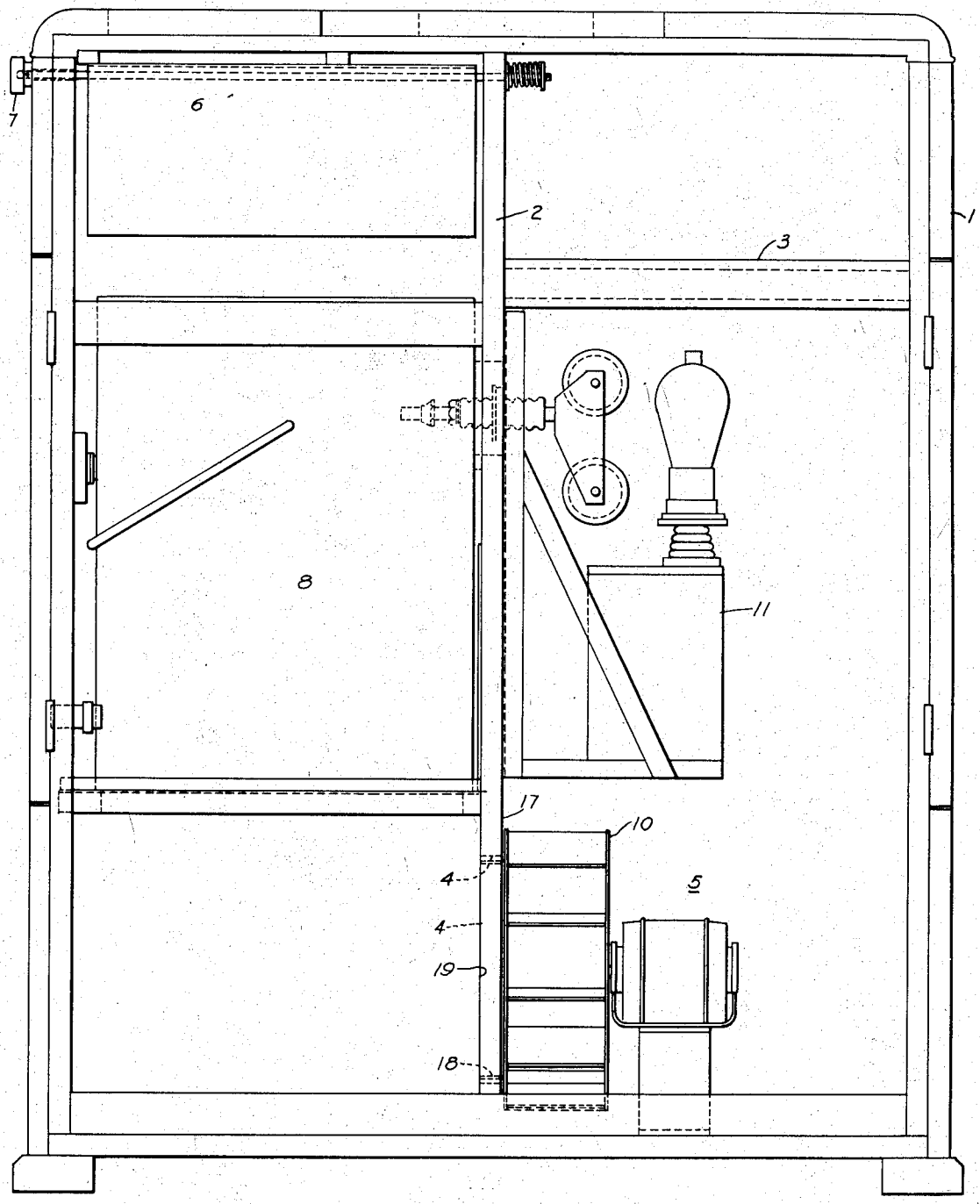
Sept. 10, 1940. R. L. HILDEBRAND 2,214,585

SELF-CONTAINED ELECTROSTATIC AIR CLEANER

Filed April 15, 1938 2 Sheets-Sheet 1

Fig. 1.



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Fig. 2.

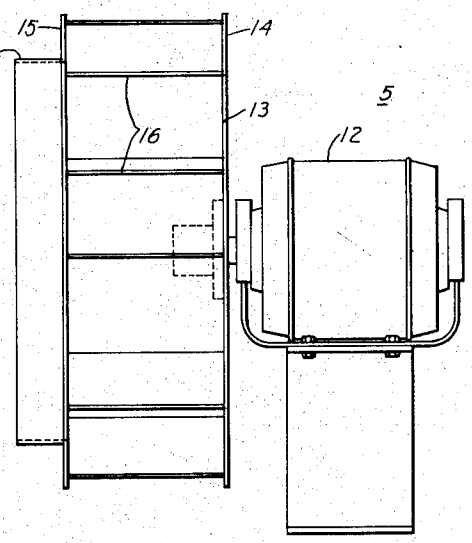


Fig. 3.

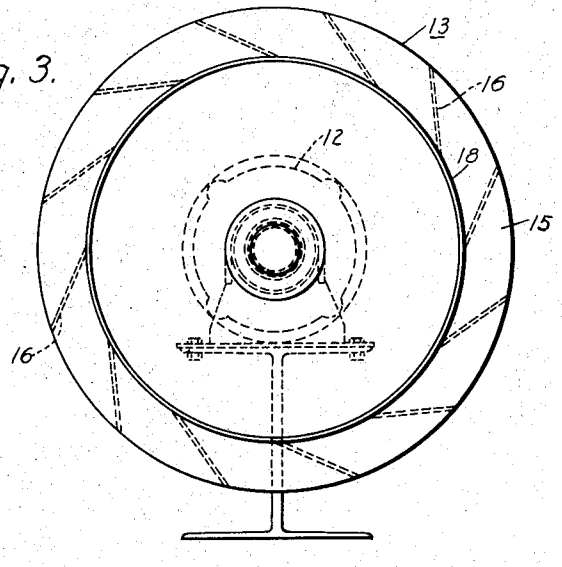
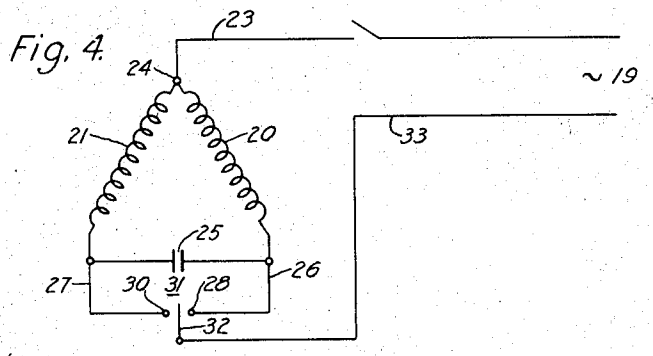


Fig. 4.



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UNITED STATES PATENT OFFICE

2,214,585

SELF-CONTAINED ELECTROSTATIC AIR CLEANER

Ralph L. Hildebrand, Pittsburgh, Pa., assignor to Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., a corporation of Pennsylvania

Application April 15, 1938, Serial No. 202,233

5 Claims. (Cl. 183—7)

This invention relates generally to a fan unit comprising an air blower or propeller and driving means therefor and which finds special application in portable and semi-portable air-conditioning units with many attendant advantages.

In a unit of this character, and particularly household room units, air is drawn in an air inlet opening in the unit and exhausted through an outlet opening, usually by means of a fan. In the course of this journey, the air is conditioned in accordance with the particular characteristics of the unit which may be, as in the instant disclosure, an air cleaner unit that removes foreign particles, such as dust.

In household units and the like, it is sometimes desirable to have two different rates of air flow through the unit, one for general use and the other for special or exceptional use. Thus, for example, if the unit is an air cleaner or an electrical precipitator, a low rate of air flow may be sufficient for most purposes, but when a large number of persons congregate a higher rate may be desired. Or again, one rate may be desired when the air being cleaned is recirculated, that is, air which has previously passed through the cleaner and is drawn back into the cleaner from the room, and the second rate may be preferred when the air being cleaned is substantially all fresh air.

The common methods of controlling the air flow are by the use of dampers or the like in the air circulating system or by varying the speed of a common type single direction motor driving the fan blower propeller. Either scheme has objections which in the interests of economy and ease of control may be deemed serious. I propose to obtain two different rates of air flow by a means which I believe to be entirely new. Briefly, I employ a fan blower having two different outputs depending upon its direction of rotation, and by driving the propeller by a reversible motor controlled by a single switch, a selection of the two rates can be easily and readily obtained. Inasmuch as most households have single-phase service, the choice of the more common types of motors is extremely limited for reasons of economy. However, by utilizing a capacitor run motor and by connecting the capacitance to the one or the other windings or circuits thereof, I provide a motor adaptable to my purpose. In fact, many of the characteristics of the capacitor motor harmonize so completely with the characteristics of the fan blower I have chosen that an ideal combination for the purpose is obtained having many advantages.

One advantage of my combination fan unit is the tendency to yield a constant volume of air flow through the unit for a given rotation of the same. As is well known, a centrifugal blower of a squirrel-cage type with angular or curved blades has a tendency to reduce its volume of discharge with an increase of air resistance, and this, of course, lightens the load on the motor. However, the capacitor motor on the other hand has a tendency to increase its speed with the reduction of its load particularly when the rotor is a high resistance rotor. This lightened load on the motor will, therefore, tend to increase the speed of rotation of the motor and fan, bringing the volume up again so that the overall combination is one that seeks to maintain a constant volume of air flow.

A second advantage that I obtain is the ease with which I can reverse the direction of rotation. By connecting the elements of the capacitor motor to the single-phase supply line, I can with only a simple switch select the direction in which the motor and fan is to rotate, and, if desired, I can also incorporate into the switch a position which will render the motor and fan inactive.

In the operation of an electric precipitator designed for household use, noise must be minimized in order for the unit to be commercially acceptable, and it is a further feature of my invention to so associate the parts of such an air cleaning device that quiet operation results. Moreover, the parts are associated so that dust is not deposited on them except, of course, in the cell where it is desired to collect the dust. Thus the interior of the unit is maintained clean even with long continued use.

It is, of course, more or less essential for a household unit of the type being described to be quiet in its operation. To incorporate this quietness in my unit without sacrificing the above and other advantages of my invention, I add a shroud to the blower which follows the contour of the aperture in a wall of the unit comprising the inlet to the fan blower.

Further advantages and features of my invention will be apparent from the following description of an embodiment thereof, in the drawings of which:

Figure 1 is a view of an electrical precipitator with the back panel removed, and generally showing an internal assembly view of the main parts thereof;

Fig. 2 is a side view of my motor and fan;
Fig. 3 is an end view of the fan; and
Fig. 4 is a symbolic diagram showing the connections to a capacitor motor adapted to my invention.

Referring more specifically to Fig. 1, I have shown an air cleaner unit with the back thereof removed and which comprises a cabinet 1 divided by a partition 2 into two compartments. The right-hand compartment is further divided by a horizontal air filter 3. The partition 2 has a circular aperture 4 therein which serves as the means by which air may be drawn from the left-hand compartment and discharged into the right-hand compartment by a fan indicated in its entirety by the numeral 5.

Generally, an air cleaner of the type disclosed operates upon the following principles. Air may be drawn from an air inlet (not shown) in the top of the cabinet over the left-hand compartment, or air may be drawn from an inlet (not shown) at the back end of the cabinet at the upper portion of the left-hand compartment. A damper 6, whose position is controlled by a knob 7, determines which of these inlets is the source of supply for air to the unit. The inlet at the top of the unit is usually opened to the premises in which the cleaned air is discharged, while the inlet in the back of the unit may be adjacent an open window or a discharge for a conduit (not shown) leading to a fresh air supply. By means of the knob 7, I can control the position of the damper 6 which will give any relative ratio of fresh air and recirculated air that is desired to be passed through the unit. The air is drawn into the unit by the fan 5 through either or both of these inlets and passes into an ionizing and dust collecting cell 8, from whence it passes to the fan blower or propeller 10 and is forced upward through the right-hand compartment through the filter 3 and an outlet opening (not shown) in the top of the cabinet above the right-hand compartment. The filter 3 is primarily a protective device for preventing heavy foreign matter from falling into or being inserted into the electrical apparatus below it, and which includes the high-voltage power pack 11 for supplying the necessary high voltages to the cell 8.

The ionizing and collecting cell 8 may be constructed in any approved manner, as, for example, in accordance with the teachings of Patent No. 2,129,783, of G. W. Penney, granted September 13, 1938, and assigned to the Westinghouse Electric & Manufacturing Company.

It should be noted that the flow of the air through the unit is such that the air to be cleaned passes through the cleaning cell 8 almost immediately after being drawn into the cabinet. After this, only cleaned air envelops the rest of the parts of the precipitator unit such as, for example, the blower and the power pack rectifier means 11.

Referring more particularly to Figs. 2, 3 and 4, the fan 5 comprises a symmetrical, reversible capacitor motor 12 driving a centrifugal blower 13 similar in construction to a squirrel cage. This blower comprises an end plate 14 and an annular end ring 15 between which are secured blades 16. In assembling the fan in the unit, the ring 15 is juxtaposed as close as possible to the surface 17 of the partition 2, the aperture 4 of which is slightly greater than the internal diameter of the ring 15.

Extending from the ring 15 is a shroud 18 of a diameter very slightly less than the aperture 4 and extending substantially to the surface 19 of the partition 2. By this construction I introduce an exceptionally narrow path of high resistance around the outside of the blower from the intake to the discharge, and which substantially eliminates the turbulence of the air flowing into or around the blower and which I have found to be an annoying source of sound in household units of the character described.

The propeller may be constructed in any manner desired, but I have found that a very satisfactory blower can be made by casting the same in its entirety. It may be observed that the blades 16 are at an angle to a radius drawn to either end thereof. When this fan blower is rotated in one direction, that is, with the blades curved or extending backward, one volume of air is obtained, but when the propeller is rotated in a reverse direction at substantially the same speed, a second and lesser volume is obtained. Thus with the motor of the type described and the fan substantially as that shown, a volume of approximately 250 cubic feet per minute was discharged when the fan was run with the blades backwardly curved, and in the reverse direction of rotation a volume of 100 cubic feet per minute was obtained against the same air pressure restriction.

I provide a simple manner of controlling the rotation of the motor which is shown in Fig. 4. In this figure, the windings 20 and 21 are symbolic of the induction windings of the capacitor motor and are electrically spaced therein. This spacing, of course, is in accordance with the usual design principles and is preferably 90° although I do not desire to be limited thereto. Moreover, the number of turns and size of the wires of each of these windings may also be controlled for obtaining different motor characteristics in the different directions of rotation, as is well known in the art, but in the preferred embodiment the power delivered in either direction is substantially the same as is the speed of rotation although it is obvious that I may make the power greater in the direction for greatest output of the fan and lesser in the opposite direction.

One end of each winding and the power lead 23 are conductively connected together as represented by terminal 24. Across the other ends of the windings symbolically indicated at 20 and 21 is a condenser 25. Leads 26 and 27 conductively extend from the junction points of the two sides of the condenser to two poles 28 and 30 of a switch 31 having a movable blade or other circuit controlling means 32, the fixed terminal of which is connected to the other power lead 33.

If now the blade 32 is placed upon the terminal or pole 28, it is obvious that the winding 20 becomes the main winding and the winding 21 becomes the auxiliary winding, the two parallel circuits being firstly, the winding 20, and secondly, the winding 21 in series with condenser 25. By placing the switch blade 32 upon the terminal of pole 30, the winding 21 becomes the main winding, and the auxiliary circuit is comprised of the winding 20 and condenser 25 in series. If desired, the switch 31 may have a third position in which the power conductor 33 is disconnected from the motor and this is symbolically indicated by the vertical position of the circuit controlling member 32.

By varying the operating characteristics of the motor in the different directions of rotation, and by controlling the angle of the blades, any desired volume differential may be obtained at any

desired speed of rotation of the motor within, of course, the design limitations; and the selection is obtainable with my connections by simply throwing the switch from one pole to the other. No additional speed and direction controlling appurtenances are required, as would be necessary with other types of single phase motors adaptable for operation in the customary household supplied only with single-phase power Moreover after trying many variations I have found the operation of the described household precipitator unit to be exceptionally quiet, regardless of the direction of rotation of the motor, when the disk 15 and shroud 18 are close to the partition, and the shroud 18 extends substantially to the surface 19 of the partition.

While I have described my fan unit applied to an air cleaner essentially of the self-contained household type, it is apparent that I am not limited thereto. It is obvious that many changes may be made within the spirit and scope of the invention described. It is desired, therefore, that the appended claims be given the broadest construction consistent with their language and limited only by the prior art.

I claim as my invention:

1. In a device of the class described, a cabinet, a partition in said cabinet having a circular aperture near the bottom thereof, said partition creating two zones in said cabinet for the passage of air, a centrifugal blower, having annular disks and air-propelling blades therebetween, a shroud connected to the inner periphery of one of said disks, a motor mounted in one of said zones and having a shaft to which said blower is secured with the last said disk very close to one surface of said partition, and said shroud extending within said aperture, and terminating substantially at the other surface of said partition, said shroud being of external diameter slightly less than that of the said aperture whereby quiet operation results.

2. The structure of claim 1 wherein the motor is a reversible capacitor motor.

3. An electrical precipitator for household use comprising, a cabinet, a partition in said cabinet having a circular aperture near the bottom thereof, said partition creating two passage zones in said cabinet for the passage of air, said cabinet having an air intake opening at the top of one of said zones, and an air outlet opening at the top of the other of said zones, an electrical air-cleaning cell disposed in one of said zones intermediate said intake opening and said aperture, a centrifugal blower for drawing air into said one zone through said intake opening, through said cell, and finally discharging the air out through said outlet opening, said blower being disposed below said cell, said blower comprising annular discs and air-propelling blades therebetween, a shroud connected to the inner periphery of one of said discs, a motor mounted in one of said zones and having a shaft to which said blower is secured with the last said disc very close to one surface of said partition, and said shroud extending within said aperture, and terminating substantially at the other side of said partition, said shroud being of external diameter slightly less than that of the said aperture whereby quiet operation results.

4. An electrical precipitator for household use comprising, a cabinet, a partition in said cabinet having a circular aperture near the bottom thereof, said partition creating two passage zones in said cabinet for the passage of air, said cabinet having an air intake opening at the top of one of said zones, and an air outlet opening at the top of the other of said zones, an electrical air-cleaning cell disposed in one of said zones intermediate said intake opening and said aperture, a centrifugal blower for drawing air into said one zone through said intake opening, through said cell, and finally discharging the air out through said outlet opening, said blower being disposed below said cell, said blower comprising annular discs and air-propelling blades therebetween, a shroud connected to the inner periphery of one of said discs, a motor mounted in one of said zones and having a shaft to which said blower is secured with the last said disc very close to one surface of said partition, said shroud being of an external diameter slightly less than that of the portion of the surface of said partition which defines said aperture, whereby quiet operation of said precipitator results.

5. An electrical precipitator for household use comprising a cabinet, a partition in said cabinet having a circular aperture near the bottom thereof, said partition creating two passage zones in said cabinet for the passage of air, said cabinet having an air intake opening at the top of one of said zones, and an air outlet opening at the top of the other of said zones, an electrical air-cleaning cell disposed in one of said zones intermediate said intake opening and said aperture, a centrifugal blower for drawing air into said one zone through said intake opening, through said cell, and finally discharging the air out through said outlet opening, said blower being disposed below said cell, said blower comprising annular discs and air-propelling blades therebetween, a shroud connected to the inner periphery of one of said discs, a motor mounted in one of said zones and having a shaft to which said blower is secured with the last said disc very close to one surface of said partition, said shroud of an external diameter slightly less than that of the portion of the surface of said partition which defines said aperture, whereby quiet operation of said precipitator results, the said blades being disposed at an angle to the radii in the same plane from the center of said discs, whereby said blower delivers air at one rate when rotating in one direction, and at a different rate when rotating in the opposite direction, said motor being reversible.

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