flow would be in the reverse direction. Sufficiently large regions are provided above and below the cells for uniform velocity distribution of the gases passing through the cells.

Baffles such as **88** and **90** may be disposed below the framework to deflect and guide the gas stream that may be flowing to or from the opening in the side wall **10**. These baffles preferably terminate in the region below the cells so as not to interfere with the drainage of water that may flow downwardly during washing of the cell units.

The cells rest on the surfaces of the framework **44** and are placed side by side. The lower edges of the cell casing **66** rest on, and can slide on, the members comprising the framework, with the sides of a casing resting, for example, on the members **54** and **58**, and the cell ends on the side angles **52** and **54**. The cells are preferably inserted without the removable item comprising the grounded electrode **70** and the parts secured to it. This item is added after the rest of the cell has been placed in proper position in the casing **2**.

The gas-cleaning means of this embodiment is energized by unidirectional voltage in accordance with the teachings more particularly described in Patent No. 2,129,783, granted September 13, 1938 to G. W. Penney, and assigned to the Westinghouse Electric & Manufacturing Company. To this end the ionizing means is positively energized by means of a conductor schematically designated by I+ and the insulated plates are positively energized by a conductor schematically indicated at P+. The cell casing **66** is grounded by virtue of its contact with the metal framework **44** which, in turn, is suitably welded or otherwise secured to the sides **8**, **10**, and **12** of the casing **2**, preferably gas-tightly.

To convert the commercially-available household voltage supplies to values required by the electrical precipitating means, I secure a power-pack, indicated in its entirety by the reference character **92**, inside the casing. The power-pack is so arranged that it will fit a long narrow enclosure in an upper corner of the casing **2**, and is completely wired for connection to the conventional house wiring circuit. Leads **94** may terminate in the usual plug adapted to engage any suitable outlet.

The power-pack comprises a pair of rectifying tubes **95**, a pair of condensers **96** and **98**, each paralleled by resistances **100** and **102**, respectively, and a transformer **104** for supplying filament current to the rectifier tubes and the necessary high potential for the rectifying circuit, one end of which is grounded to the casing as indicated at **106**. One of the leads **94** includes an indicating device **108** and a door switch **110**. The indicating device may be an ammeter which, by the deflection of its pointer, will give an indication of the operating condition of the precipitating means, and the door switch **110** controls the energy supply to the power-pack.

The respective parts comprising the power-pack are all mounted within the substantially gas-tight and water-tight inner casing **112** having a door **114** hinged at its bottom and adapted to be maintained closed by any suitable latching means, such as, for example, a pair of bolts projecting through apertures **116** in the door and engaging threaded lugs **118** secured to the inside of the casing **112**.

The indicating instrument is mounted on the front of the power-pack casing, and the upper door **24** is provided with a suitable, tight, glass window through which the instrument may be observed.

The door switch **110** comprises a pair of separated, female contacts **120** at the front of the power-pack casing, which can be closed by means of a male, plug contactor **122** secured to the inside of the upper door **24**. Consequently, the power-pack can be energized only while the upper door **24** is closed, and since the lower door **22** cannot be opened unless the upper door is first in open position, it is quite obvious that access to the interior of the unit cannot be gained until after the energized circuit is broken.

As a further precaution against excess voltages existing on the precipitator parts before the door **24** can be fully opened, I provide a time delay means in the form of a screw **124** having a head **126** outside of the door **24**, and a shank **128** extending inside of it, the shank being threaded for the major portion of its length but being smooth at the portion which passes through the cooperating aperture in the door **24**. A cotter pin **130** extends through the shank to prevent the screw from being withdrawn through the aperture of the door.

The screw **124** is adapted to be screwed into a nut **132** welded, or otherwise secured, to the front wall of the power-pack casing. The threaded aperture of the nut is aligned with an oversized aperture in this front wall of the power-pack casing so that the shank may be screwed continuously into the nut, a void being provided behind the front wall of the power-pack casing to permit unobstructed travel of the screw. In closing the doors, the screw **124** must be threaded substantially completely into the nut before the contactor **122** closes the circuit across the contacts **120**. In opening of the doors this screw must be unthreaded and the first movement opens the circuit to the power-pack. Subsequent unthreading provides a time delay feature permitting the energy of the condensers to be drained by their parallel resistors so that by the time the screw **124** is completely unthreaded from the nut, substantially no voltage is present on the condensers.

The power-pack casing has suitable apertures through which suitable conductors extend for connection to the proper parts of the cells, al-

though in some instances, jumpers such as 140 may be employed to convey the energy from one cell to another so that the conductors need be connected only to one cell. In the event that the unit is to be employed with less than the number of cells for which it was designed, one or more plates 142 may be employed to cover the openings in the framework 44 not provided with cells.

Inasmuch as electrical precipitators operate on the principle of collecting dust upon suitable electrodes, in this case the parallel plates in the cells, it is advisable, for maximum efficiency, to occasionally wash the accumulated dirt from these plates. In the unit of my invention, it is unnecessary to remove any of the cells for this purpose although they are removably mounted therein. For washing the plates the upper door 24 may be opened while the lower door remains tightly latched so that, consequently, the part of the unit below the upper door is substantially water-tight. A hose may then be inserted through the upper opening 32 and a water stream played upon the precipitating cells 46 until they are thoroughly cleaned. The bottom floor 6 of the casing 2 is sloped downwardly toward a central drain 144 which may be connected to any suitable waste pipe system for draining off the water. This drain may itself provide a suitable grounding connection for the unit, but obviously any other grounding means may be employed. After a water washing, it may be desirable to spray oil on the precipitating parts of the unit.

From the foregoing it is at once perceived that I have provided a very simply constructed unit which may be readily installed in existing air-treating systems, the ducts or conduits of which are schematically indicated by the broken lines of Fig. 2. This unit contains all the necessary apurtenances, in the form of precipitating cells and power-pack, required for the cleaning of air. Moreover, access to the inside of the unit for cleaning or for servicing can be easily had without any danger to the operator in view of the safety and protective precautions incorporated in the unit.

The lower door 22 is of such height that when closed it prevents water from getting out of the cabinet while the cells are being washed down, and extends substantially to the top of the precipitator cells. Because of the number of parallel plates in the cells, any water flowing through them flows out of the cells substantially vertically so that none of the water can flow into the ventilating system which is preferably shut down during the washing operation.

Additionally, it may be observed that the power-pack is well out of the gas stream and, consequently, does not interfere appreciably with the airflow. Moreover, this gas-flow must pass substantially entirely through the precipitating cells because the edges of the cell casings rest upon the members of the framework which are made to snugly, and preferably, gas-tightly fit the inside of the casing 2. If desired, a further compressible strip may be secured to the door 22 opposite the front side 48 of the framework.

While I have described my invention in the preferred form, it is quite obvious that many equivalents of the features described may be employed and other features added, as, for example, the windows 146 by means of which the interior of the casing may be observed, and an aperture 148 in the framework through which a conductor from the power-pack may be passed leading to a part of the precipitating means. Additionally, all exposed conductors to and from the power-pack are fully insulated, and suitable rubber rings or other insulating means may be employed to seal any apertures through which they pass.

I claim as my invention:

1. An electrical unit for cleaning dust particles from a gaseous stream by electrical precipitation, and adapted especially for insertion into, or as part of, the conduits of a ventilating or air-conditioning system, or the like, said unit comprising a casing having substantially vertical sides, said casing being normally closed except for a pair of openings adapted for connection to said conduits; open-ended, electrical precipitating means supported in said casing intermediate said openings, said means being constructed and arranged in said casing so that the gas passing from one of said openings to the other must pass through said precipitating means; electrical power-transforming means for energizing said precipitating means, including a condenser for supplying high potentials to said precipitating means; one of said sides having opening means and closure means therefor for access to said precipitating means, said closure means including a switch-operating means for deenergizing said electrical means when said closure means is first moved toward open position an amount insufficient for access to the interior of said casing, said closure means further including protective means for preventing, after operation of said switch-operating means, opening of said closure means for access to the interior of said casing until said condenser has been substantially completely discharged.

2. An electrical unit for cleaning dust particles from a gaseous stream by electrical precipitation, and adapted especially for insertion into, or as part of, the conduits of a ventilating, or air-conditioning system, or the like, said unit comprising a casing having a top, substantially-vertical sides substantially rectangular in section, and a bottom, said casing being normally closed except for elements defining a pair of openings adapted for connection to said conduits, one of said openings being in proximity to the said top, and the second in proximity to the said bottom; a framework secured in said casing; electrical precipitating means, comprising one or more open-ended cells having substantially vertical dust-collecting electrodes, supported on said framework, said framework and means being constructed and arranged in said casing so that the gas passing from one of said openings to the other must pass through said means; said framework including spaced bars upon which the edges of said cells rest; one of said sides having an opening through which said cells may be inserted or removed; and a closure means for the last said opening, including a compressible material along its periphery, and fastening means for said closure means for compressing said material against the edges defining the last said opening whereby the closure is made substantially water-tight; said casing having a further opening above said precipitating means and closure means therefor whereby when the last said means is open said precipitating means may be washed by means of a hose inserted through the last said opening; and drain means for draining washing fluid said bottom being sloped to said drain means.

3. An electrical unit for cleaning dust particles from a gaseous stream by electrical precipitation, and adapted especially for insertion into, or as

part of, the conduits of a ventilating, or air-conditioning system, or the like, said unit comprising a casing having a top, substantially-vertical sides substantially rectangular in section, and a bottom, said casing being normally closed except for elements defining an upper and a lower opening adapted for connection to said conduits; a framework secured in said casing; electrical precipitating means, comprising one or more open-ended cells having substantially vertical dust-collecting electrodes, supported on said framework, said framework and means being constructed and arranged in said casing so that the gas passing from one of said openings to the other must pass through said means; said framework including spaced bars upon which edges of said cells rest and can slide; one of said sides having an opening through which said cells may be inserted or removed; and a closure means for the last said opening, including a compressible material along its periphery; and fastening means for said closure means for compressing said material against the edges defining the last said opening whereby the closure is made substantially water-tight; said casing having a further opening above said precipitating means and closure means therefor whereby when the last said means is opened said precipitating means may be washed by means of a hose inserted through the last said opening, and drain means for draining washing fluid; encased electrical power-transforming means in said casing above and for said precipitating means, and protective means for deenergizing said electrical means when said closure means are opened.

4. The structure of claim 2 characterized by the last two said openings being in the last said side of said casing, and the said closure means for the last said openings being interlocked so that the second said closure means must be opened before the first said closure means can be opened, and the first said closure means must be closed before the second said closure means can be closed; electrical power-transmitting means for said precipitating means; and protective means on said second closure means for deenergizing said electrical means when the second said closure means is opened.

5. An electrical unit for cleaning dust particles from a gaseous stream by electrical precipitation, and adapted especially to be part of, and connected to the conduits of, a ventilating or air-conditioning system, or the like, said unit comprising a casing having a top, substantially-vertical sides, and a bottom, said casing being normally closed except for elements defining a pair of openings adapted for connection to said conduits, one of said openings being in the upper part of said casing, and a second in proximity to said bottom; an open framework secured in said casing above said second opening; electrical precipitating means comprising one or more open-ended cells each having ionizing means and substantially vertical dust-collecting electrodes to be disposed successively in the direction of gas-flow; said framework comprising members upon which either end of said cells may rest, thereby supporting said cells; said casing having openings and closures therefor, and said framework and said precipitating means being constructed and arranged in said casing so that said cells may be reversed, so that gas passing from either one of said openings to the other will pass successively first through the said ionizing means and then through said dust-collecting electrodes.

6. An electrical unit for cleaning dust particles from a gaseous stream by electrical precipitation, and adapted especially to be part of, and connected to the conduits of, a ventilating or air-conditioning system, or the like, said unit comprising a casing having a top, substantially-vertical sides, and a bottom floor, said casing being normally closed except for elements defining a pair of openings adapted for connection to said conduits, one of said openings being in the upper part of said casing, and the second in proximity to said bottom floor; an open framework secured in said casing above said second opening; electrical precipitating means comprising one or more rectangular-prismatic, open-ended cells each having ionizing means and substantially vertical dust-collecting electrodes to be disposed successively in the direction of gas-flow; said framework comprising members upon which either end of said cells may rest, thereby supporting said cells; said casing having openings and closures therefor, and said framework and said precipitating means being constructed and arranged in said casing so that said cells may be reversed, so that gas passing from any one of said openings to the other will pass successively first through said ionizing means and then through said dust-collecting electrodes; said casing having a further opening and closure means therefor above said precipitating means whereby when the last said closure means is open said precipitating means may be washed by means of a hose inserted through said last opening, said bottom floor being provided with a drain and having a surface sloping toward said drain.

EDWARD H. R. PEGG.