

L. M. STIRLING

CONTRA-FLOW VENTILATING APPARATUS

2 Sheets-Sheet 1

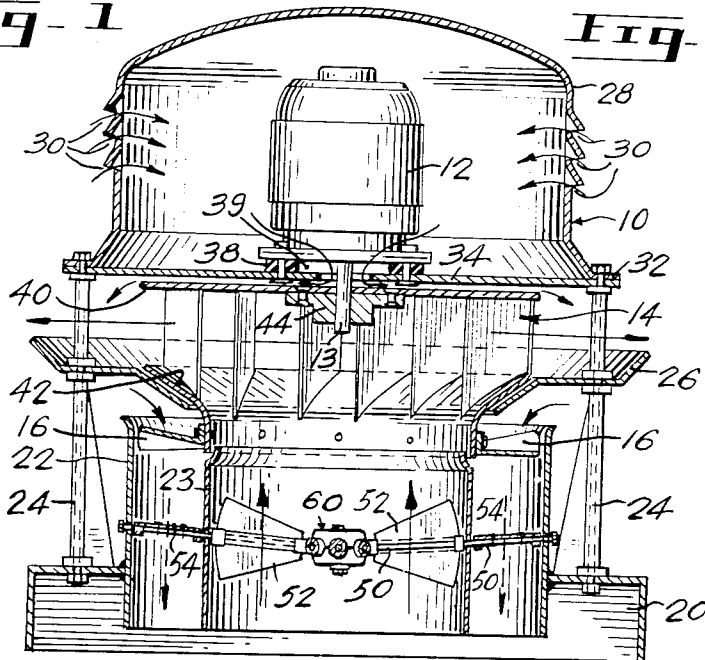


Fig. 3

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Aug. 10, 1965

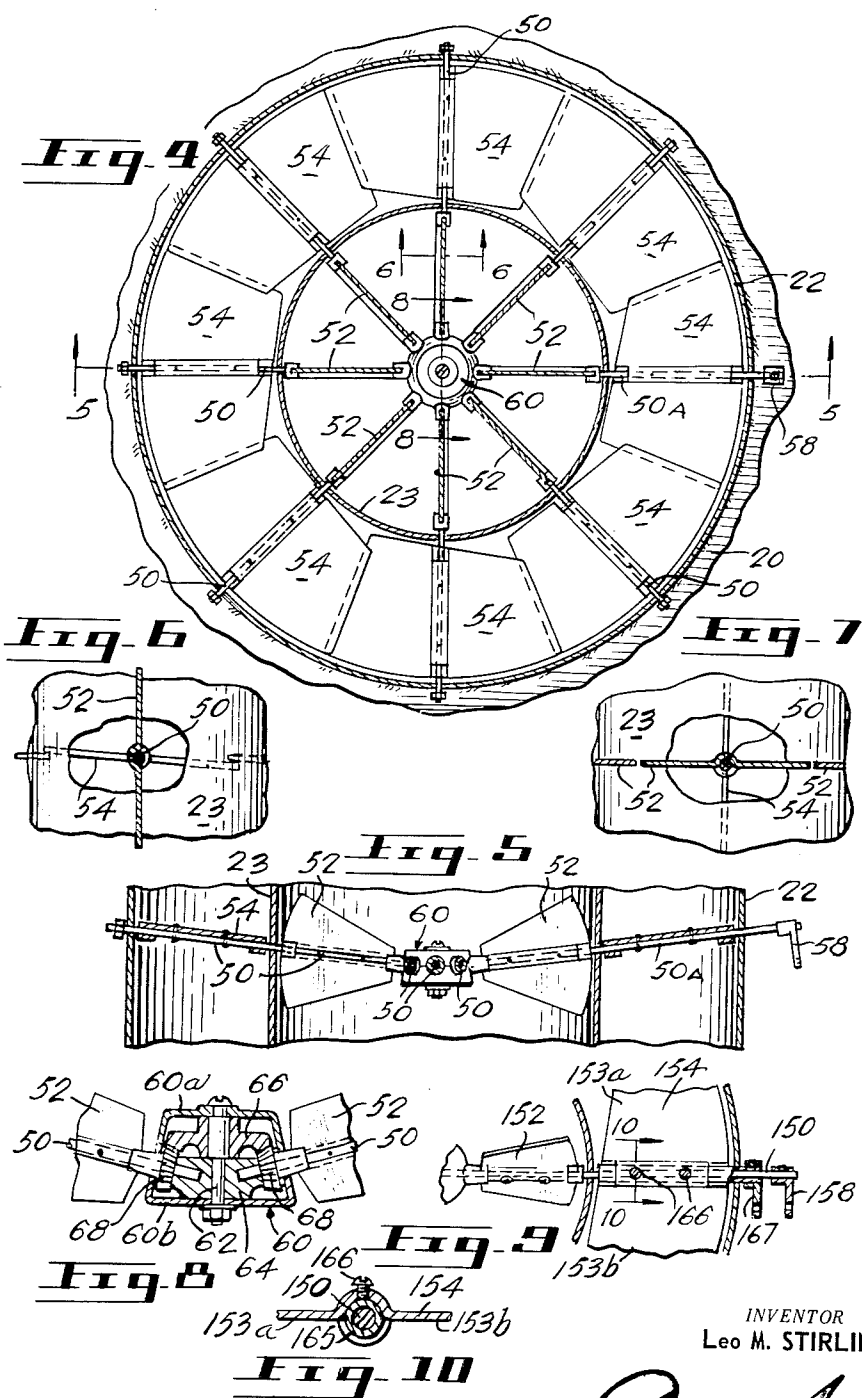
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3,199,773

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Filed Oct. 14, 1963

2 Sheets-Sheet 2



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3,199,773
CONTRA-FLOW VENTILATING APPARATUS
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 Filed Oct. 14, 1963, Ser. No. 315,967
 6 Claims. (Cl. 230-117)

The present invention relates to the manufacture of fans and more particularly to the manufacture of fans particularly suited for use in industrial air circulation, ventilating, air conditioning and heat transfer installations.

The type of fan which the present invention is concerned is that which provides contra-flow air currents in a single unit permitting the double function of exhausting and introducing air in a ventilating system. For example, this type of fan is illustrated and described in detail in the applicant's United States Patent 2,790,596, issued April 30, 1957. In this construction, means are provided in the form of a single fan assembly to create a parallel flow of air in opposite directions through the use of a first series of fan blades extending from a central hub with an annular rim surrounding the outer tips of the first blade set and serving as a hub for a second series of blades. The first and second series of blades are arranged concentrically and are disposed so as to be inclined in the same plane but in opposite directions.

The present invention aims to provide an improved construction of a ventilation fan of this type and for this purpose has designed a contra-flow fan arrangement which utilizes a direct drive to actuate a first bladed fan wheel to move the air in one direction and a second series of fan blades connected directly to the fan wheel and adapted to move the air in an opposite direction. The mounting and arrangement of these air moving elements is such that the overall dimensions, when compared with the earlier construction mentioned above, are considerably reduced while the capacity of the ventilating unit is at least equal to or increased over that of a comparable unit of the earlier type. In the present construction, the direct drive is applied along the axes of the fan units and the second series of fan blades is offset axially relative to the first fan wheel so that the external diameter of the combined fans is no greater than that of the fan wheel. This means that the internal ducting separating the air flows and the drive for the fans can be entirely contained within a cylindrical housing making a more compact assembly than was possible with the earlier construction.

A further feature of the present construction resides in the provision of a damper system which is also fully contained within the unit casing and which is constructed so that the flow of air in opposite directions can be controlled to provide a proportioned supply-exhaust air ratio as required. This is accomplished by mounting two sets of damper blades in concentric relationship within the inner and outer duct portions controlling the contra-flow of air of the fan blades and providing means whereby these damper blades can be rotated in a shutter like action to control the respective air flows. In one preferred construction, the movement of the inner and outer damper blades is linked so that by moving a controlling lever in one direction the inner damper blades will close and the outer damper blades will open an equivalent amount or vice versa. In an alternative arrangement, independent controls can be provided to each set of damper blades if so desired.

Having thus generally described the nature of the invention, particular reference will be made to the accompanying drawings, showing by way of illustration preferred embodiments thereof, and in which;

FIGURE 1 is a view in front elevation showing a direct drive dual air stream ventilator with controlled dampers in accordance with the invention.

FIGURE 2 is a view corresponding to FIGURE 1 with portions of the casing shown in section to illustrate the fan blading arrangements more clearly.

FIGURE 3 is an enlarged cross sectional view of the construction of FIGURES 1 and 2 to illustrate the air flow paths and damper blade control arrangement in more detail.

FIGURE 4 is an enlarged horizontal cross section of the construction shown in FIGURE 1 as seen along the line 4-4 of FIGURE 1.

FIGURE 5 is a cross sectional view of FIGURE 4 along the line 5-5 to illustrate the mounting of the damper blades in more detail.

FIGURE 6 is a sectional view of the construction of FIGURE 4 as seen along the line 6-6 to show the relative position of inner and outer damper blades with the outer blades in closed position.

FIGURE 7 is a sectional view corresponding to FIGURE 6 to illustrate the relative position of the damper blades with the inner blades in closed position.

FIGURE 8 is a sectional view of FIGURE 4 as seen along the line 8-8 to illustrate the gearing arrangement between the damper blades.

FIGURE 9 is a sectional view of a segment of the inner and outer damper blades as they would appear in an alternative arrangement permitting separate adjustment of inner and outer blades.

FIGURE 10 is a sectional view of the construction of FIGURE 9 along the line 10-10 to illustrate a preferred arrangement for connecting the outer blades for controlled movement independently from the inner blades.

With particular reference to FIGURES 1 and 2 of the drawings, a dual flow fan construction, in accordance with the invention, consists of a main casing and supporting frame 10 wherein there is mounted for a direct drive from a motor 12, a first fan wheel assembly 14 to which there is connected a second blade assembly 16, as shown most clearly in FIGURE 3. In this construction, the fan wheel 14 is bladed so as to draw the air upwardly through its centre portion and expel the air from about the periphery while the blades of the assembly 16 are inclined in a direction to move the air downwardly in the opposite direction. It will be appreciated that driving arrangements other than that shown could be utilized, for example, the motor 12 could be offset from the axis of the device and a belt drive could be utilized.

As shown, the casing 10 is made up of a base portion 20 of substantially annular formation with an exterior duct portion 22 fitting concentrically of the base 20 and being attached thereto by suitable welding or the like. A plurality of upright cylindrical standards or supporting rods 24 are mounted on the base 20 in circumferentially spaced relationship and these are utilized to support an annular air deflecting flange 26 and a casing top 28 of dome-like configuration. The casing top 28 is provided with a plurality of louvered openings 30 about its outer circumference and an outstanding annular flange 32 by means of which it is assembled to the casing supports 24. In the construction illustrated, a circular motor supporting plate 34 is provided and the motor 12 is mounted centrally of this plate on rubber mounts 38 providing an air space 39 beneath the motor. This air space 39 allows some of the air sucked into the casing top 28, through the drop in pressure created by the main exhaust flow created by the fan wheel 14, to flow under the motor during its circulation passage thus ventilating the motor. The air sucked into the casing top 28 also serves to cool and ventilate the motor and to prevent possible accumulation of exhausted gases within the casing top, for ex-

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ample exhausted gasses which might be explosive and, therefore, dangerous if permitted to accumulate in a motor containing enclosure.

The preferred fan wheel assembly 14 illustrated is of a type known to the trade as a "backwardly curved wheel" and the tapered blades or vanes are mounted between a flat backing plate 40 and an inwardly flaring annular collar 42. The second set of blades 16 are mounted in regular circumferentially spaced relationship about the lower portion of the annular collar 42 so as to be in concentric relationship with the wheel assembly 14 and offset axially by reason of the inward flare of the collar 42 so that the outer periphery of the blades 16 is substantially equal to the outer diameter of the wheel 14. The backing plate 40 is provided with a centrally located shaft attachment fitting 44 to which the shaft 13 of the motor 12 is secured so that in the construction shown the complete rotating assembly of wheel 14 and blades 16 are supported by and driven directly from the motor 12.

In order that the contra-flowing air currents are correctly directed, the lower inner portion of the deflecting flange 26 fits closely to, but does not contact, the annular collar 42 of the wheel assembly 14. As is shown most clearly in FIGURE 3, the blades of the assembly 16 are surrounded by the upper portion of the exterior duct portion 22. An inner duct portion 23 of cylindrical formation is supported concentrically within the exterior duct portion 22 by a plurality of damper supporting shafts 50, as will be described later in connection with the novel damper arrangement of the invention. The upper end of the inner duct 23 is reduced so as to provide clearance for the lower end of the annular collar 42 to which the blades 16 are mounted.

As shown in plan in FIGURE 4, the damper assembly of the present dual-flow ventilator of the invention is mounted concentrically of the casing 19 and is adapted to control the air flow passing through the inner 23 and outer 22 duct portions under the action of the fan wheel 14 and blade assembly 16. As previously mentioned, damper supporting shafts 50 extend radially inwards from the exterior of the duct portion 22 to adjacent the centre of the inner duct 23 and a first series of damper blades 52 are mounted on the shafts 50 to control the flow through the duct portion 23 and a second series of damper blades or vanes 54 are mounted on the shafts 50 to control the flow through the outer duct portion 22.

In the construction illustrated, the blades 52 are segment-shaped and dimensioned so that when rotated into duct blocking position the side portions of each blade are only slightly spaced from the side portions of the adjacent blades so as to almost completely block the flow of air. The blades or vanes 54 are not symmetrical and are dimensioned so that a portion of the side margins of each blade overlaps a corresponding portion of the adjacent blades to provide the maximum blockage and to prevent the blades 54 from being rotated beyond fully closed position. As is shown most clearly in FIGURE 5, for example, the inner ends of the shafts 50 are connected into a central hub and gear casing 60 which is in two parts 60a, 60b held together by a bolt 62 which also serves as the retaining means for a shaft end support 64 and an axis for a planetary type bevel gear 66. A bevel gear 68 is mounted on the end of each shaft 50 journaled in the support 64 and all of these gears 68 are in meshed engagement with the main gear 66. With this arrangement, rotation of any of the shafts 50, in the present construction the shaft 50a, causes a corresponding rotation of the remaining shafts on which the damper blades are mounted. For the purpose of providing a means connectable to an exterior control means either mechanical or electrical, the outer end of the shaft 50a is provided with an offset lever extension 58. In the preferred construction presently described, the blades 52 and the blades 54 are secured to the shaft 50 at substantially 90° to each other so that when one set of blades is set at full damping position, the other set is at full open

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position with any intermediate setting being the same. With this arrangement, any desired supply-exhaust air ratio can be obtained by movement of a single control.

In the event that it is desired to provide means for separate control of exhaust and/or supply with respect to the damping mechanism, the construction would be altered slightly in that the shafts 150 would extend radially inwards as before with the inner blades 152 secured to their respective shafts but the mounting of the blades 154 would be on tubular sleeves 165 which in turn would freely fit over the shafts 150. Each blade 154 would be shaped centrally to provide opposing semi-circular segments 153a, 153b which fit over the sleeve 165 and retained thereto by retaining screws 166, see FIGURES 9 and 10. The tubular sleeves 165 are of sufficient length to extend outwardly of the duct portion 22 and each sleeve end provided with an offset lever extension 167. In this construction, all the lever extensions 167 would be interconnected to a common control ring (not illustrated) so that rotary movement of the ring would cause a simultaneous and corresponding opening or closing movement of the blades 154 independently of the controlling movements of lever extensions 158 and the shafts 150 which would now act only on the blades 152.

In operation, the dual-flow ventilator of the invention would be mounted, say for example on the roof of a building with the base 20 securely mounted over a suitable opening. The inner and outer portions 23, 22 would be connected to suitable additional ducting leading to the portion of the building or apparatus within the building to be ventilated. When placed in operation by the starting of the motor 12, the flow of intake and exhaust air would follow opposed flow paths as indicated by the arrows in FIGURE 3, i.e. the main air supply or intake as induced by the blade assembly 16 would be drawn into the annular space 80 between the duct portions 22, 23 under the directing deflection of the lower flange of the member 26 which, with the inwardly conveying portion of the annular collar 42, also acts to baffle the supply flow from the exhaust flow passing upwardly through the inner duct portion 23. At the same time, a further supply of ventilating and cooling air is drawn in through the louvered openings 30 on the casing top portion 28 and is circulated about the motor 12 and exhausted into the main exhaust stream through a shaft accommodating opening 33 in the motor supporting plate 34.

The casing intake flow referred to is created by the drop in pressure within the casing top caused by the main exhaust discharge from the periphery of the fan wheel 14 emitting from between the motor supporting plate 34 and the annular deflecting member 26. The rotation of the fan wheel 14 draws the exhaust air up into the central portion of the wheel 14 and through the inner duct portion 23. As will be appreciated by reference to the preceding description and accompanying drawings, the diameters of the inner and outer ducts 23, 22 can be selected to give a substantially balanced supply-exhaust flow capacity and this in turn can be readily controlled by the damper arrangement of the invention to any desired intermediate supply-exhaust ratio. The simple compact design of the present dual-flow ventilator, embodying a direct drive eliminating any driving chains or belts, a minimum of casing elements to separate and guide the contra-flowing air streams, and the reduction in overall diameter and height of the present combined fan wheel and opposing fan blade assembly as well as the concentric double damper arrangement provides constructional and installation advantages not found in the prior art ventilator constructions of this general nature.

Further, as the present fan construction has no bearings or motor in the air stream, it can be used to exhaust highly corrosive gases or high temperature without any modifications. In such applications, dampers could be deleted as it is obvious that the whole unit could be supplied without air control damper if desirable. In this case, of course,

means other than the illustrated damper blade supporting shafts shown would be utilized to support the inner duct portion, for example, a fixed supporting spider could be utilized.

I claim:

1. A contra-flow ventilating fan assembly adapted for use in industrial air circulating systems comprising, a first fixed cylindrical air conducting outer casing of constant diameter, a second fixed cylindrical inner casing of lesser diameter than said outer casing mounted to and concentrically of said outer casing, said inner casing being of slightly lesser length than said outer casing and having one end disposed below the corresponding end of said outer casing, a contra-flow fan blade assembly mounted in axial alignment with and above said inner and outer casings, means to support said fan assembly, a flat top plate and an inwardly tapering bottom collar of annular formation, said fan assembly having a first fan wheel having fixed tapered fan blades extending radially inwards between said flat top plate and said inwardly tapering bottom collar of annular formation, and a second set of fan blades mounted at the roots to said fan wheel annular collar so as to extend radially outwards therefrom and being inclined whereby when rotated with said fan wheel to cause a movement of air in a direction opposite to that caused by said fan wheel blades, means supporting said inner cylindrical casing concentrically of and relative to said outer casing permitting free rotation of said second fan blade assembly within an annular space between said inner and outer casings, driving means including a driving motor partitioned from and mounted directly above said contra-flow fan assembly with a connection to said first fan wheel, a fixed annular air flow deflecting means surrounding said fan wheel and having a portion extending inwardly between the outer periphery of said fan wheel and the blades of said second blade assembly thereby being adapted to maintain separate the opposite air flows passing through said inner and outer casings under the influence of said first fan wheel and second blade assembly, and damper means located beneath said second blade assembly to control the said separate opposite air flows.

2. A contra-flow ventilating assembly as claimed in claim 1 wherein said damper means to control said separate opposite air flows comprises damper blades mounted within said inner and outer casings and means to control said damper blades.

3. A contra-flow ventilating fan assembly adapted for use in industrial air circulating systems comprising, a first fixed cylindrical air conducting outer casing of constant diameter, a second fixed cylindrical inner casing of lesser diameter than said outer casing mounted to and concentrically of said outer casing, said inner casing being of slightly lesser length than said outer casing and having one end disposed below the corresponding end of said outer casing, said inner casing end having a peripheral portion of reduced diameter, a contra-flow fan blade assembly mounted in axial alignment with and above said inner and outer casings, means to support said fan assembly, a flat top plate and an inwardly tapering bottom collar of annular formation, said fan assembly having a first fan wheel having fixed tapered fan blades extending radially inwards between said flat top plate and said inwardly tapering bottom collar of annular formation, and a second set of fan blades mounted at the roots to said fan wheel annular collar so as to extend radially outwards therefrom and being inclined whereby when rotated with said fan wheel to cause a movement of air in a direction opposite to that caused by said fan wheel blades, the outer diameter of said second fan blade assembly being substantially equal to the outer diameter of said first fan wheel and less than the inner diameter of said outer casing with the diameter of said

fan wheel annular collar at the point of said second fan blades attachment being slightly greater than the said reduced diameter portion of said inner casing permitting free rotation of said second fan blade assembly within an annular space between said inner and outer casings, driving means including a driving motor disposed above and connected to said first fan wheel, a fixed annular air flow deflecting means surrounding said fan wheel and having a portion extending inwardly between the outer periphery of said fan wheel and the blades of said second blade assembly thereby being adapted to maintain separate the opposite air flows passing through said inner and outer casings under the influence of said first fan wheel and second blade assembly, and means to control the said opposite air flows.

4. A contra-flow ventilating assembly as claimed in claim 3 wherein said means to control said opposite air flows comprises damper means within said inner and outer casings and means to control said damper means.

5. A contra-flow ventilating fan assembly adapted for use in industrial air circulating systems comprising, a first fixed cylindrical air conducting outer casing of constant diameter, a second fixed cylindrical inner casing of lesser diameter than said outer casing mounted to and concentrically of said outer casing, said inner casing being of slightly lesser length than said outer casing and having one end disposed below the corresponding end of said outer casing, said inner casing end having a peripheral portion of reduced diameter, a contra-flow fan blade assembly mounted in axial alignment with and above said inner and outer casings, means to support said fan assembly, a flat top plate and an inwardly tapering bottom collar of annular formation, said fan assembly having a first fan wheel having fixed tapered fan blades extending radially inwards between said flat top plate and said inwardly tapering bottom collar of annular formation, and a second set of fan blades mounted at the roots to said fan wheel annular collar so as to extend radially outwards therefrom and being inclined whereby when rotated with said fan wheel to cause a movement of air in a direction opposite to that caused by said fan wheel blades, the outer diameter of said second fan blade assembly being substantially equal to the outer diameter of said first fan wheel and less than the inner diameter of said outer casing with the diameter of said fan wheel annular collar at the point of said second fan blades attachment being slightly greater than the said reduced diameter portion of said inner casing permitting free rotation of said second fan blade assembly within an annular space between said inner and outer casings, a driving motor mounted above and in axial alignment with said fan blade assembly and having a driving shaft directly connected to said first fan wheel, a fixed annular air flow deflecting means surrounding said fan wheel and having a portion extending inwardly between the outer periphery of said fan wheel and the blades of said second blade assembly thereby being adapted to maintain separate the opposite air flows passing through said inner and outer casings under the influence of said first fan wheel and second blade assembly, and means to control the said opposite air flows.

6. A contra-flow ventilating fan assembly, comprising an annular base, spaced apart standards extending upwardly from said base in circumferentially spaced relationship, a first air conducting duct of cylindrical formation mounted concentrically of said base, a second air conducting duct of cylindrical formation and of lesser diameter than said first duct mounted concentrically within said first duct in spaced relation therewith, means to support said second duct within said first duct in said spaced relation, an air deflecting member of annular formation having opposed outwardly and inwardly sloping flanges mounted on said standards in spaced concentric relationship with said base and above the upper

ends of said first and second ducts, a motor mounting plate of circular outline mounted on said standards above and in spaced concentric relationship with said annular air deflecting member, a driving motor mounted centrally of said motor supporting plate and having a driven shaft extending through an axial opening in said motor supporting plate, a fan wheel having fixed tapering fan blades extending between a flat top plate and an inwardly tapering bottom annular collar, said fan wheel top plate being connected directly to said motor shaft extending concentrically from said motor mounting blade with said blades adapted to cause a movement of air from the axes of said fan blade assembly to the periphery in one direction, a further plurality of fan blades mounted at the roots to said fan wheel annular collar so as to extend radially outwards therefrom and being inclined when rotated with said fan wheel to cause a movement of air in a direction opposite to that created by said fan wheel, the outer diameter of said second fan blade assembly

being less than the inner diameter of said first air-conducting duct with the diameter of said fan wheel annular collar at the point of said blade attachment being slightly greater than a reduced upper portion of said second duct permitting free rotation of said second fan blade assembly within the annular space between said first and second ducts.

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