United States Patent

McLain et al.

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[54] ELECTROSTATIC AIR CLEANER

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[73] Assignee: **Air Control Industries, Inc.**

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[52] **U.S. Cl.**.....**55/137,** 55/124, 55/126, 55/138, 55/139, 55/143, 55/144, 55/146, 55/148, 55/151, 55/154, 55/481, 55/483, 55/484, 55/485

[51] **Int. Cl.**.....**B03c 3/47**

[58] **Field of Search**.....55/136–146, 154–156, 55/124, 126, 148, 151, 481, 483, 484

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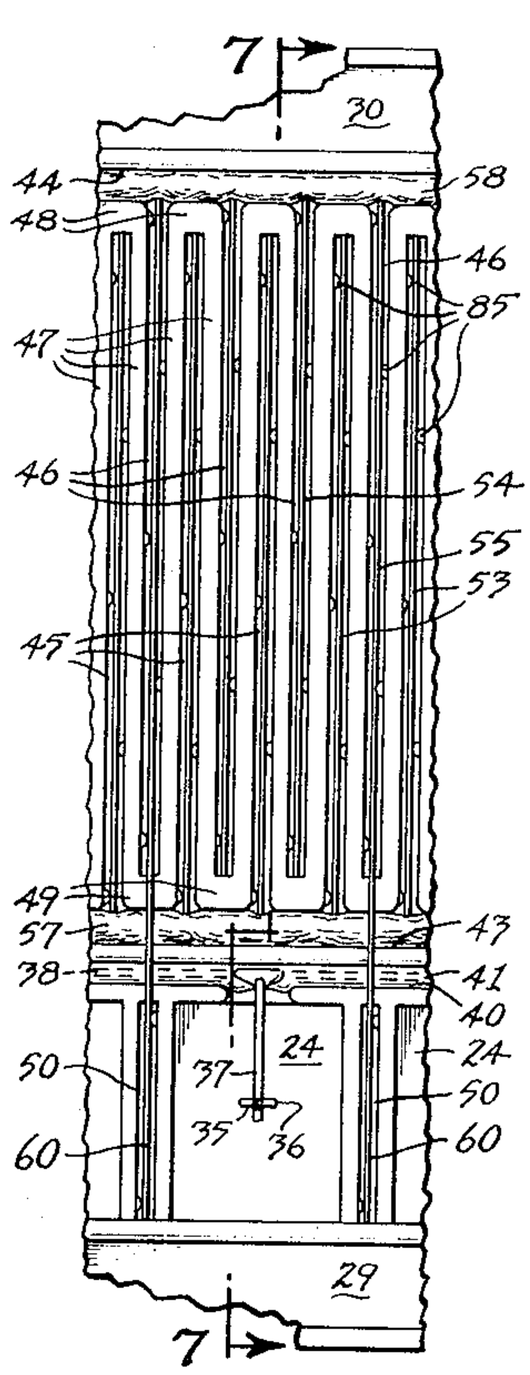
[57] **ABSTRACT**

An electrostatic air cleaning device including alternately charged and grounded collector plates extending between a pair of opposed insulated supporting walls. The walls are provided with recesses supporting the charged collector plates staggered relative to the grounded collector plates. A charging conductor extends transversely of the collector plates to engage the projecting edges of one set of collector plates, and a grounding conductor extends transversely of the plates to engage the opposite edges of the other set of collector plates.

3 Claims, 7 Drawing Figures



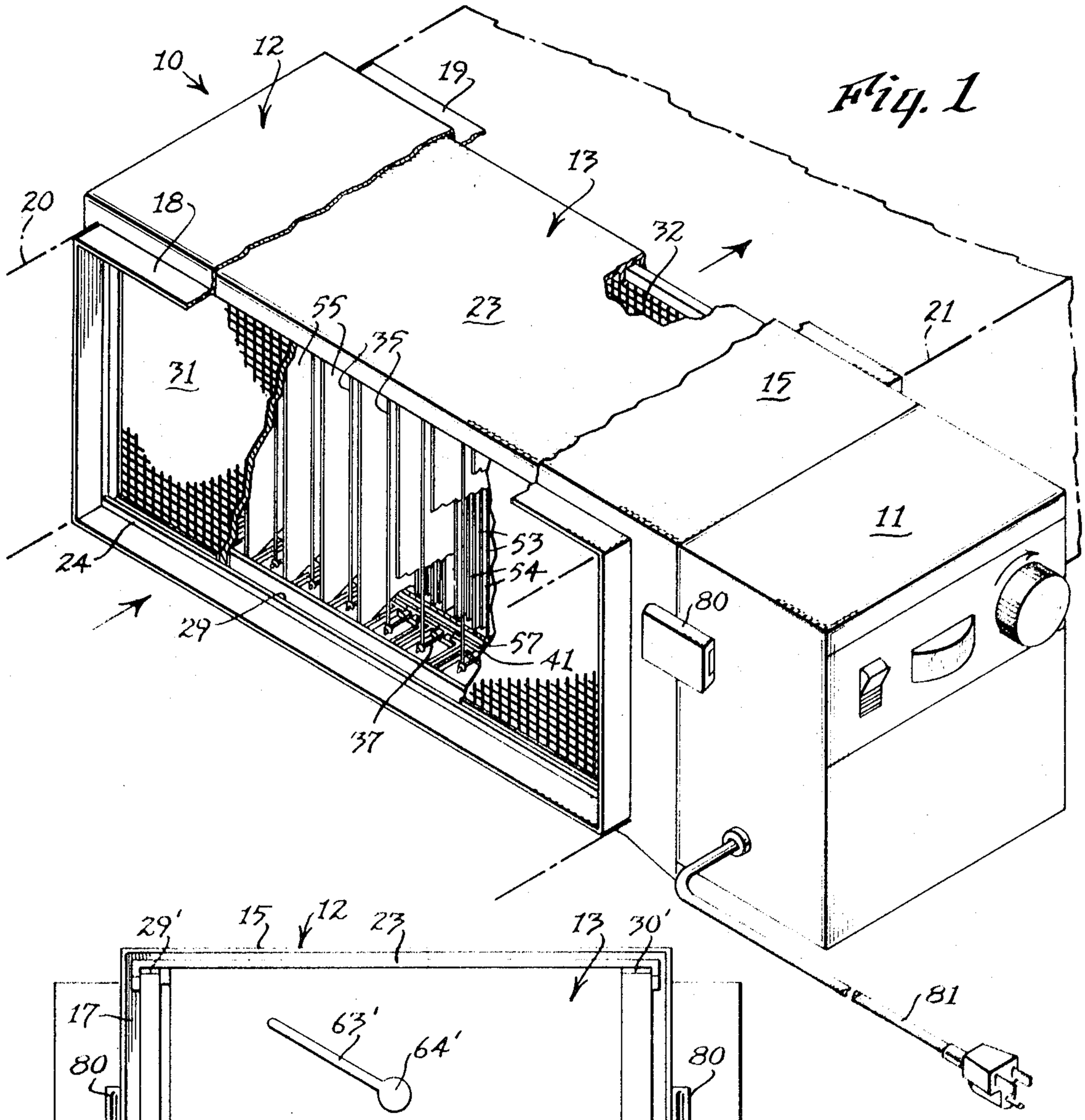


Fig. 1

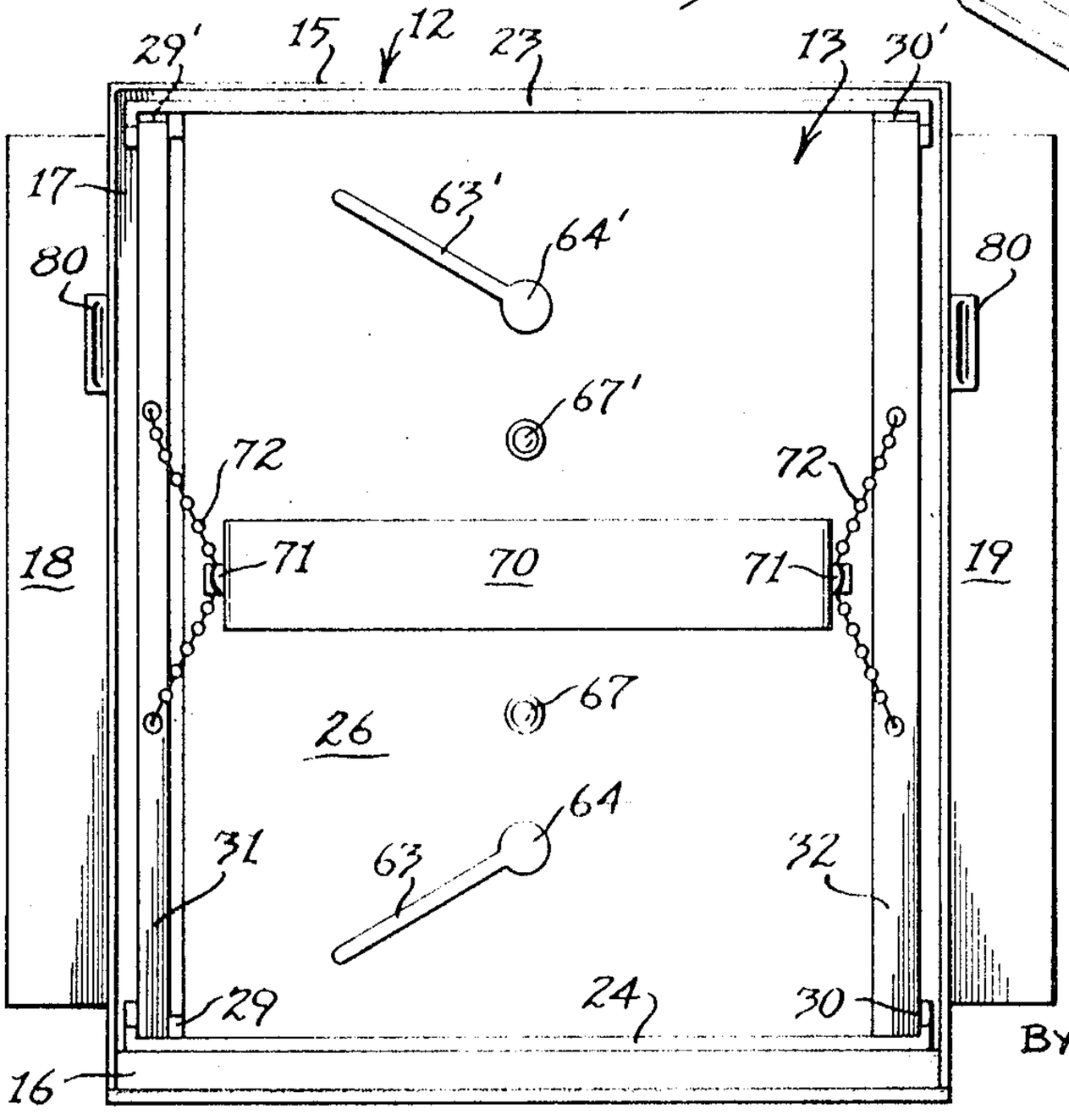


Fig. 2

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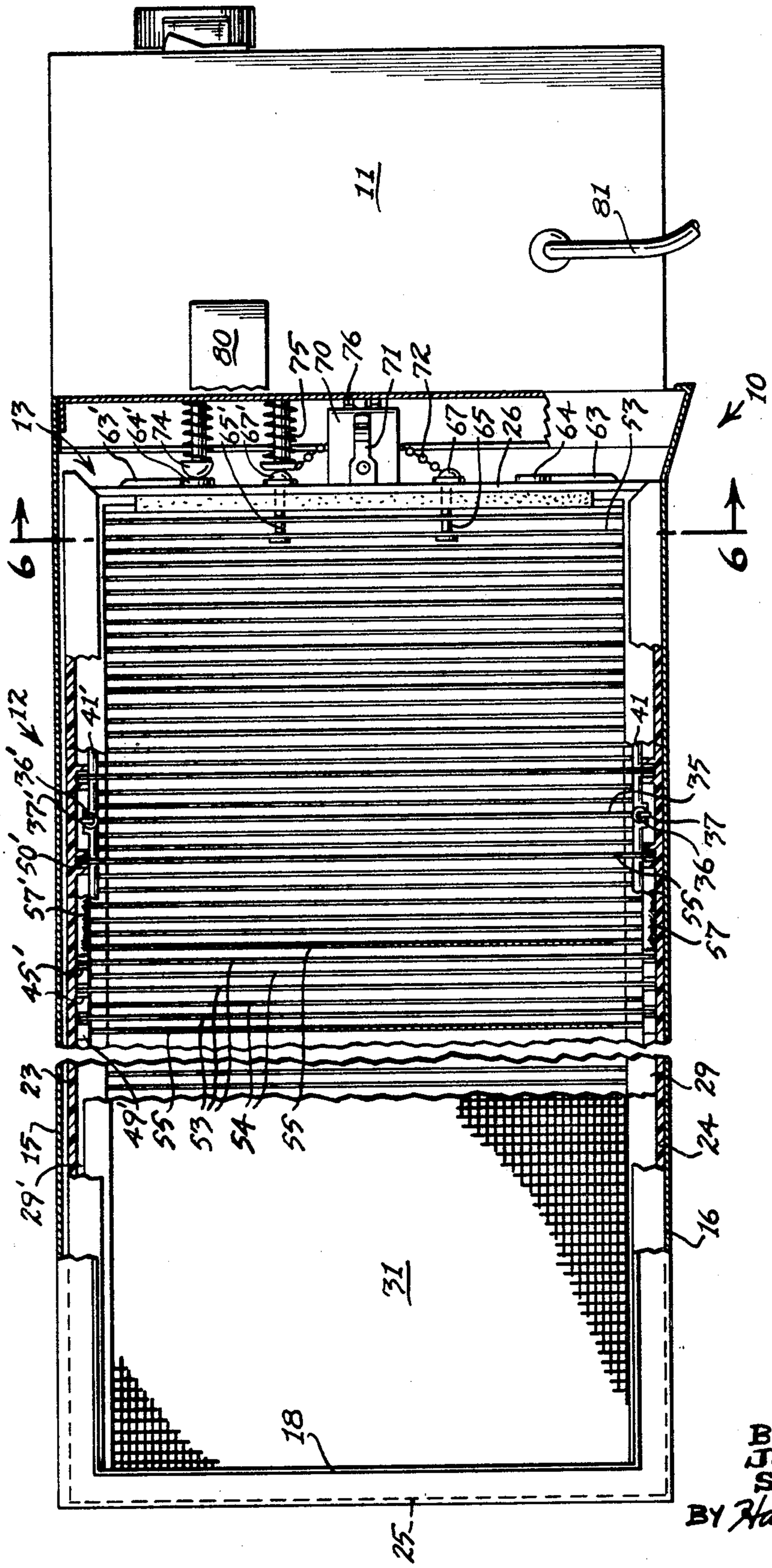

Fig. 3

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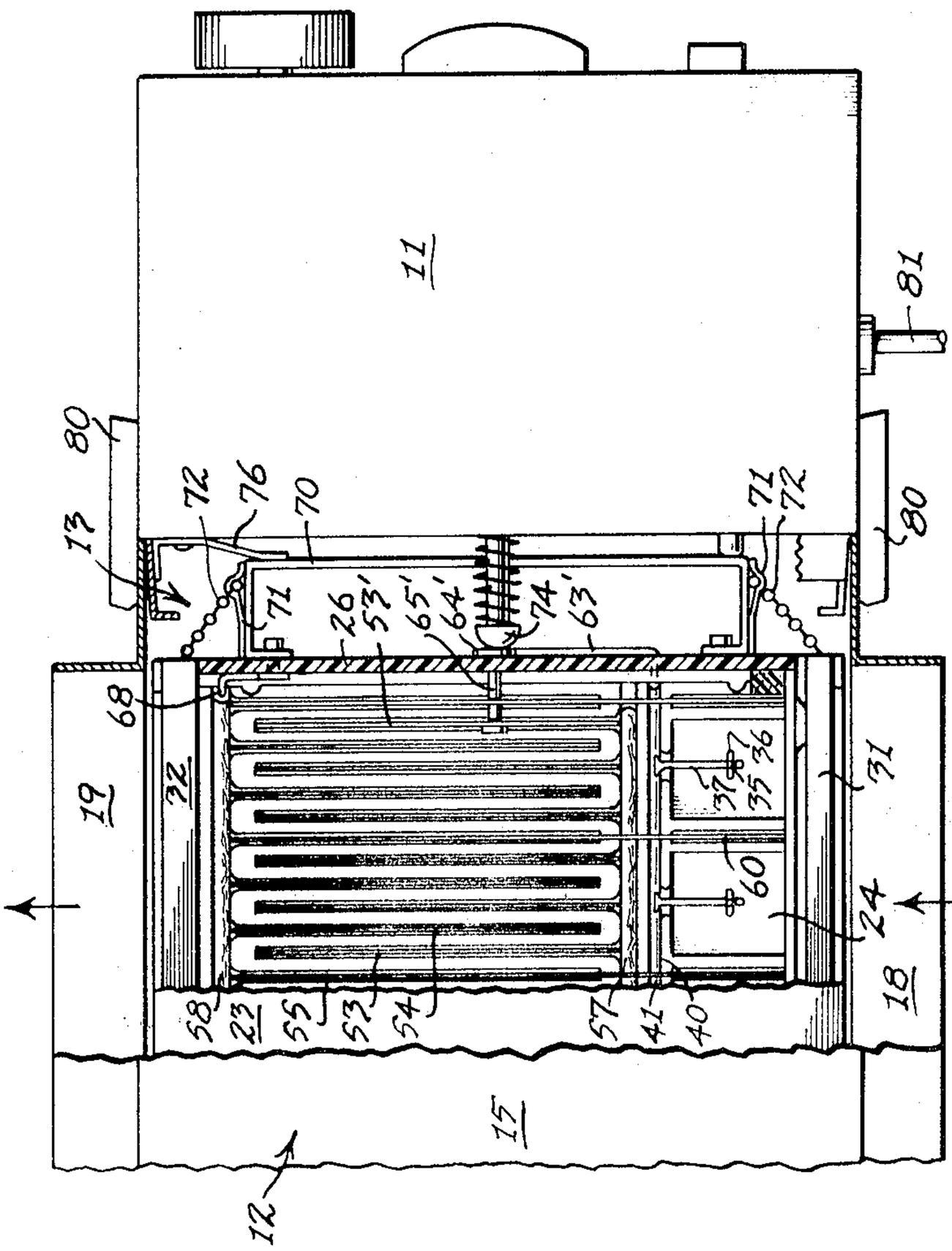

Fig. 4

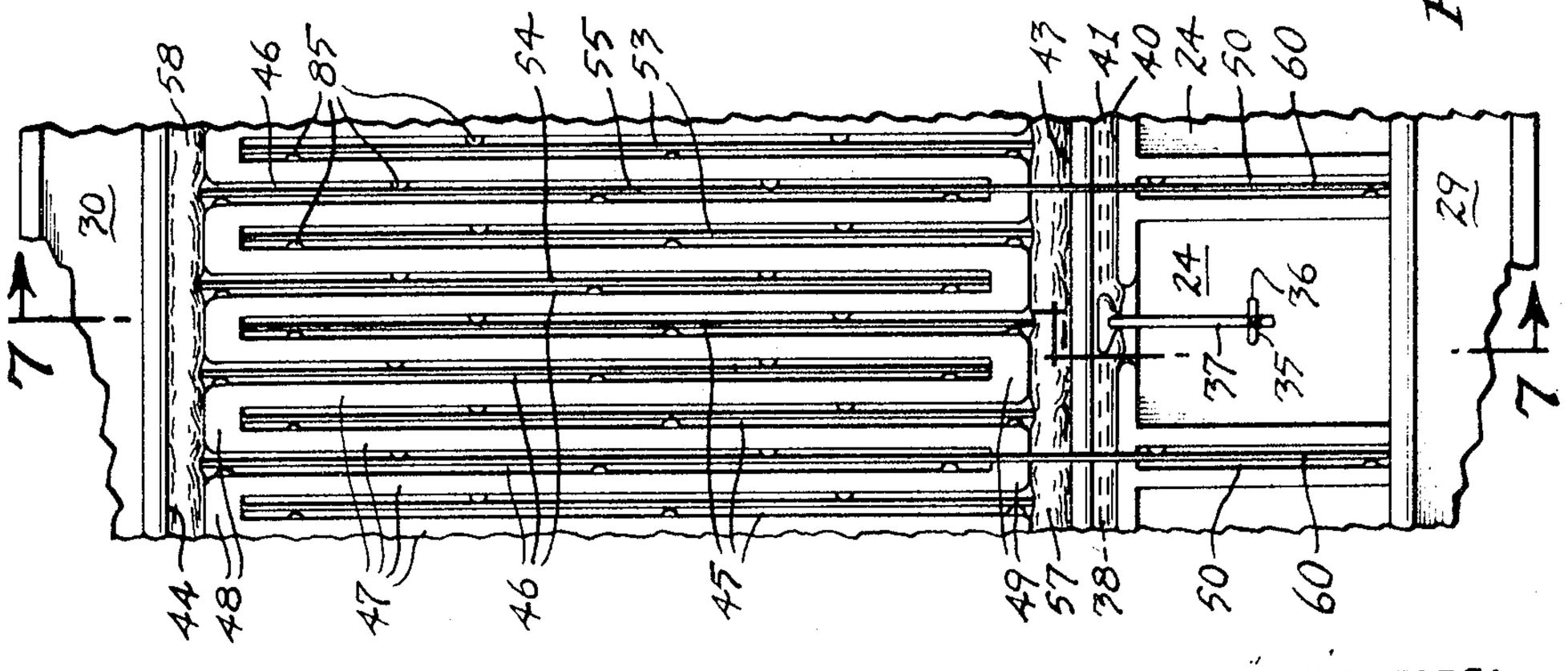

Fig. 5

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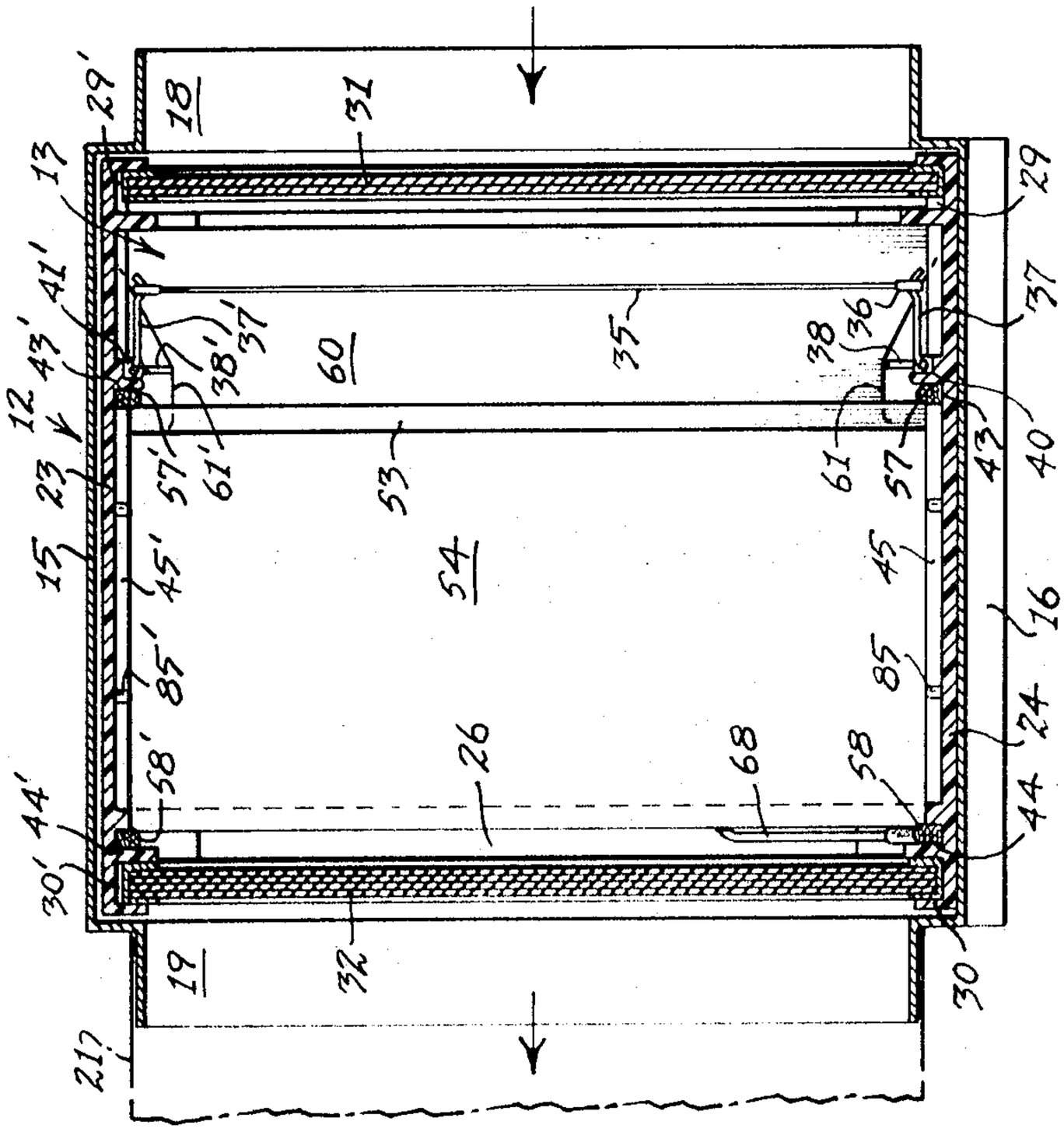

Fig. 7

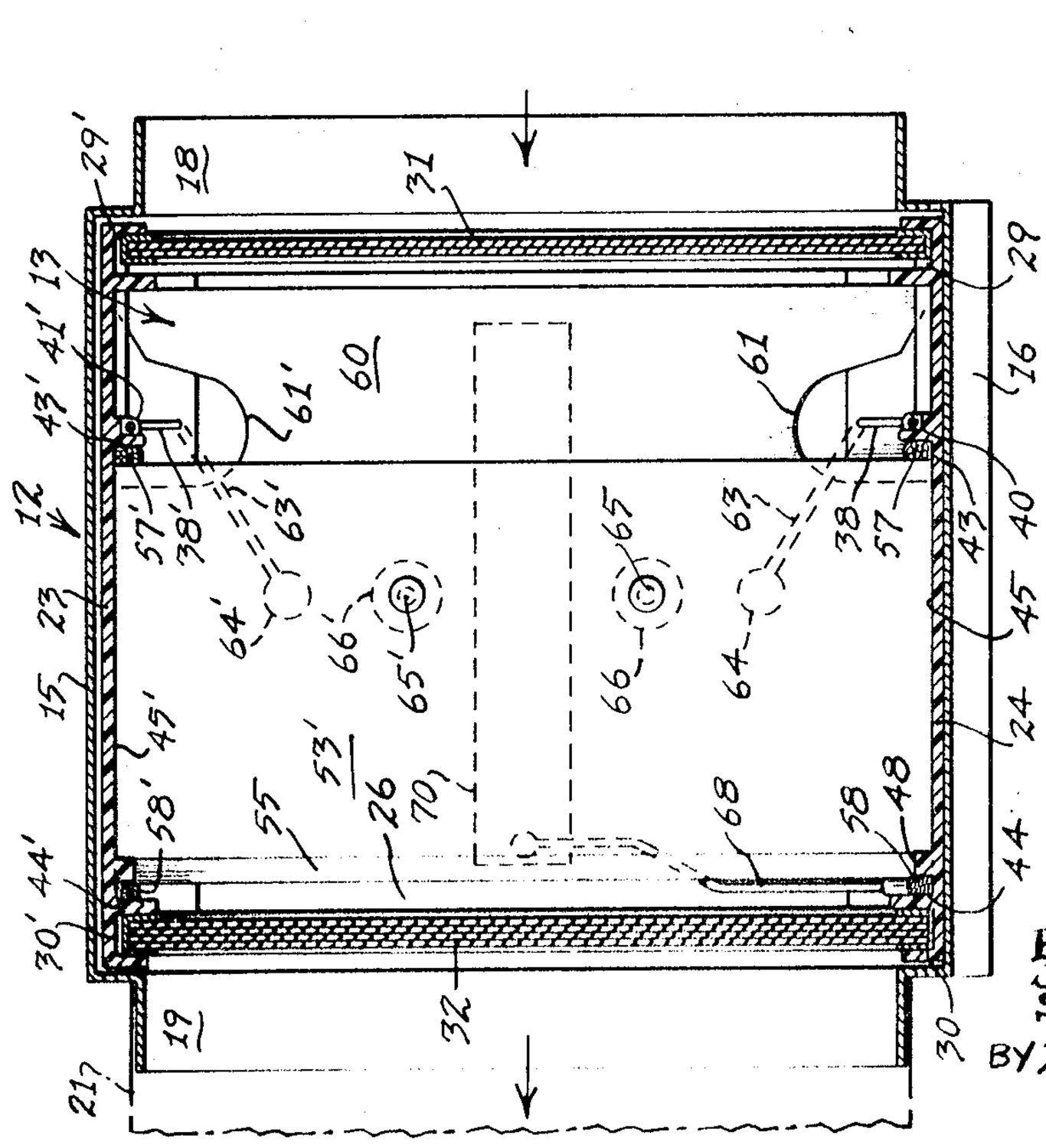

Fig. 6

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ELECTROSTATIC AIR CLEANER

BACKGROUND OF THE INVENTION

This invention relates to an electrostatic air cleaning device, and more particularly to the structure of the walls supporting the collector plates.

Electrostatic precipitators of air cleaning devices are well-known in the art. Such devices usually include two stages for treating the air, a first ionizing stage and a second collector stage. In the ionizing stage, the air moves past one or more ionizing wires from which are spaced ground electrodes to provide an electrostatic field in which the particles in the air are ionized or electrically charged. The ionized particles then move through the second collector stage, which constitutes a plurality of alternately charged and grounded parallel collector plates creating electric fields. The ionized particles are attracted to one collector plate or the other, depending upon the charge on the particle. The air then leaves the second stage, minus the particles, in a cleaner and more purified state.

Most electrostatic precipitators are provided with power packs, most of which include a voltage doubling circuit for applying a voltage to the ionized wires approximately twice as great as the voltage applied to the collector plates.

The idea of extending some of the grounded collector plates forward between the ionizer wires to also function as a grounded electrode for the ionizing wires is also known.

However, the collector plates in most electrostatic precipitators are supported in spaced apart relationship by means of rods. Some of the rods function also as conductors for the alternate charged plates. However, the grounded plates, through which the charged rods extend, must be insulated from the charged rods in some manner. Such insulation is effected either by placing insulating material between the rods and the grounded plates, or by extending the charged rods through enlarged openings in the grounded plates, and providing a second set of rods for supporting and electrically connecting the grounded plates.

The prior art does teach some electrostatic precipitators having recesses or notches for supporting the edges of some of the collector plates, but most of these precipitators also include the above-mentioned rods for either additional support or for applying a voltage to the plates.

SUMMARY OF THE INVENTION

It is therefore an object of this invention to provide an electrostatic air cleaning device in which the opposed supporting walls for the collector plates include recesses or grooves in a particular arrangement, not only for supporting the edges of the collector plates, but also for supporting all the electrical conductors to the collector plates and the ionizer electrodes.

Elongated transverse recesses are formed in at least one of the supporting walls for receiving the charging and grounding conductors. Alternately offset plate recesses are formed in the supporting walls between the conductor recesses for receiving the collector plates parallel to each other, but staggered front to rear, so that the front edges of one set of collector plates will electrically contact one conductor, while the opposite edges of the other set of collector plates will electrically contact the other conductor.

By providing the recessed supporting wall structure in accordance with this invention, a minimum of component parts are required for the assembly of the devices, thus expediting the assembly for mass production.

Moreover, by providing practically the entire means for supporting, not only the collector plates, but also the conductors and the ionizing wire mounting means, the obstruction to the flow of air past the ionizer wires and the collector plates is reduced to a minimum.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a top, front perspective view of the device, with portions broken away, and disclosing the device mounted in an air conduit, disclosed in phantom;

FIG. **2** is an enlarged right-end view of the device disclosed in FIG. **1**, with the power pack removed;

FIG. **3** is an enlarged front elevation of the device disclosed in FIG. **1**, with portions broken away;

FIG. **4** is a fragmentary top-plan view of the right end portion of the device, with portions broken away;

FIG. **5** is an enlarged, fragmentary, top-plan view, with the top of the housing and the top supporting wall removed to disclose the ionizing and collector areas;

FIG. **6** is a section taken along the line **6—6** of FIG. **3**; and

FIG. **7** is a slightly reduced section, taken along the line **7—7** of FIG. **5**.

DESCRIPTION OF THE PREFERRED EMBODIMENT

As best disclosed in the drawings, the electrostatic air cleaning device **10** made in accordance with this invention includes a power pack **11**, a casing or housing **12**, and an air cleaning unit or cell **13**.

The casing **12**, as disclosed in the drawings, includes a top wall **15**, a bottom wall **16**, an end wall **17**, a front flanged opening **18** and a rear flanged opening **19**. The right end of the casing **12**, as disclosed in the drawings, is open to receive the power pack **11**.

As best disclosed in FIGS. **1**, **6** and **7**, front flanged opening **18** may be inserted into a front air duct section **20**, and the rear flanged opening **19** may be inserted into a rear duct section **21**, so that air may flow in the direction of the arrows from the front duct section **20** through the casing **12** and out through the rear duct section **21**.

The right end of the casing **12** is also open to permit the insertion of the air cleaner cell **13** from the right end, while the power pack **11** is disconnected from the casing **12**.

The air cleaning cell **13** includes a top supporting wall **23** and a bottom supporting wall **24** both of which are identical in construction, and are fixed in spaced apart parallel relationship by the opposed end walls **25** and **26**.

The front and rear extremities of the bottom wall **24** comprise elongated recesses or tracks **29** and **30** extending transversely of the cell **13**, or transversely of the direction of air flow, to slidably receive the bottom edges of the pre-filter and after-filter lint screens **31** and **32**, respectively, of any convenient construction. The function of the pre-filter screen **31** is to remove the larger solid particles from the air stream prior to charging the smaller particles in the air stream. The function of the after-filter screen **32** is primarily to collect excess particles which may become dislodged from the collector plates by the flow of air through the cell **13**.

Mounted in the forward portion of the air cleaner cell **13** are a plurality of transversely spaced vertical ionizer wires **35**. The ends of each ionizer wire **35** comprise circular loops **36** which are engaged by hook members **37** projecting forward, and mechanically and electrically connected to the ionizer conductor **38**. The ionizer conductor **38** is in the form of a conductive cable or wire extending transversely of the cell **13** in an elongated groove **40** formed in the bottom wall **24** of the cell **13**. All of the hook members **37** and loop members **36** are conductive to transmit the electrical charge from the ionizing conductor **38** to the ionizer wires **35**. The ionizer conductor **38** may be held in the elongated groove **40** by means of a cement coating **41** (FIGS. **5** and **6**).

Formed in the bottom supporting wall **24** adjacent to and parallel with the ionizer conductor groove **40** is the elongated front conductor recess **43**, as best disclosed in FIGS. **5** and **7**. The front conductor recess **43** extends the entire length of the bottom wall **24**, which is transverse to the direction of air flow through the cell **13**.

In a similar manner, an elongated rear conductor recess **44** is formed in the bottom supporting wall **24** in front of and adjacent the rear screen track **30**, also best disclosed in FIGS. **5** and **7**.

Formed in the bottom wall **24** between the front conductor recess **43** and the rear conductor recess **44** are a plurality of

parallel first collector plate recesses **45** and second collector plate recesses **46**. All of the collector plate recesses **45** and **46** are elongated and extend in the same direction as the air flow through the cell **13**. The collector plate recesses **45** and **46** share common side walls **47** which are insulated. All of the first recesses **45** have their rear ends closed by the rear insulated walls **48**, and their front ends open to communicate with the front conductor recess **43**. Conversely, all of the second collector plate recesses **46** have their front ends closed by the front insulated walls **49**, and their rear ends open to communicate with the rear conductor recess **44**. Thus, as best disclosed in FIG. **5**, the side walls **47**, rear end walls **48** and front end walls **49** form a single continuous, and sinuous wall, undulating back and forth between the alternating first and second recesses **45** and **46** from one end to the other of the bottom supporting wall **24**. Because of this construction, the first recesses **45** are staggered or offset forward relative to the second recesses **46**.

Aligned with every third, or any other desirable multiple, of the second collector plate recesses **46** is an extension plate recess **50** extending between the ionizer conductor groove **40** and the front screen track **29**, and substantially equally spaced apart transversely and on opposite sides of each ionizer wire **35**.

As previously indicated, the top wall **23** is constructed, preferably molded, in the same shape as the bottom supporting wall **24**, and is provided with the same grooves and recesses formed in the bottom supporting wall **24**. The corresponding grooves and recesses in the top wall **23**, where described or disclosed, are indicated by the same reference numerals, followed by a prime.

A plurality of rectangular charged collector plates **53** are mounted within the cell **13** spaced parallel to each other and parallel to the direction of air flow, and are mounted to alternate with a plurality of grounded collector plates **54** and **55**. The bottom edge of each charged plate **53** is received in a plate recess **45** so that its front edge projects forward into the front conductor recess **43**. To provide a snug fit, the width, or the dimension of the charged plate **53** extending in the direction of air flow, is preferably slightly longer than the length of the plate recess **45** so that the rear edge of the plate **53** will abut against the rear end wall **48**, while its front edge projects slightly into the front conductor recess **43**. In a similar manner, the top edge of the charged plate **53** is received in the corresponding and vertically aligned recess **45'** in the top supporting wall **23**.

Snugly received in the front conductor recess **43** is an elongated front conductor, disclosed in the form of an elongated electrical cable **57**. When the cable **57** is fitted in its recess **43**, the cable **57** mechanically and electrically engages the front edge of each of the charged collector plates **53**, thus retaining the collector plate **53** in its recess **45**.

Each of the grounded collector plates **55** is provided with a forward extension section **60**, so that when the bottom edge of the plate **55** is seated in a plate recess **46**, which is in alignment with an extension plate recess **50**, the extension section **60** will also seat in the recess **50**. The grounded collector plates **55** are provided with cutout portions **61** to provide an air gap insulation between the grounded plates **55** and the front conductor cable **57** and the ionizer conductor **38**. The extended plate sections **60** provide ground electrodes for each of the ionizer wires **35**.

All of the remaining plate recesses **46** receive the bottom edges of the rectangular, grounded collector plates **54**. Other than having this extended plate section **60**, the grounded collector plates **55** are quite similar to the grounded collector plates **54**. Both plates **54** and **55** have front edges which engage the front end walls **49**, and have their rear end walls projecting slightly into the rear conductor recess **44**.

A rear conductor cable **58** is snugly fitted into the entire length of the rear conductor recess **44**, to mechanically and electrically engage the rear edges of each grounded collector plate **54** and **55**.

The top edges of the grounded collector plates **54** and **55** are also received in plate recesses in the top supporting wall **23** identical to and vertically aligned with the bottom plate recesses **46**, but which are not specifically disclosed in the drawings.

Since these plate recesses **45** and **46** are disclosed as being identical in length, although staggered in the direction of air flow, the charged collector plates **53** and the grounded collector plates **54** may be identical in construction, and even interchangeable, so that their functional differences are determined, not by their construction, but by their location in one or the other of the recesses **43** and **44**, which determines whether the collector plate engages the front conductor cable **57**, or the rear conductor cable **58**.

The right end of the ionizer conductor **38** projects upward, where it is electrically connected by soldering, or otherwise, to an ionizer leader wire **63** extending through the end wall **26**. The leader **63** terminates in an ionizer contact **64** on the exterior of the end wall **26**, as best disclosed in FIGS. **2** and **6**.

The charged collector plate **53'**, which is closest to the right end wall **26**, is electrically connected to a conductor rod **65**. The rod **65** projects to the right through an enlarged opening **66** in the end grounded collector plate **55**, then through the right end wall **26** where it terminates in the collector charging terminal **67**. Since the collector plate **53'** engages the front conductor cable **57**, any voltage which is impressed upon the terminal **67** will be supplied to all the collector plates **53** and **53'**, which are electrically connected in parallel through the cable **57**.

The rear conductor cable **58** is also grounded at its right end through the ground leader **68**, which rises on the inside of the right end wall **26**, extends through the wall **26**, and is electrically connected to the ground bar **70**, which also functions as a handle for manipulating the cell **13**. Conductive spring clips **71** may be formed at each end of the handle **70** for detachably receiving conductive chains **72** connected to the right ends of the screens **31** and **32**. Thus, any stray potential charges which may be impressed upon the screens **31** and **32** will be discharged through their grounded connections **72**, **71** and **70**.

As disclosed in FIGS. **6** and **7**, the top wall **23** is provided with a front cable **57'**, a rear cable **58'**, an ionizer conductor **38'** and all the other identical elements found in the lower supporting wall **24**.

The power pack **11** includes conventional electrical elements and circuitry, and preferably includes a voltage doubling circuit. A potential of approximately 8,000 volts DC is transmitted from the power pack **11** through the electrode or probe **74** to the ionizer terminal **64'**, so that each ionizer wire **35** has a potential of 8,000 volts DC. One-half the voltage of the ionizer wires is supplied through the electrode or probe **74** from the power pack **11** to the collector terminal **67'** to impress the voltage of 4,000 volts DC upon each of the charged collector plates **53** through the end collector plate **53'** and charging conductor **57**. The power pack **11** is also provided with a ground contact **76** for engaging conductor handle **70**, to complete the ground circuit to the grounded collector plates **54** and **55**.

Power pack **11** is detachably connected to the casing **12** by means of the latches **80**, so that the potentials are impressed upon the ionizer wires **35** and collector plates **53**, **54** and **55**, only when the power pack **11** is attached to the casing **12**.

The main reason that duplicate top and bottom electrical conductors **38'**, **38**, **57'**, **57**, **58'** and **58** are mounted in the top and bottom supporting walls **23** and **24**, is so that electrical connections can be made between the power pack **11** and the various electrical elements in the cell **13**, when the cell **13** is right side up or upside down. Thus, if the cell **13** were turned upside down, the ionizer probe **74** would contact the ionizer terminal **64**, instead of the terminal **64'**, and the collector charging probe **75** would contact he collector charging terminal **67**, instead of the terminal **67'**, and the ground contact **76** would still engage the handle **70**, since the handle **70** is located in the center of the end wall **26**.

The power pack **11** may be supplied with current through the supply cord **81** from any convenient source of electricity.

The collector cells **13** are also adapted to be stacked vertically, or end-to-end, or both, in order to process air in larger capacity ducts. The casings **12**, would of course, be larger to receive the multiple cells **13**.

The side walls **47** of the plate recesses **45** and **46** may be provided with lateral protuberances **85** (FIG. **5**), if desired to snugly engage the opposite surfaces of the collector plates **53**, **54** and **55**, to afford tighter seats.

In actual operation, the pre-filter screen **31** catches the larger visible particles as the air enters the cell **13** from the duct **20**. The smaller particles are charged by the ionizer wires **35**, and then are attracted to one or the other of the collector plates **53**, **54** or **55**, depending upon the charge on the particles. The after-filter screen **32** primarily traps any particles which accumulate upon the plates and are subsequently removed by the passage of air. However, the after-filter screen **32** also functions in case of power failure to filter additional larger particles not separated by the pre-filter screen **31**.

It has been found that the collector cell **13** removes over 90 percent of all air-borne contaminants, even particles as small as 0.01 microns, which includes cigarette smoke and some viruses.

What is claimed is:

1. An electrostatic air cleaning device comprising:

a. opposed supporting walls of insulating material having opposed, substantially planar, inner faces,

b. first elongated insulated recesses in at least one of said inner faces, substantially parallel to the air flow through said device,

c. each of said first recesses having an open upstream end and a closed downstream end,

d. second elongated recesses in at least said one of said inner faces, parallel to and alternating with said first recesses,

e. each of said second recesses having an open downstream end and a closed upstream end,

f. an elongated upstream conductor recess extending transversely in at least said one of said inner faces in open communication with said open upstream ends, and substantially coplanar with said first recesses,

g. an elongated downstream conductor recess extending transversely in at least said one of said inner faces in open communication with said open downstream ends, and substantially coplanar with said second recesses,

h. an elongated upstream conductor longitudinally received in said upstream conductor recess,

i. an elongated downstream conductor longitudinally received in said downstream conductor recess,

j. first collector plates extending between said supporting walls,

k. each of said first collector plates having upstream and downstream edges and being received in a first recess so that said upstream edges project through said open upstream ends into said upstream conductor recess to mechanically and electrically contact said upstream conductor,

l. second collector plates extending between said supporting walls,

m. each of said second collector plates having upstream and downstream edges and being received in a second recess so that said downstream edges project through said open downstream ends into said downstream conductor recess to mechanically and electrically contact said downstream conductor,

n. means for applying an electrical voltage to one of said conductors.

o. means for electrically grounding said other conductor,

p. ionizing means upstream of said upstream conductor comprising ionizer electrodes extending between said opposed supporting walls.

2. The invention according to claim **1** in which said ionizer electrodes comprise a plurality of ionizer wires, an elongated groove extending transversely in at least one of said inner faces upstream of said upstream conductor recess and substantially insulated therefrom, an elongated ionizing conductor received in said groove and in electrical communication with said ionizer wires, and means for connecting said ionizing conductor to said voltage applying means.

3. The invention according to claim **2** in which some of said collector plates which are electrically grounded comprise ionizer plate sections projecting upstream between said ionizer wires, said plate sections having recessed portions spaced from said ionizing conductor and said upstream conductor, said upstream conductor being connected to said voltage applying means.

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