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Webster et al.

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[54] AIR FILTER UTILIZING SPACE TRAPPING OF CHARGED PARTICLES

[75] Inventors: **Harold F. Webster**, Scotia; **N. Rey Whetten**, Burnt Hills, both of N.Y.

[73] Assignee: **General Electric Company**, Schenectady, N.Y.

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[52] U.S. Cl. **55/123**, 55/138, 55/139, 55/146, 55/154

[51] Int. Cl. **B03c 3/04**

[58] Field of Search 55/108, 120, 136, 55/123, 130, 137, 138, 139, 146, 150, 154

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Primary Examiner—Dennis E. Talbert, Jr.
Attorney—John F. Ahern, Julius J. Zaskalicky and Louis A. Maucha

[57] **ABSTRACT**

A duct for the transmission of an air flow therethrough is provided with parallel planar arrays of electrical conductors which are angularly positioned relative to the axis of the air flow. The conductors are parallel to each other and connected to a source of alternating current voltage for generating two dimensional multipolar alternating current electrodynamic fields across the duct. The electrical forces generated by the multipolar fields trap charged particles in the air flow and the orientation of the air flow relative to the angular position of the conductor planar arrays causes the particles to be directed to a side of the duct for collection and subsequent removal. The trapping of the particles is enhanced by coating the conductors with a high dielectric strength material.

26 Claims, 6 Drawing Figures

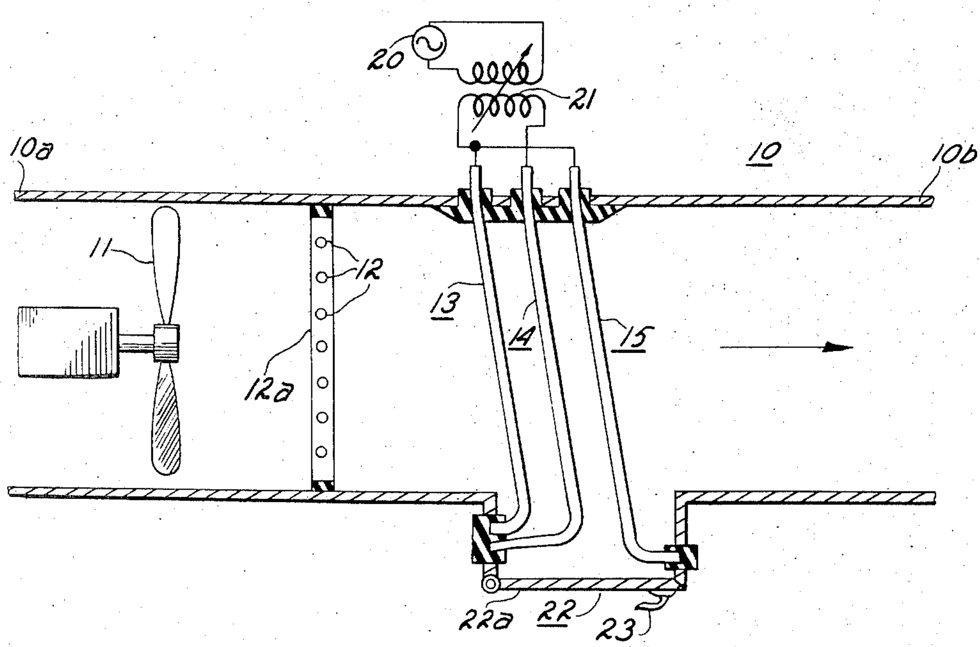

Fig. 1

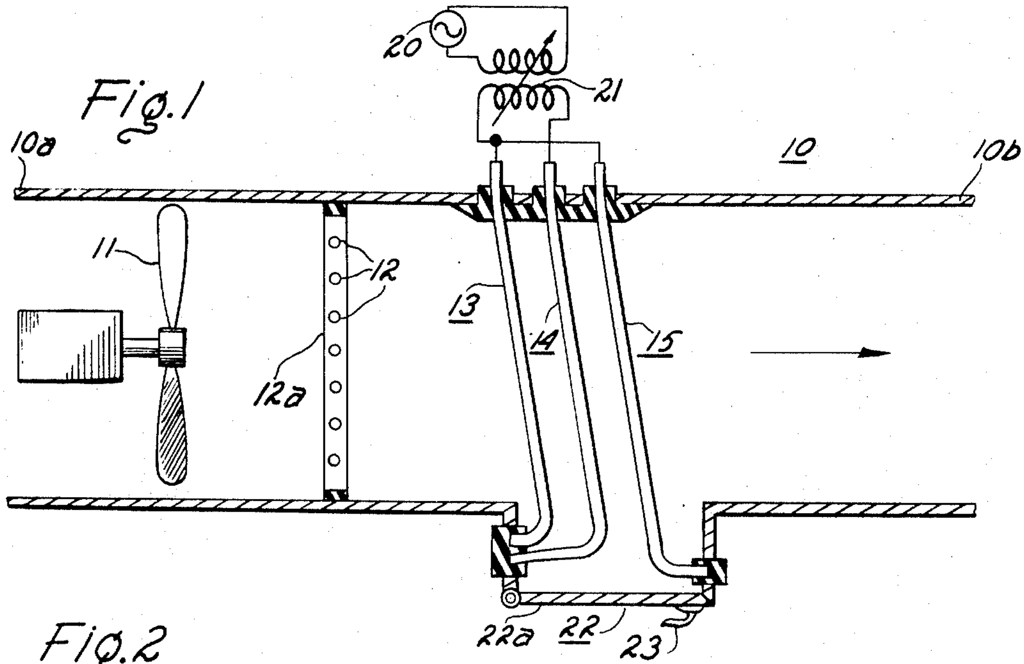

Fig. 2

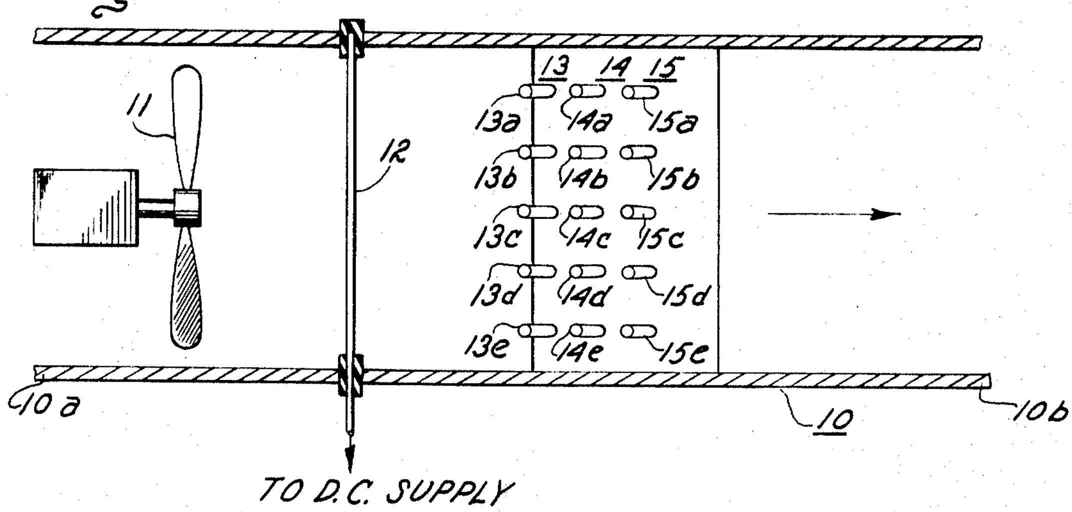

Fig. 3

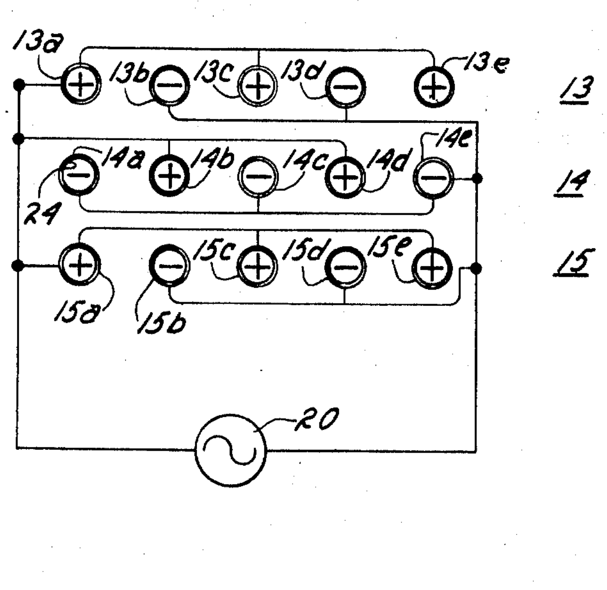

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Fig. 4

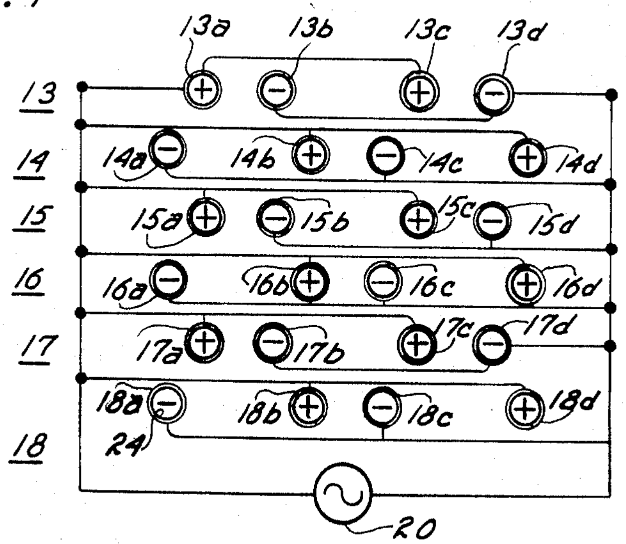
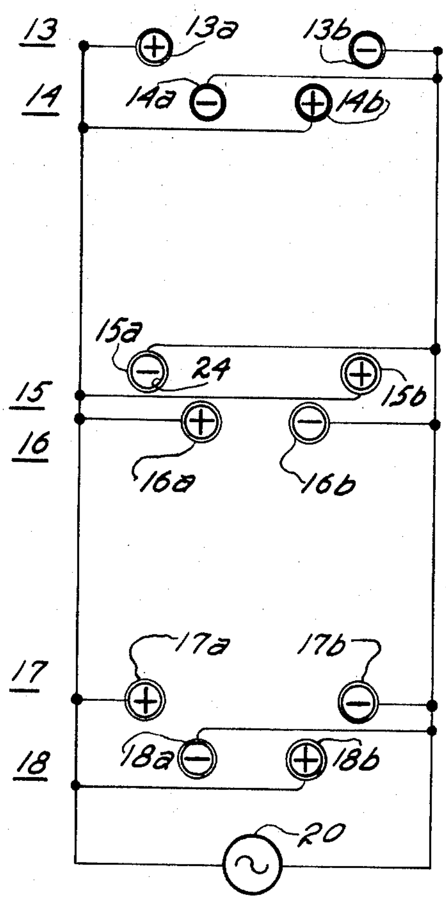
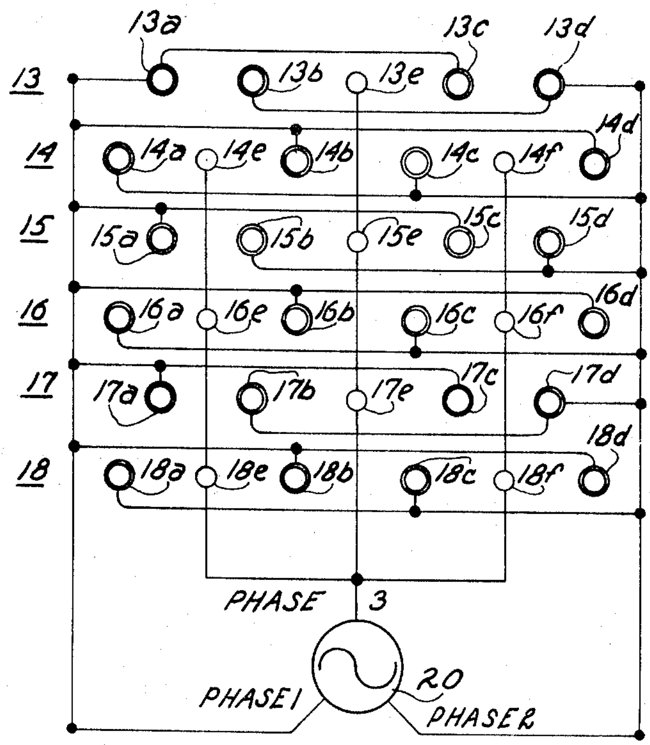


Fig. 6




13a
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17a
17b
17e
17c
17d
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18a
18e
18b
18c
18f
18d
PHASE 3
20
PHASE 1
PHASE 2

Fig. 5

AIR FILTER UTILIZING SPACE TRAPPING OF CHARGED PARTICLES

Our invention relates to a home appliance type air filter, and in particular, to an air filter which may be utilized as an adjunct to a room air conditioner for precipitating out particles from an air stream by the space trapping of charged particles.

Home appliances such as room air conditions are provided with filters which provide some degree of air filtration but in many cases such filter is not adequate. Various types of air filters are known and some of them undoubtedly may be utilized as an adjunct to room air conditioners, however, such filters generally remove only the larger size particles, i.e. having diameter dimensions in excess of 100 microns.

Electrostatic filters, also known as electrostatic precipitators of the direct current type, are known and are capable of precipitating out particles of size smaller than 100 microns. However, the charged particles in D.C. precipitators are driven into contact with electrode plates and build up a layer which must be removed periodically if the apparatus is to continue satisfactory operation. The layer of particles on the electrodes is usually removed by washing the filter. This procedure for the removal of the particles is inconvenient, time consuming, subject to damage and is obviously undesired.

Therefore, a principle object of our invention is to provide an air filter which traps particles in space rather than on the surface of an electrode.

An article entitled "Electrodynamical Behavior of Charged Aerosol Particles in Non-uniform Alternating Fields and Its Applications in Dust Control" by Senichi Masuda, et al published in the German journal "Staub-Reinhaltung der Luft," Vol. 30 (1970) No. **11** is devoted primarily to the description of a single plane of parallel cylinder electrodes or rods connected to an alternating current (A.C.) voltage source for generating a series of nonuniform A.C. fields to form a so-called electric curtain which repulses charged particles in a viscous medium. My invention is directed to a particular application of the concept proposed in the Masuda publication, and in particular, to a particular geometry of parallel electrical conductors which provide superior filtering of the air supplied from a home appliance such as a room air conditioners.

Therefore, another object of our invention is to provide an air filter which is adapted to be an adjunct to a room air conditioner.

In accordance with our invention, we provide a home appliance in the form of an air filter which is suitable as an adjunct to room air conditioners. The invention utilizes the space trapping of charged particles in the filtering process and includes a duct having a first end through which an air flow is admitted. A plurality of electrical conductors distributed across the duct are connected to a source of high voltage D.C. potential for producing a corona discharge which charges particles in the air stream as they flow thereby. Further downstream in the duct are positioned a plurality of parallel planar arrays of electrical conductors angularly positioned relative to the axis of the air flow in the duct. The latter conductors are all parallel to each other and are connected to an A.C. voltage source for generating two dimensional multipolar A.C. electrodynamic fields across the duct. The particular order of multipolar fields which are generated are determined by the particular orientation and electrical connections of the conductors. The electrical forces generated by the multipolar fields trap the charged particles in the air flow and the orientation of the air flow relative to the angular position of the planar arrays of conductors causes the particles to be directed to a side of the duct from which they can be removed. The trapping of the particles is enhanced by coating the conductors with a high dielectric strength material which permits operation at higher A.C. voltage, which may be sufficiently high to produce corona discharge and charge the particles and thereby obviate the need for the separate conductors operated at high voltage D.C. The filter is especially well adapted for removing particles in the size range of 0.01 to 100 microns diameter and larger size particles may be removed by increasing the amplitude of the A.C. voltage or decreasing the spacing between the conductors which generate the multipolar fields.

The features of our invention which we desire to protect herein are pointed out with particularity in the appended claims. The invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof may best be understood by reference to the following description taken in connection with the accompanying drawings wherein like parts in each of the several figures are identified by the same reference character and wherein:

FIG. **1** is a side view, partly in section, of a first embodiment of our air filter;

FIG. **2** is a top view, partly in section, of the filter illustrated in FIG. **1**;

FIG. **3** is a schematic diagram illustrating the orientation and electrical connections of the parallel planar arrays of electrical conductors for generating quadrupole A.C. electrodynamic fields in the filter illustrated in FIGS. **1** and **2**;

FIG. **4** is a schematic diagram illustrating the orientation and electrical connections of the electrical conductors for generating hexapole A.C. electrodynamic fields;

FIG. **5** is a schematic diagram illustrating the orientation and electrical connections of the electrical conductors for generating hexapole A.C. electrodynamic fields as in FIG. **4**, with additional conductors for three phase operation which also provides the particle charging function; and

FIG. **6** is a schematic diagram illustrating the orientation and electrical connections of the electrical conductors for generating a third embodiment of multipolar A.C. electrodynamic fields.

Referring now to FIG. **1**, there is shown a side view of our filter. A duct **10** which encloses the elements of our air filter has a first end **10***a* for the admission of an air flow thereto and a second end **10***b* for the exit of the air flow therefrom. The duct may be of various shapes, however, a square or rectangular cross section appears to be the most simple form for purposes of utilizing straight electrical conductors for generating the multipolar A.C. electrodynamic fields to be described hereinafter. Obviously, the duct may have a circular or other curved or noncurved cross section and the aforesaid conductors would be curved or straight. A fan **11** which is typically motor driven is located adjacent the first end **10***a* of the duct for producing the flow of air thereto. Fan **11** may be located within the duct **10** proper or outside the duct, in the latter case generally comprising the fan motor in a room type air conditioner. In the latter case, the first end **10**a of the duct is connected to the output end of the room air conditioner such that the air after passing through the air conditioner passes through duct **10** prior to exiting into the room. The flow of air produced by fan **11** may contain particles of various sizes which were not filtered out in the room air conditioner filter, and in particular, our air filter is especially well adapted for filtering out particles in the size range of 0.01 to 100 microns in diameter. It should be understood that our air filter is not restricted in its ability to filter out particles in only this size range as will be explained in detail hereinafter.

Downstream of fan **11** and located within duct **10** is a means for electrically charging the particles in the air flow. As one example, the electrical charging means may consist of a planar array of spaced parallel conductors **12** extending across substantially the total cross section area within duct **10** and oriented preferably normal to the axis of the air flow. Conductors **12** are preferably of equal size in the range of 0.002 to 0.050 inch in diameter and are preferably equally spaced apart in the range of 0.25 to 2.0 inch. Conductors **12** may pass separately through a wall of duct **10** was shown in FIG. 2 and the ends thereof are connected to a D.C. high voltage source which has a voltage output in the order of 10 to 20 kilovolts. Alternatively, conductors **12** have their ends connected to a common bus within duct **10** adjacent a wall thereof, and the bus passes through the wall for interconnection to the D.C. source. In this latter arrangement of conductors **12**, the ends of the conductors could be retained in an electrically insulated frame member **12***a* positioned along the inner surfaces of duct **10** as depicted in FIG. 1. Conductors **12** may be oriented horizontally as shown in the side and top views of FIGS. **1** and **2**, respectively, or may be oriented vertically, or at other angles, as desired. Duct **10** may be fabricated of an electrically nonconductive material such as plastic, or alternatively, of a conductive material such as aluminum or other metal. In the latter case, electrical conductors **12** are suitably electrically insulated from the walls of duct **10** as indicated in the top view of FIG. **2**. The D.C. voltage applied to conductors **12** is sufficiently high to cause a corona discharge around each of the conductors which thereby electrically charges particles in the air flowing thereby.

Downstream of the electrical charge producing means **12** and angularly positioned within duct **10** adjacent the second end **10**b thereof is plurality of parallel planar arrays **13, 14, 15** of electrical conductors which comprise the basic aspects of our invention. Although only three planar arrays **13, 14, 15** are illustrated in FIGS. **1, 2** and **3**, it is to be understood that our invention includes any plurality of the planar arrays. These planar arrays of conductors are angularly positioned relative to the axis of the air flow in the duct and extend across substantially the total cross section area within duct **10**. The conductors in each planar array are spaced apart in parallel relationship and are angularly positioned relative to the axis of the air flow at the same angle as are the planar arrays. The angle of the planar arrays relative to the axis of the air flow is in the range between 20° and 85°, and preferably is in the high end of the range to minimize both the length of the conductors and the duct **10**. In the case of duct **10** having a square or rectangular cross section, there are an equal number of conductors in each of the planar arrays **13, 14, 15**, and such conductors are oriented parallel to opposite walls of the duct. Thus, as seen in the top view of FIG. **2**, parallel conductors **13***a–e* in planar array **13** are parallel to the side walls of duct **10**. In like manner, parallel conductors **14***a–e* and **15***a–e* are also parallel to such side walls. Obviously, the orientations of the planar arrays **13, 14, 15** could be rotated 90° such that the conductors are parallel to the top and bottom walls of duct **10**. The spacing between adjacent conductors in each planar array and the orientation of adjacent conductors in adjacent arrays as well as the electrical connections thereof is determined by the particular two-dimensional multipolar A.C. electrodynamic fields to be generated by the conductors. Thus, in the case of the FIGS. **2** and **3** embodiment, wherein FIG. **3** is a schematic representation of the three planar arrays **13, 14, 15** depicted in FIG. **2**, the conductors **13***a–e*, **14***a–e*, **15***a–e*, are adapted for generating two-dimensional quadrupole A.C. electrodynamic fields across duct **10**, the conductors being equally spaced in each planar array and aligned with corresponding conductors in adjacent arrays. The spacing between adjacent planar arrays is equal to the spacing between adjacent conductors in each array such that the conductors form the corners of equidimensioned squares.

Each planar array (**13, 14, 15**) of conductors contains at least two parallel conductors which are connected to opposite sides of an A.C. voltage source **20**. In the general case wherein each planar array contains more than two conductors, the alternate (every second) conductors are connected to the same side of the A.C. supply **20** such that adjacent conductors are connected to voltages of opposite polarity. The conductors in adjacent planar arrays are connected in an opposite polarity sense such that a first pair of diametrically opposed conductors in each group of four conductors forming the corners of a square are at one voltage polarity and the second pair at the other polarity at any single instant of time. Thus, in the FIG. 3 embodiment, the aligned conductors **13***a*, **15***a* and **13***b*, **15***b* — and **13***e*, **15***e* in alternate planar arrays **13, 15** are connected in the same manner to A.C. source **20**, whereas the conductors in array **14** also aligned with the above conductors are connected in an opposite polarity sense in order to generate the quadrupole A.C. electrodynamic fields in each group of four associated conductors.

The conductors in the planar arrays are preferably each of equal diameter which may be in a range up to ⅜ inch and the center-to-center spacing between adjacent conductors in one planar array (and adjacent aligned conductors in adjacent planar arrays) is in a range of up to 1 inch. In general, the spacing between conductors is preferably considerably greater than the conductor diameter in order to present a relatively open space between conductors to minimize the air flow impedance. As in the case of conductors **12**, the conductors in the planar arrays are supported and electrically insulated from the walls of duct **10** in the case wherein such duct is fabricated of an electrically conductive material. Again, as in the case of conductors **12**, the conductors in the planar arrays may pass separately through a wall of duct **10** and the ends thereof are connected to two common conductors connected to the A.C. supply **20** or the conductor ends may be retained in an electrically insulated frame member positioned along the inner surface of duct **10** and connected to common buses which pass through one or two opposite walls for interconnection to the A.C. source.

The quadrupole A.C. electrodynamic fields generated by the conductors in planar arrays **13, 14, 15** generate electrical forces which trap particles in the air flowing thereby. That is, in the absence of a sufficient air flow rate, the particles would remain suspended in the quadrupole fields against the force of gravity. The size of the trapped particles for a given set of parameters are not limited to a narrow range but may cover as much as 5 magnitudes in diameter size. Thus, in the case of the conductors being of ⅛ inch diameter and ⅝ inch center-to-spacing, and A.C. supply voltage of 15 kilovolts (R.M.S.) at 60 Hertz frequency, the quadrupole fields are capable of trapping particles in the size range of 0.01 to 100 microns in diameter.

The electrical forces generated by the multipolar A.C. electrodynamic fields can be increased and the particle trapping enhanced by increasing the amplitude of the A.C. voltage applied to the conductors. However, there is a limit to which the voltage can be increased for a particular spacing of bare conductors before breakdown occurs between adjacent conductors. We have found that operation at higher voltages without breakdown is achieved by coating the conductors with a high dielectric strength material such as a plastic or silicone. The coating thickness may be in the order of one millimeter or less permits an increase in the voltage in the order of 50 percent or to the point where a continuous corona discharge occurs around the conductors. The coating **24** is specifically illustrated in FIGS. 3–5. Operation at the increased voltage increases the efficiency of trapping of the particles in a given particle size range as well as causing the trapping of larger size particles. Also, operation at a sufficiently high A.C. voltage to produce corona discharge will cause uncharged particles in the air flow to become charged and therefore obviates the need for the conductors **12** and their associated D.C. voltage supply. For this purpose, the A.C. voltage applied to the conductors is made adjustable by any suitable means and is indicated in FIG. 1 by a variable transformer **21** connected across the A.C. source **20.** We have also found that varying the spacing between adjacent conductors will vary the size of particles that can be trapped, and in particular, an increase in the spacing will result in the trapping of smaller size particles.

The combination of the electrical forces generated by the multipolar fields which trap the particles, and the orientation of the air flow (of sufficient flow rate) relative to the angular position of the conductors causes the particles to be directed to the side of the duct wherein the conductors exit through duct **10** at the downstream side exit. For this purpose, a means is provided in the wall of duct **10** in which the downstream end of the conductors are supported for collecting particles directed therein. This collecting means may be chamber **22,** as one example, formed in the bottom wall of duct **10** and having a hinged bottom wall **22*a*** to which is attached a handle **23** that is operated, when desired, for emptying chamber **22** of the collected particles. The side walls of chamber **22** may conveniently provide the exit for the conductors **13*a–e*, 14*a–e*, 15*a–e*** as illustrated in FIG. 1. Other suitable means for collecting the particles would be the use of a chamber **22** having an open end associated with a suitable bag or other collecting means into which the particles are directed.

FIG. 4 illustrates a second orientation of conductors for generating hexapole A.C. electrodynamic fields. In this embodiment, the coated or uncoated conductors in alternate planar arrays have identical orientation such that they are in alignment. The conductors in the odd numbered planar arrays (**13, 15, 17**) include at least one pair of closely spaced conductors (**13*a*, *b*** — and **17*a*, *b***) whereas the even numbered arrays (**14, 16, 18**) include at least one pair of widely spaced conductors (**14*a*, *b* — 18*a*, *b***) to form the corners of the hexagons. Alternate conductors in each array and aligned conductors in the several parallel arrays are connected to the same side of the A.C. supply **20** as in the manner of FIG. 3. Thus, conductors **13*a*, *c*** and **14*b*, *d*** and **15*a*, *c*** and **16*b*, *d*** and **17*a*, *c*** and **18*b*, *d*** are connected to the left side of the power supply **20** as illustrated in FIG. 4 which is assumed to be momentarily at a positive polarity voltage whereas the other conductors **13*b* — 18*c*** are at such moment supplied with a negative polarity voltage. Three planar arrays of the conductors are obviously needed to complete the six corners of any one hexagon. Hexagons formed by the various three pairs of conductors each have equal length sides and equal angles due to the orientation of such conductors. FIG. 4 illustrates each planar array as including two pairs of conductors, it being understood that each array may contain a greater number of such pairs depending upon the cross-sectional dimension of the duct. As in the case of the FIG. 3 embodiment, the use of coating **24** or the conductors permits higher voltage operation which increases the efficiency of particle trapping, and at a sufficiently high voltage to produce corona discharge it obviates the need for the additional particle charging means including conductors **12** and the D.C. voltage supply.

FIG. 5 illustrates a second embodiment of orientation of conductors for generating hexapole A.C. electrodynamic fields, and in particular, an orientation adapted for operation with three phase A.C. voltage. The conductors **13*a–d*, 14*a–d*, 18*a–d*** are each preferably coated with the high dielectric strength material described with reference to FIG. 3, and alternate conductors in each array are connected to the same A.C. phase, similar to FIG. 4. However, additional bare conductors are added in the center of each hexagon formed by the aforementioned coated conductors, and such bare conductors are connected to the third A.C. phase. Thus, as shown in FIG. 5, bare conductor **13*e*** in planar array **13** is oriented parallel to conductors **13*a–d*** (as well as all the other conductors) is located midway between coated conductors **13*b*** and **13*c*** and is connected to the third phase (3) of the 3 phase A.C. supply **20.** In like manner, bare conductors **14*e*** and **14*f*** in planar array **14** are oriented parallel to the other conductors, located midway between coated conductors **14*a*, 14*b*** and **14*c*, 14*d***, respectively, and connected to the third phase A.C. line. The FIG. 5 embodiment is operated at an A.C. voltage sufficiently high to cause corona discharge around the bare conductors **13*e*, 14*e*, 14*f* — 18*e*, 18*f*** which thereby charges the particles in the air flow and obviates the need for conductors **12** and their associated D.C. high voltage source. Thus, FIG. 5 illustrates a second simplified embodiment wherein the upstream particle charging means 12 is eliminated.

A third embodiment of the multipolar A.C. electrodynamic fields which are suitable for use in our air filter is illustrated in FIG. 6 wherein the coated or uncoated conductors are oriented in the manner of the conductors in FIG. 4 but the spacings between each successive pair of planar arrays of the conductors is considerably greater than the spacings in FIG. 4. In particular, the FIG. 6 embodiment includes an orientation and spacing of conductors wherein the multipolar A.C. electrodynamic fields are generated by only two of the three planar arrays forming each multipolar field in the FIG. 4 embodiment. Thus, a first planar array 13 contains widely spaced conductors *13a* and *13b* and a second planar array 14 positioned parallel and close to array 13 contains closely spaced conductors *14a* and *14b* similar to the conductors in the FIG. 4 embodiment. However, distinct from FIG. 4, the next group of two parallel planar arrays 15, 16 of conductors are widely spaced from the first group, and in the second group conductors *15a* and *15b* are aligned with conductors *13a* and *13b*, respectively, whereas conductors *16a* and *16b* are aligned with conductors *14a* and *14b*, respectively. The spacing between planar arrays 14 and 15 is at least 3 times the spacing between adjacent conductors *13a* and *14 a*. Although the various aligned conductors such as *13a*, *15a*, *17a* are shown connected to opposite sides of the A.C. power supply, this is not a limitation since the wide spacing between adjacent pairs of planar arrays of conductors reduces any interaction of the electric fields to a negligible amount.

FIG. 6 indicates that the electrical conductors may be arranged in many patterns in order to generate multipolar A.C. electrodynamic fields of any desired order. Thus, for example, octopolar and higher order A.C. electrodynamic fields may readily be obtained by proper orientation of the conductors.

The multipolar A.C. electrodynamic fields generated by the conductors in each of the disclosed embodiments are of the two-dimensional type and the A.C. voltage applied to such conductors is in the range of 0.5 to 50 kilovolts for most applications with an operating voltage of about 10 kilovolts being typical for many applications.

From the foregoing description, it can be appreciated that our invention makes available an improved home appliance air filter which is especially well adapted as an adjunct to a room air conditioner for removing particles in the size range not generally removed by the passive type filters utilized in the air conditioner device. It should be understood that the room air conditioner mentioned herein is not limited to the window mounted cooling type device but is meant to include the pure fan type device as well as the conventional home heating and cooling systems, especially hot air systems. Finally, our invention may also be used as an adjunct to appliances such as stoves for removing odors and to room electric heaters, as further examples of utility. Our air filter operates on the principle of trapping particles in an air flow in multipolar A.C. electrodynamic fields generated by planar arrays of high dielectric strength material coated conductors connected to an A.C. source. The trapped particles are directed to the side of the duct containing the elements of the air filter due to the angular position of the planar arrays relative to the axis of the air flow. Having described four particular embodiments of our invention, it is obvious that multipolar A.C. electrodynamic fields of other order than that illustrated may also be utilized to obtain the particle trapping effect and therefore it is to be understood that changes may be made in the particular embodiments as described which are within the full intended scope of the invention as defined by the following claims.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. An air filter utilizing space trapping of charged particles and comprising
   - a duct having a first end for the admission of an air flow thereto and a second end for the exit of the air flow therefrom,
   - means adjacent the first end of said duct for producing the flow of air which may contain particles especially in the size range of 0.01 to 100 microns in diameter,
   - means downstream of said air flow producing means and located in said duct for electrically charging the particles in the air flow, and
   - parallel planar means downstream of said air flow producing means and angularly positioned relative to the axis of the air flow for generating two-dimensional multipolar alternating current electrodynamic fields across said duct, the electrical forces generated by the multipolar fields trapping the charged particles, the orientation of the air flow relative to the angular position of said parallel planar means causing the trapped particles to be directed to a side of the duct which supports said parallel planar means.

2. The air filter set forth in claim 1 and further comprising means in communication with the side of said duct to which the particles are directed for removing the particles from said duct whereby the air flow exiting from the second end of said duct has a significantly smaller amount of the particles as compared to the air flow admitted to the first end.

3. The air filter set forth in claim 2 wherein
   said parallel planar means consists of a plurality of parallel planar arrays of electrical conductors connected to a source of alternating current voltage.

4. The air filter set forth in claim 3 wherein
   said electrical conductors are oriented in substantially parallel relationship with respect to each other, and at the same angle relative to the axis of the air flow as are the parallel planar arrays.

5. The air filter set forth in claim 4 wherein
   alternate of said electrical conductors in each planar array are connected to the same side of the source of alternating current voltage to thereby establish the multipolar alternating current electrodynamic fields, the particular order of multipolar fields generated being determined by the particular orientation of said conductors.

6. The air filter set forth in claim 4 wherein
   adjacent said electrical conductors in each planar array are connected to opposite sides of the source of alternating current voltage to thereby establish the multipolar alternating current electrodynamic fields, the particular order of multipolar fields generated being determined by the particular orientation of said conductors.

7. The air filter set forth in claim 6 wherein

the conductors in each planar array are equally spaced apart and aligned with corresponding conductors in adjacent planar arrays, the spacing between adjacent planar arrays being equal to the spacing between conductors in each planar array whereby the multipolar alternating current electrodynamic fields are of the quadrupole type.

8. The air filter set forth in claim **6** wherein the conductors in alternate planar arrays being in alignment, conductors in first of the alternate arrays including at least one pair of closely spaced conductors and the second of the alternate arrays including at least one pair of widely spaced conductors whereby the multipolar alternating current electrodynamic fields are of the hexapole type.

9. The air filter set forth in claim **6** wherein the electrical conductors are coated with a high dielectric strength material thereby permitting application of higher alternating current voltage to said electrical conductors and resulting in increased efficiency of trapping of the particles.

10. The air filter set forth in claim **5** wherein the electrical conductors are coated with a high dielectric strength material thereby permitting application of a sufficiently high alternating current voltage to said electrical conductors to cause corona discharge and result in the electrical charging of the particles whereby said particle electrical charging means is integrated with said parallel planar means.

11. The air filter set forth in claim **4** wherein said electrical conductors are straight in the region traversing said duct.

12. The air filter set forth in claim **11** wherein the spacing between adjacent electrical conductors is in the range up to 1 inch.

13. The air filter set forth in claim **11** wherein the electrical conductors are each of equal diameter.

14. The air filter set forth in claim **13** wherein the diameter of said electrical conductors is in the range up to ⅜ inch.

15. The air filter set forth in claim **4** wherein the alternating current voltage applied to said electrical conductors is in the range of 0.5 to 50 kilovolts.

16. The air filter set forth in claim **15** wherein the alternating current voltage applied to said electrical conductors is approximately 10 kilovolts.

17. The air filter set forth in claim **5** wherein the alternating current voltage source is an adjustable voltage source, an increase in the voltage applied to said electrical conductors resulting in larger size particles being trapped and directed to the side of the duct.

18. The air filter set forth in claim **2** wherein said particle removing means is a chamber formed in the side of said duct into which the particles are directed.

19. The air filter set forth in claim **4** wherein said plurality of electrical conductors are arranged in at least two parallel planar arrays, each planar array including at least two electrical conductors.

20. The air filter set forth in claim **19** wherein the planar arrays of electrical conductors are angularly positioned relative to the axis of the air flow forming an angle in the range of 20° to 85°.

21. The air filter set forth in claim **1** wherein said particle electrical charging means comprises a second plurality of electrical conductors disposed across said duct upstream of said parallel planar means and connected to a direct current high voltage source for producing a corona discharge around the latter electrical conductors which charges the particles as they flow thereby.

22. The air filter set forth in claim **8** and further comprising said electrical conductors being coated with a high dielectric strength material, and the planar arrays of coated electrical conductors further comprising a bare electrical conductor located in parallel relationship midway between each pair of widely spaced conductors thereby permitting application of a sufficiently high alternating current three phase voltage to said coated and bare electrical conductors to cause corona discharge around the bar conductors and resulting in the electrical charging of the particles whereby said particle electrical charging means is integrated with said parallel planar means.

23. An air filter adapted as an adjunct to a room air conditioner or the like and comprising

a duct having an admission end for an air flow and an exit end,

means for electrically charging particles which may be in the air flow, and

a plurality of parallel planar arrays of electrical conductors positioned across said duct at an angle relative to the axis of the air flow in the range of 20° to 85°, the electrical conductors in each planar array alternately connected to opposite sides of an alternating current voltage source for generating two dimensional multipolar alternating current electrodynamic fields across the duct, the particular order of multipolar fields generated being determined by the particular orientation of the conductors, the electrical forces generated by the multipolar fields trapping the charged particles in the air flow in the duct, the orientation of the air flow relative to the angular position of the parallel planar arrays causing the charged particles to be directed to a side of the duct for subsequent removal therefrom.

24. The air filter set forth in claim **23** wherein the admission end of said duct is connected to the output of a room air conditioner or the like, and the electrical conductors coated with a high dielectric strength material thereby permitting application of higher alternating current voltage to said electrical conductors without causing breakdown between adjacent conductors and resulting in increased efficiency of particle trapping.

25. The air filter set forth in claim **23** wherein the admission end of said duct is connected to the output of a room air conditioner or the like, and said particle electrical charging means consists of a high dielectric strength material coating on said electrical conductors thereby permitting application of a sufficiently high alternating current voltage to cause corona discharge around said conductors which charges the particles.

26. The air filter set forth in claim **23** wherein the admission end of said duct is connected to the output of a room air conditioner or the like, a fraction of said electrical conductors are coated with a high dielectric strength material thereby permitting application of higher alternating current voltage to all of said conductors and resulting in increased efficiency of particle trapping, and

said particle electrical charging means consists of the remaining fraction of conductors which are bare, the application of the higher alternating current voltage to the bare conductors corona discharge therearound which charges the particles.

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