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Wellman

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[54] **ELECTROSTATIC AIR CLEANING APPARATUS**

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[73] Assignee: **Carrier Corporation,** Syracuse, N.Y.

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[52] **U.S. Cl.** **55/129,** 55/126, 55/131, 55/138, 55/139, 55/146, 55/147, 55/148, 55/151, 55/155, 55/481

[51] **Int. Cl.**.....**B03c 3/36**

[58] **Field of Search**.....55/138, 137, 136, 55/131, 132, 129, 128, 146, 147, 148, 150, 151, 155, 124, 126, 139, 481

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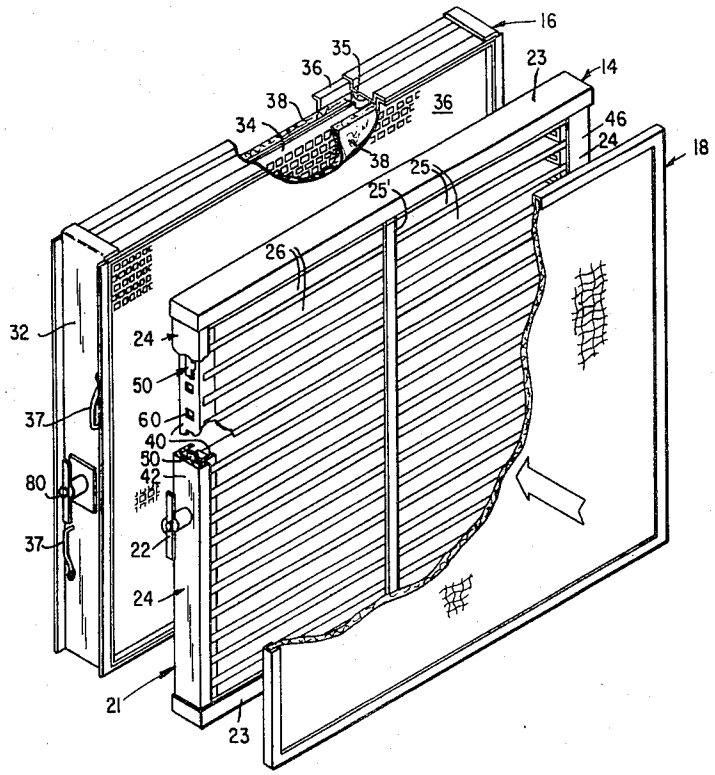
[57] **ABSTRACT**

An electrostatic air cleaner including an ionizer and a charged particle collector utilizing a mat or pad of fibrous media disposed in an electrostatic field wherein the ionizer is constructed of alternately spaced wires and structural members of a width so as to block air flow, the construction permitting the physical size of the collector and ionizer to be substantially the same over an extended range of air flow variation.

3 Claims, 6 Drawing Figures



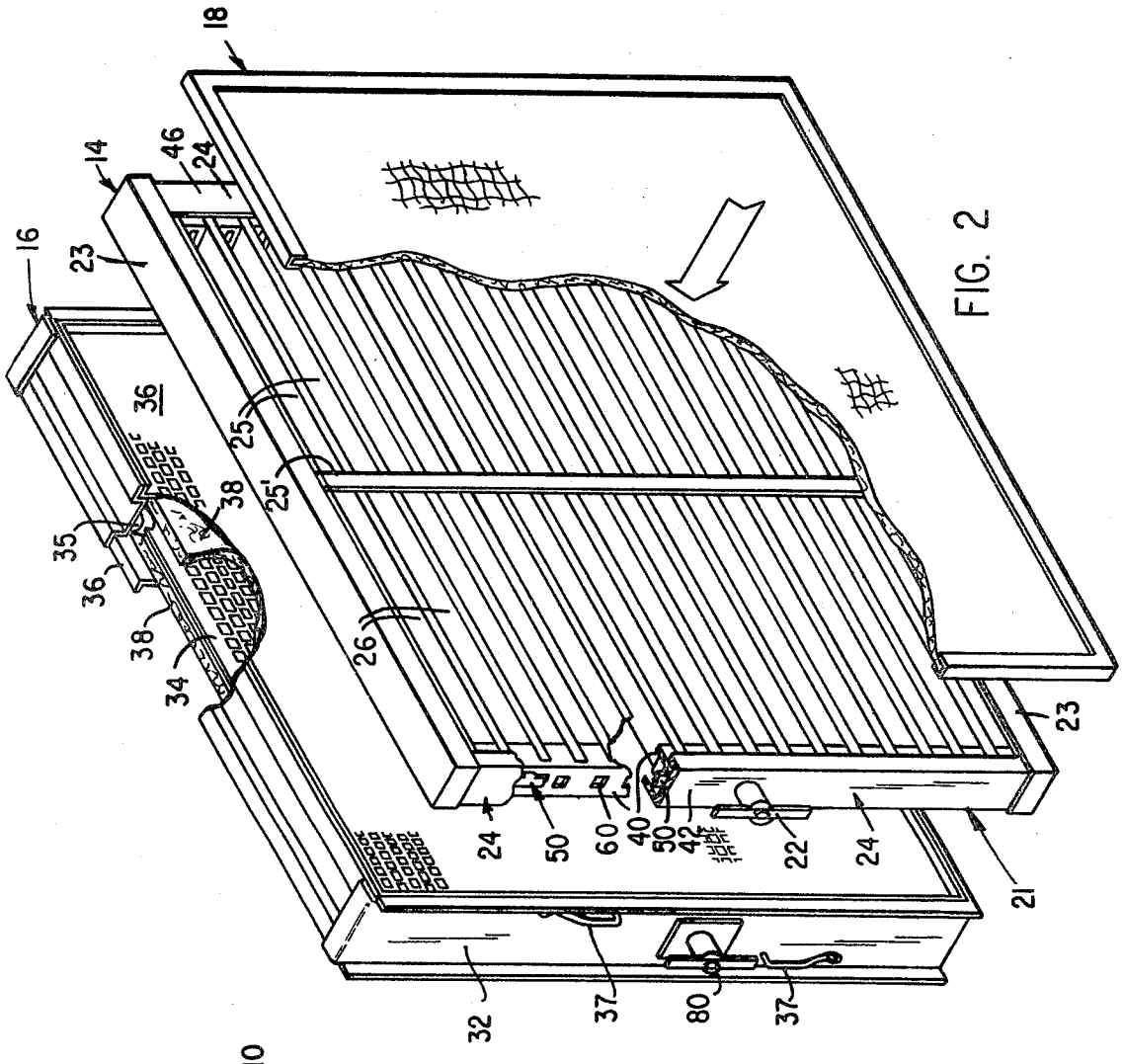


FIG. 2

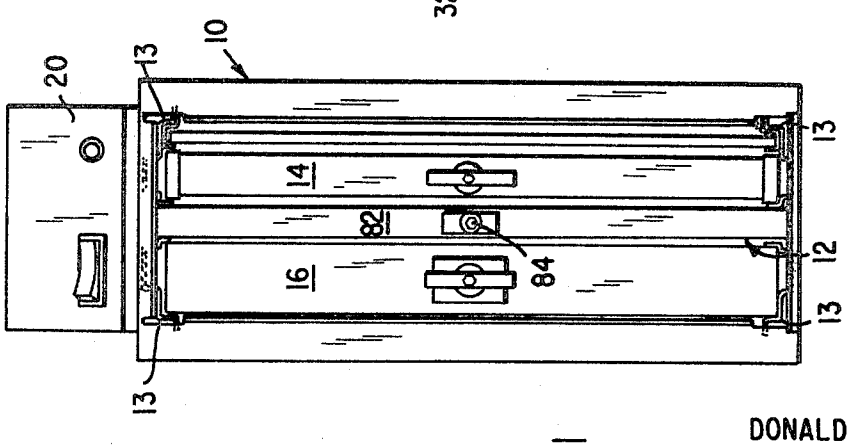


FIG. 1

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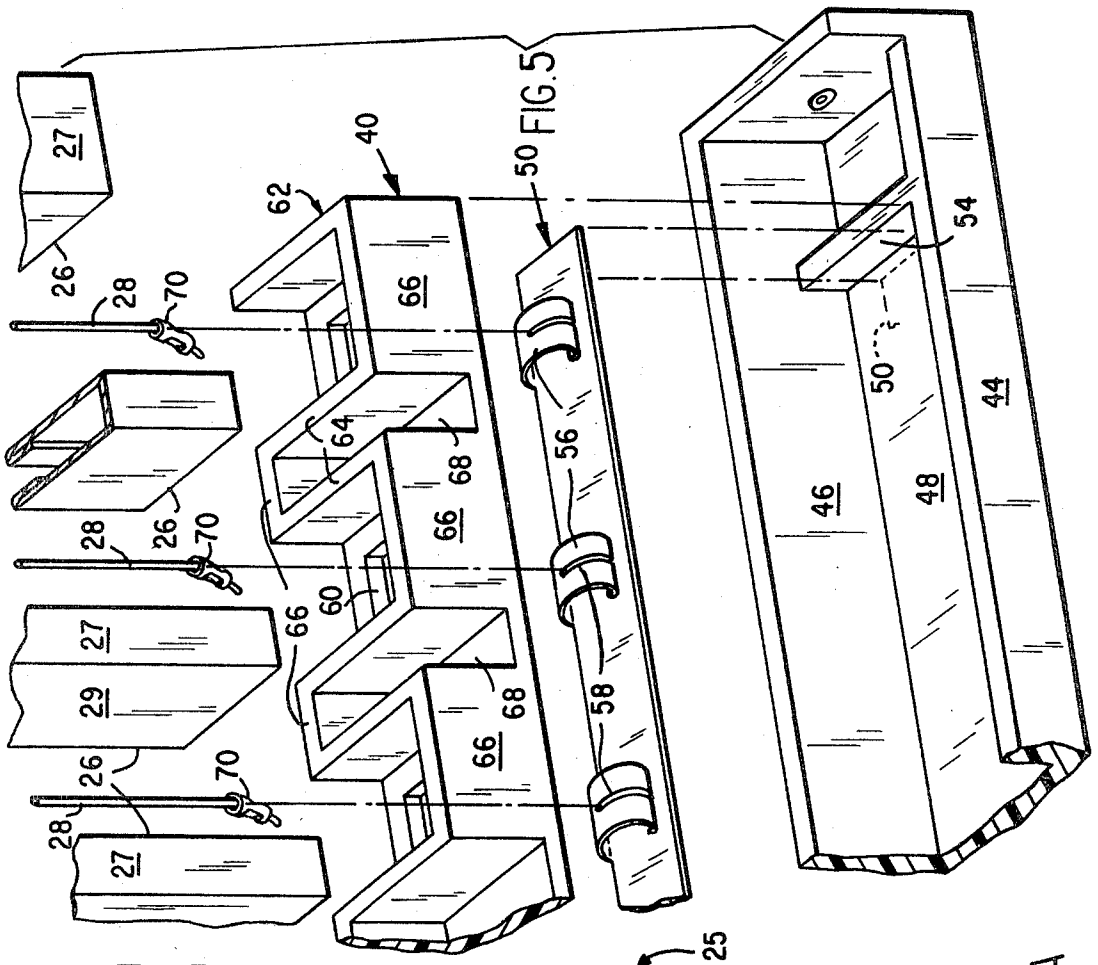

FIG. 5

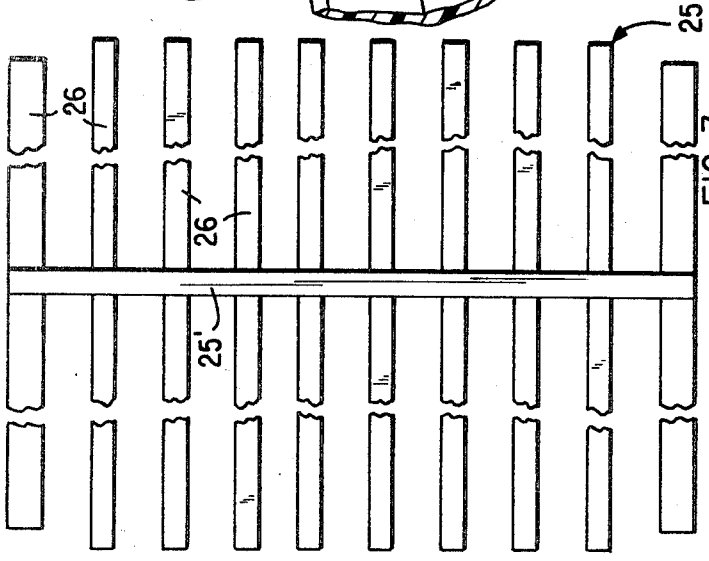

FIG. 3

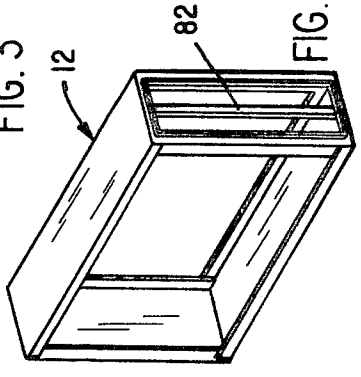

FIG. 1A

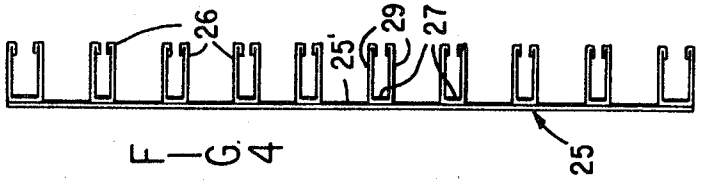

FIG. 4

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ELECTROSTATIC AIR CLEANING APPARATUS

BACKGROUND OF THE INVENTION

This invention relates to electrostatic air cleaning units incorporating an ionizer and a charged particle collector. The unit comprises a casing for the components which may be inserted as a part of a duct system employed with forced air heating and/or cooling apparatus serving an enclosure such as a residence or the like.

The units are provided with a power supply adapted to receive household power of conventional voltage and transform it to a D.C. power source of substantial voltage. The increased voltage is applied to the ionizer and collector for the purpose of creating electrostatic fields in the area transversed by the air stream flowing through the duct system. The ionizer often comprises a plurality of wires each of which is disposed adjacent a plate so as to define a plurality of passages, each with an electrostatic field disposed therein, the electrostatic field being of a magnitude that a corona discharge occurs from the wire. Particles of dirt or dust entrained in air flowing within the passage receive an electrical charge of a particular polarity.

The collector section is located immediately downstream of the ionizer section and while it may take various forms this invention is concerned with a collector construction of the media type. In this type of collector, a mat or pad of fibers of a relatively nonconductive material is interposed between two metallic screens properly separated by a nonconducting frame member. One of the screens is connected directly to the power source so as to receive an electric charge of substantial magnitude and of the same D.C. polarity as the charge applied to the ionizer wires. The second or grounded screen defines with the first screen an electrostatic field accommodating the mat. The fibers in the mat have the characteristic of concentrating the electrostatic field in locations adjacent the surface of the fibers. The charged dust or dirt particles flowing from the ionizer through the collector are attracted to the media fibers and cling thereto providing a cleaner air stream for flow to the heating or cooling apparatus located further downstream in the duct system.

When it becomes necessary to increase the capacity of an electrostatic air cleaner so as to be used for example with larger capacity forced air furnaces, the physical size of the collector is increased for the capacity of the cleaner is dependent upon the surface area of the collector as well as other factors such as particle migration which is a function of total columbic charge per dust particle and the field strength of the dust collecting field, and the volume of air per unit time passing through the collector section. This invention has for its principal object the provision of an ionizer that may be physically increased in size at the same rate as the collector so that the supporting frames for each component will remain substantially the same and thus avoid air distribution problems encountered when the two elements are of different dimensions.

Other factors that contribute to the problem of standardization of physical size of the components involve the electrical characteristics of the equipment. Economy dictates that a transformer of a capacity of 25 watts or less output be employed, for transformers in excess of this output are relatively expensive. Safety considerations require that the amperage drawn by the components be limited to a value not to exceed 5 milliamperes. In smaller size air cleaners where air flow as required by the heating appliance is relatively low, the charged particle collector can be sized to include (1) a frame, compatible in physical size with the duct system, and (2) a media pad, compatible with a satisfactory pressure drop requirement and with the provision for satisfactory surface area to which the particles may cling, while operating within the amperage limitation set forth above. An ionizer frame of substantially the same dimensions as the collector frame and with the wire and plate construction described above may also be provided. The spacing and dimensions of the wires and plates is determined by the volume of air flow, the residence time of air in the passages formed by the plates (a function of the velocity of the air flowing through the cleaner) as well as the current draw. The wires, of course, have a current imposed thereon which will create the desired electrostatic field with the understanding too strong a field provides arcing and too weak a field, inadequate ionization of the particles. As a practical matter an ionizer, in smaller size cleaners, will have ionization capacity in excess of that necessary to accomplish efficient particle charging while operating within the electrical limits described above.

The problem with the type ionizer described presents itself when it is necessary to utilize an electrostatic air cleaner having a collector of the kind described with larger size furnaces. Air flow is increased and so to maintain satisfactory air velocity at the face of the collector, the frame, pad and screens associated with the collector are enlarged keeping the velocity at a level to insure efficient air cleaning at an acceptable pressure drop. When the ionizer frame is enlarged and the plates and wires are increased correspondingly, an excessive current draw occurs because the current draw is a function of wire length which of course increases. To use the same ionizer as employed with the smaller cleaners creates an air distribution problem as the frames of each component are no longer of the same dimensional relationship. To enlarge the capacity of the collector by providing two collector frames arranged at an angle to one another in the manner of a V (with the open portion confronting the ionizer frame) while employing the same physical size ionizer, unduly extends the length of the cleaner. To increase the capacity of the collector by increasing the thickness of the pads is undesirable because excessive pressure drop is involved.

SUMMARY OF THE INVENTION

This invention relates to an ionizer construction for use in electrostatic air cleaners utilizing a media type charged particle collector. The ionizer design includes ionizer wires spaced between elongated U-shaped metallic channels wherein the web portion of the channel serves to block or restrict air passing through the cleaner to the spaces therebetween. The spaces serve as wire accommodating passages and have wires centered therein connected to the power source to create an electrostatic field between the wire and the adjacent channel legs. The channels are grounded so that the desired electrostatic field may obtain.

With the construction described, satisfactory particle ionization within limits of a current draw of less than 5 milliamperes and a voltage less than 6,500 volts may be obtained over a greater range of air flow velocity and structural unit dimensions. When it is desired to vary

the size of the cleaner by enlarging the dimensions of the collector, the ionizer may be enlarged correspondingly to maintain minimum thickness of the cleaner without sacrificing either performance or safety.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a view in elevation of an electrostatic air cleaner illustrating a support casing and equipped with an ionizer constructed in accordance with the invention;

FIG. 1A is a perspective view, reduced in size, illustrating the casing or wrapper with the tracks or guides for the ionizer and collector removed;

FIG. 2 is an exploded view of the ionizer, collector and prefilter units shown in FIG. 1;

FIG. 3 is a view in elevation on a part of the ionizer structure;

FIG. 4 is a view in plan of the ionizer shown in FIG. 3; and

FIG. 5 is an exploded fragmentary view of certain of the parts of the ionizer.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring more particularly to the drawings, there is shown an electrostatic air cleaner **10** incorporating an ionizer construction forming the subject of this invention.

Electrostatic air cleaners of the type illustrated are employed in the return air duct of a forced air heating appliance of the kind used to heat an enclosure such as a residence or the like. Electrostatic air cleaners are devices for filtering foreign material from an air stream by applying an electrostatic charge to the particles of dirt or dust present in the air stream as it flows in the duct system. The apparatus is effective to create a second electrostatic field wherein the charged particles are caused to accumulate or deposit themselves because of the nature of the charge placed in the second field.

The device here illustrated includes a casing or wrapper **12** in which the components of the electrostatic air cleaner are supported. The casing is open at both sides and the top, as viewed in FIG. 1A, so it may be incorporated in a duct system as a component of the system. Arranged within the casing so as to be traversed by the air stream flowing therethrough are ionizer **14**, charged particle collector **16** and a prefilter **18** for mechanically removing particles from the air stream.

Preferably, the casing is provided with track members **13**, note FIG. **1**, for slidably receiving the frame members, forming a part of the ionizer and collector. The casing, in addition, mounts power supply **20** for converting household current to a power source of the type necessary to create the electrostatic fields required. To this end, a transformer is included within the power supply and is capable of converting conventional A.C. household current to a D.C. source, of the order of 5,000 volts. The casing **12** is essentially U-shaped so as to permit the slidable assembly of the frames described above should it be necessary to insert or remove either the ionizer or collector. As will be noted from both FIGS. **1** and **2**, the frames are provided with handles which also function as a part of the electrical supply system in a manner to be later described.

The ionizer **14** includes a frame **21** formed of opposed metallic sides **23** and opposed ends **24**. Each of the side members is a channel-shaped metallic member adapted to engage track **13** disposed within the casing **12**. The ends **24** are formed of plastic material and serve to mount the remaining members of the ionizer in a manner to be later described.

Arranged within the frame **21** by connection to the frame sides **23** is a unitary member **25** composed of a plurality of spaced elongated imperforate metallic channels **26** connected by a cross member **25'** as shown in FIGS. **3** and **4**. The metallic channels **26** include a web portion **27** and opposed leg portions **29**, the ends of which are bent back upon themselves in the manner shown in FIGS. **4** and **5**. It has been found that when the channels are formed so that they restrict air flow through the ionizer to a range of between 45 percent and 85 percent of the total face area of the ionizer, the physical size of the ionizer can be varied directly as the physical size of the collector over a substantial range of cleaner capacity as defined by volume of air flow.

Referring more particularly to FIG. **5**, the end members **24** of the ionizer frame are shown composed of two plastic molded parts **40** and **42**. Outer member **42** is shown as substantially U-shaped in section. It is to be noted, however, that one leg **44** is shorter in height than the other leg **46**. Web portion **48** defines, with inner member **40**, a chamber in which metallic bus bar **50** is disposed. The bus bar **50** includes tabs **56** integrally formed therewith but bent back upon the bar in the manner illustrated in FIG. **5**. Each of the tabs is provided with a slot **58** extending from one edge to approximately the central portion of the tab. A combination electrical contact mounting post and handle assembly **22** is connected through a side **24** to the bus bar **50** to supply electrical energy to the ionizer wires connected in a manner to be later described to the bus bar.

Inner member **40** is designed to overlie bus bar **50** so as to form the chamber described above. The base of member **40** includes a plurality of openings **60** in registry with the tabs **56**. Member **40** is provided with an upstanding wall **62** formed of a plurality of spaced cross partitions **64** integrally formed and connected with peripheral wall portions **66**. With the cross partitions **64** spaced in the manner illustrated in FIG. **5**, recesses **68** for accommodating the ends of member **26** are provided. Inner member **40** is dimensioned so as to fit snugly within the channel provided in outer member **42**. Fastening elements are provided for connecting the sides **23** to the end members **24**. With the bottom end of the frame **24** connected to the sides, the unitary member **25** in then connected to the side by inserting the ends of channels **26** in the recesses **68**. Wires **28** are then attached to the bus bar **50** by passing the portion of the wire above enlarged locking element **70** through the groove **58** which enables tab **56** to act as a resilient retaining element. The other ends of channels **24** and wires **28** are mounted in similar side members so as to form a unitary ionizer capable of being slidably assembled within tracks **13**.

The collector employed with the ionizer described includes a mounting frame **32** formed of metallic material so that opposed sides as well as the opposed ends serve as conductors. Centrally located within the frame **32** is charging screen **34**. The screen is mounted to the frame by insulating members **35** disposed at spaced locations about the inner surface of the frame. Located at the opposed sides of the frame, parallel to the central screen, are separate end screens **36** retained in assembled relation with the frame through screen retainer el-

ements 37. Media pads or mats formed of intertwined fibers of relatively nonconducting material such as marketed under the name "Dynel" are interposed between the central screen 34 and each of the outer screens 36. An electrical contact mounting post 80 is provided on an end side of the frame. The mounting post acts as a handle and permits the frame to be slidably assembled in the track 13 formed on casing 12 for the purpose of accommodating the collector. The mounting post 80 is formed of a conductive material so that the output of the power supply may be applied to the central screen connected to the underside of the post for the purpose of charging same.

The casing 12 is provided with a web 82 on its normally open end. The web is provided with an electrical contact mounting post 84 connected directly to the power supply. When the collector and ionizer frames have been inserted in the casing and a door, not shown, is assembled over the open side of the casing, electrical power supplied to mounting post 84 is delivered to the frames through a resilient bar secured to and insulated from the underside of the door spanning and engaging the posts. If desired, a collector assembly of the type illustrated in co-pending application Ser. No. 676,123, now U.S. Pat. No. 3,509,696 assigned to the assignee of this application may be employed in place of that described.

Considering the operation of the invention with the ionizer frame and collector frame assemblies inserted in the casing as illustrated in FIG. 1 and the door, not shown, applied as described, electrical energy from the power supply is applied via the mounting posts 22, 80, 84 and the resilient strip in the underside of the door to the ionizing wires 28 through bus bar 50 and to the central screen 34 of the collector, the wires 28 being in spaced relation to the legs of the channel members 26 which are grounded due to member 25' engaging sides 23. A plurality of electrostatic fields are created across the face of the ionizer frame so as to be traversed by the air stream flowing therethrough. The channels block and restrict air flow through the passages located therebetween, which passages, of course, have electrostatic fields imposed therein. Foreign particles entrained in the air stream are provided with an electrical charge in the known manner. The charged particles then enter the collector which as pointed out above supports the media pads in a second electrostatic field. As pointed out above the charged particles collect in the electrostatic field. Thus, the particles are withdrawn from the air stream as it passes through the cleaner enroute to the heating appliance. It will be obvious to those skilled in the art that the spacing of the wires relative to the channels, the dimension of the web and the length of the legs may be ascertained once the design output and efficiency of the cleaner is established. With the construction described, efficient and effective use of the charging wires in the ionizer section is assured. When the collector section is enlarged in order to increase the capacity of the cleaner, the ionizer frame may be correspondingly enlarged without exceeding safe operating electrical limits of the machine.

While I have described a preferred embodiment of the invention, it is to be understood the invention is not limited thereto since it may be otherwise embodied within the scope of the following claims.

I claim:

1. An electrostatic air cleaner comprising a casing having an inlet and an outlet enabling air to be treated by the cleaner to flow through the casing, said casing serving as an enclosure for certain of the parts of the cleaner,

an ionizer including a supporting frame having opposed sides and opposed ends arranged within the casing,

a collector assembly including a supporting frame having opposed sides and opposed ends arranged within the casing in spaced relation to the ionizer, spaced screen members defining an electrostatic field therebetween, a pad of fibrous material interposed in the space between the screens, means associated with the frame for receiving an electrical charge and imposing same on one of said screens,

electrical power supply means including a transformer, electrical conducting means for transmitting electrical energy from the transformer to the collector assembly and the ionizer,

said ionizer further including a plurality of spaced structural members having a pair of relatively flat parallel surfaces connected by a flat surface confronting the path of air flow into the casing so as to define a plurality of spaced air passages, the structural members being dimensioned so that air flow through the ionizer is restricted to a range between 45 percent and 85 percent of the total face area of the ionizer, means connecting the structural members to the frame, a plurality of wires, one of which is arranged in each of the ionizer air flow passages, electrical conducting means disposed within the ionizer frame in mechanical and electrical engagement with the wires, electrical post means mounted on the frame for connecting the ionizer electrical conducting means to the electrical power supply means through the electrical conducting means associated with the electrical power supply means.

2. An electrostatic air cleaner as described in claim 1 wherein said ionizer frame including opposed sides formed of an electrically conductive material and opposed ends formed of a dielectric material, with the connecting means engaging the sides formed of electrically conductive material.

3. An electrostatic air cleaner as described in claim 2, wherein the opposed ends of said ionizer frame include first and second members, one of which is apertured, adapted to telescopically engage one another, the electrically conducting means on said ionizer frame arranged between said members, said wires being connected to the bus bar through the apertures in said one member.

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