Aug. 4, 1964 S. H. DOWNS **3,143,283**

FAN EQUIPMENT

Filed July 27, 1961 2 Sheets-Sheet 1

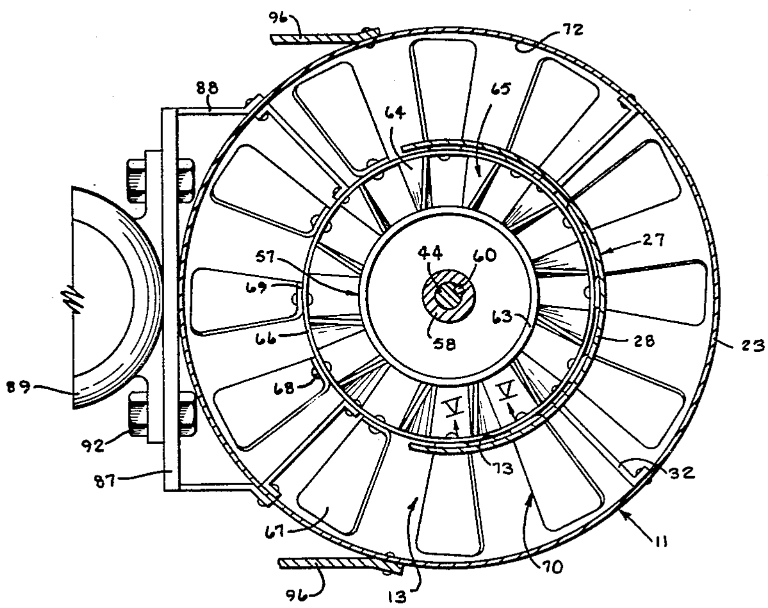

Fig. 4

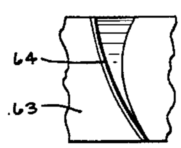

Fig. 5

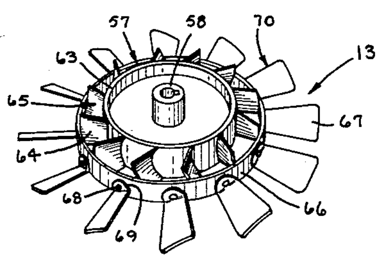

Fig. 6

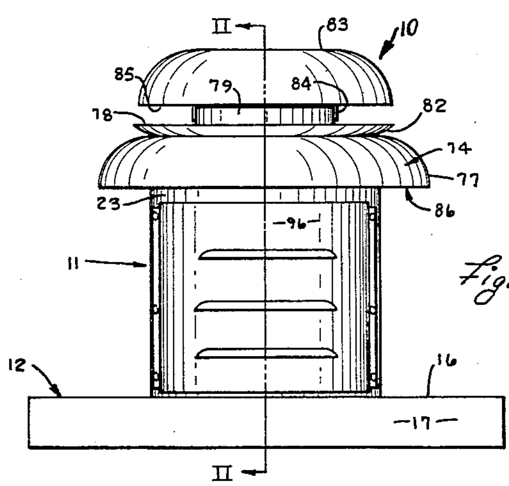

Fig. 1

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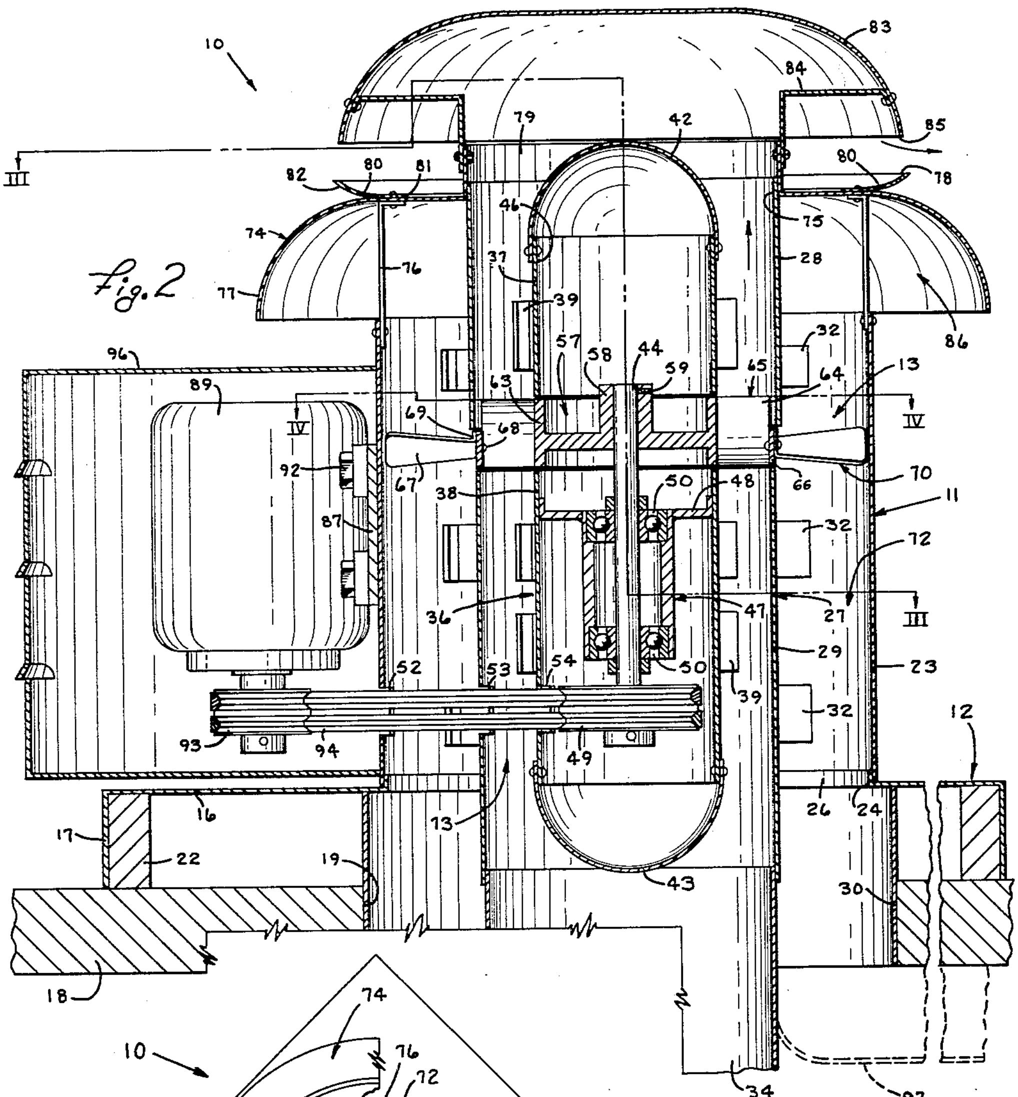

Fig. 2

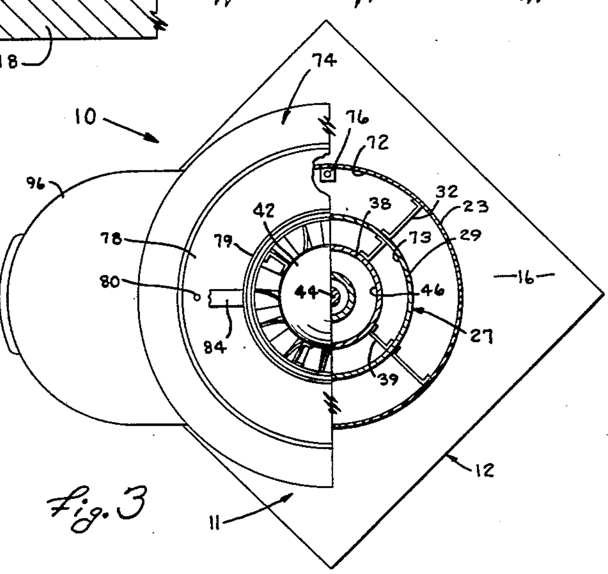

Fig. 3

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FAN EQUIPMENT

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This invention relates in general to an axial flow fan construction and, more particularly, to a type thereof including a housing construction defining concentric, annular passageways and an axial flow impeller having two sets of blades, one set being disposed within the innermost passageway and the other set being disposed within the outermost passageway, said blades being arranged to effect axial flow of gas through said annular passageways in opposite axial directions.

Gas-moving, such as ventilating, apparatus having a dual impeller capable of simultaneously moving gas or air in opposite directions along adjacent paths is well known in the art. For example, Stirling Patent No. 2,790,596 discloses a "dual fan construction" which is representative of the prior art. However, there are several very important differences between the dual fan constructions of the prior art and the applicant's improved structure, such differences being closely related to, or having evolved from, the fact that the efficiency of air flow is seriously and adversely affected by the presence in said air flow of any structure which tends to crease turbulence. It is well known that axial flow fans, particularly of the propeller type, are not normally able to develop total pressures which are as great as those developed by centrifugal fans of an equivalent diameter. Moreover, axial flow fans are usually operated at relatively high tip speeds where losses resulting from turbulence are usually magnified. Thus, if turbulence can be reduced in an axial flow fan unit, then a greater pressure head is available for useful work, such as drawing or forcing air through ducts connected to the fan unit. It is also recognized that the shape and arrangement of the blades in an axial flow fan can materially affect its performance.

Accordingly, a primary object of this invention has been the provision of an improved, dual fan construction having wall structure defining a pair of coaxial, annular passageways which are carefully designed to minimize resistance to the axial flow of gas or air (hence turbulence) through said passageways in respectively opposite axial directions.

A further object of this invention has been the provision of a dual fan construction, as aforesaid, including a single, axial flow impeller having two sets of axial flow blades arranged in two concentric circles, the outer blades being disposed within the outer annular passageway and the inner blades being disposed within the inner annular passageway for effecting movement of air through said passageways simultaneously in opposite axial directions when said impeller is rotated in one rotational direction.

A further object of this invention has been the provision of a dual fan construction, as aforesaid, which is completely weatherproof when mounted for normal use as a ventilator, which is provided with baffles whereby the exhaust air discharged by said impeller is directed away from the zone from which fresh air is being drawn into the fan construction by said impeller.

A further object of this invention has been the provision of a dual fan construction, as aforesaid, which is pleasing in appearance, which is compact, which can be used in an axially horizontal or an axially vertical position substantially interchangeable, which is very simple to install and which requires a minimum of maintenance.

Other objects and purposes of the invention, particularly where other uses are involved, will be apparent to

persons familiar with this type of equipment upon reading the following descriptive material and examining the accompanying drawings, in which:

FIGURE 1 is a side elevational view of a dual fan construction embodying the invention.

FIGURE 2 is a sectional view taken along the line II—II in FIGURE 1.

FIGURE 3 is a sectional view taken along the line III—III in FIGURE 2.

FIGURE 4 is a sectional view taken along the line IV—IV in FIGURE 2.

FIGURE 5 is a sectional view substantially as taken along the line V—V in FIGURE 4.

FIGURE 6 is an oblique view of said impeller.

For convenience in description, the terms "upper," "lower" and words of similar import will have reference to the dual fan construction of the invention, as shown in FIGURES 1 and 2, which illustrate its normal position of operation when used as a roof ventilator. However, it will be recognized that such reference would not be applicable where the fan construction is mounted, for example, upon a side wall. The terms "inner," "outer" and derivatives thereof will have reference to the central rotational axis of the impeller, hence, the central common axis of the wall members in which said impeller is supported.

General Description

The objects and purposes of the invention, including those set forth above, have been met by providing a fan housing including three coaxial and substantially cylindrical wall structures arranged in radially spaced and radially aligned positions to define inner and outer, concentric and annular passageways through which gas, such as air, can be moved in opposite axial directions by a dual, axial flow impeller mounted within said housing. The impeller has two concentric sets of blades respectively disposed within the inner and outer passageways of the housing for simultaneously effecting said air flow in opposite axial directions. The impeller is supported by a shaft and bearing structure which is disposed within the zone defined by the inner wall structure and which is connected to suitable drive mechanism. The impeller housing includes appropriate baffles near the upper ends of the inner and outer passageways for directing the exhausted air upwardly away from the supply of fresh air. Under normal circumstances, the exhaust air moves through the inner passageway and the fresh air moves through the outer passageway to facilitate such separation.

Detailed Construction

The dual fan construction **10** (FIGURES 1 and 2), which illustrates a preferred embodiment of the invention, includes a fan housing **11** supported upon a base **12** and containing an axial flow impeller **13** rotatably disposed therein. More specifically, the base **12**, in this particular embodiment, is a relatively flat and rectangular structure fabricated from sheet metal and including a horizontal top wall **16** and four upright side walls **17** which are supported upon the upper surface of a roof **18**, in this particular embodiment. Additional support elements **22** may be disposed between the top wall **16** and the roof **18** to support or strengthen the base **12**. The roof **18** preferably has a relatively large, central opening **19** which is covered by the base **12** and which cooperates with the fan housing **11** in a manner discussed hereinafter.

The fan housing **11** (FIGURES 2, 3 and 4) has an outer, preferably cylindrical casing **23** which, for a roof mounting of the dual fan **10**, is axially vertical and is supported upon the top wall **16** of the base **12**. Said top wall **16** has a central opening **24** with an upright, annular flange **26** which is snugly sleeved within and secured to the lower end of the outer casing 23, as by welding. A sleeve or duct 30, which preferably is larger in diameter than the outer casing 23, may be held within the opening 19 in the roof 18 so that it extends upwardly into the base 12 and to the top wall 16 thereof.

An intermediate wall 27 (FIGURE 2) is comprised of upper and lower, coaxial and preferably cylindrical wall portions 28 and 29 which are axially spaced from each other a selected distance. The upper wall portion 28 is preferably slightly larger in diameter than the lower wall portion 29, and both wall portions are held coaxially within and radially spaced from the outer casing 23 by support fins or brackets 32. An exhaust duct 34 may be sleeved within or upon the lower end of the intermediate wall 27 and extends therefrom into the interior of the building.

The inner wall 36 (FIGURE 2) is comprised of coaxial, upper and lower wall portions 37 and 38 which are preferably cylindrical and are axially spaced from each other a selected distance. The wall portions 37 and 38 are rigidly held coaxially within and spaced from the wall portions 28 and 29, respectively, by means of support fins or brackets 39. The upper and lower ends of the wall portions 37 and 38, respectively, are closed by hemispherical caps 42 and 43.

A shaft 44 (FIGURE 2) is coaxially and rotatably supported within the chamber 46, defined within the inner wall 36, by a bearing assembly 47 which may have conventional thrust and/or radial bearings 50 therein. The bearing assembly 47 is mounted upon a bearing support 48 which is in turn secured to the wall portion 38 within the chamber 46. A pulley 49 is mounted upon the lower end of the shaft 44. Belt openings 52, 53 and 54 are provided respectively through the outer casing 23, lower wall portion 29 and lower wall portion 38 in radial alignment with the pulley 49.

The axial flow impeller 13 (FIGURES 2, 4 and 6) has a center structure 57 including a hub 58 into which the upper end of the shaft 44 is snugly received and held by means including a set screw 59 and a key 60. The center structure 57 has a coaxial, cylindrical flange 63 which has an outside diameter preferably substantially equal to the outside diameter of the inner wall 36. Said cylindrical flange 63 extends between and closely adjacent to the opposing ends of the wall portions 37 and 38. However, the space therebetween is sufficient to avoid interference of the wall portions with the rotation of the center structure 57, hence with the impeller 13.

A first set 65 of axial flow blades 64 (FIGURES 4, 5 and 6) are preferably integral with and extend radially from the cylindrical flange 63 at uniform intervals around the peripheral surface thereof. The lower, axial edges of the blades 64 and the cylindrical flange 63 preferably lie substantially within a horizontal plane adjacent to, but spaced slightly upwardly from, the upper edges of the wall portions 29 and 38. The lower end of the upper wall portion 28 of the intermediate wall 27 extends downwardly around the tips of the inner blades 64 about half the axial length thereof and is spaced radially outwardly from said blades. A flat annular element or cylindrical band 66 snugly encircles and is secured to the tips of the blades 64 between the opposing ends of the wall portions 28 and 29, said band being of substantially the same diameter as the lower wall portion 29.

As shown in FIGURE 5, the inner blades 64 are curved and their concave sides face in the direction of rotation. The radius of curvature of the concavity decreases from the tip of each blade 64 toward the root thereof, and the angle between the rotational plane of the impeller and the chord line extending across the concave face of each blade 64 increases from the blade tip toward the blade tip toward the blade root. Although the particular blade configuration is capable of producing a highly acceptable performance as regards both efficiency and capacity, other configurations may be utilized. The blades 64 are preferably integral with the flange 63, hence the center structure 57, of the impeller 13.

The blades 67 (FIGURES 2 and 4) in a second set 70 of axial flow blades have flanges 69 at their roots which are preferably secured to the annular band 66 by means, such as rivets 68, which extend through the band 66. The blades 67 are located at uniform intervals along the band 66 and they extend radially from said band toward and close to the outer casing 23. As shown in FIGURE 6, the outer blades 67 are slightly and transversely curved so that they each have a concave surface facing partially downwardly and partially in the direction of their rotation.

In this particular embodiment, the outer blades 67 (FIGURE 2) are substantially longer radially than the inner blades 64 and said outer blades extend in an axial direction about the same distance as the axial length of the band 66. Accordingly, the annular passageway 72 between the outer casing 23 and the intermediate wall 27 has a larger radial dimension than the radial dimension of the annular passageway 73 between the intermediate wall 27 and the inner wall 36. Furthermore, the blades 64 and 67 (FIGURE 4) are preferably arranged so that rotation of the impeller 13 in a counterclockwise direction, as appearing in FIGURE 4, effects a downward movement of air through the outer passageway 72 and an upward movement of the air through the inner passageway 73.

An annular baffle 74 (FIGURES 2 and 3) has a coaxial opening 75 approximately equal to the outside diameter of the upper portion 28 of the wall 27. Said baffle 74 has a flange 79 around said opening 75, which flange is sleeved over the upper end of said wall portion 28 where it may be secured, as by welding, to said wall portion 28. The baffle 74 is also held by brackets 76, which are secured to and extend between said baffle 74 and the upper end of the casing 23. The inlet passage 86 defined between the baffle 74 and the upper end of the casing 23 is preferably at least equal to the cross-sectional area of the annular passageway 72. Said baffle 74 has an outwardly and downwardly curving flange 77 which serves as a weather guard and defines with the upper end of said casing 23 said inlet passage 86 to the upper end of the outer passageway 72.

An annular deflection baffle 78 (FIGURE 2) has a central opening 81 which encircles the flange 79 on said baffle 74. The baffle 78 is mounted concentrically upon the upper surface of the baffle 74 and may be secured thereto, as by rivets or the like. The baffle 78 has an outer flange 82 of relatively shallow depth which curves upwardly and outwardly, and which combines with the flange 79 to provide an annular, upwardly facing cavity. Bleed openings 80 may be provided in the lower portion of the flange 82 to permit the escape of moisture which can collect within the baffle 78. The baffle 78 extends radially slightly beyond the cylinder defined by the outer casing 23.

A downwardly opening, bowl-shaped cover 83 (FIGURES 1 and 2) is supported by brackets 84 upon the inner flange 79 of the baffle 74 so that the rim 85 of the cover 83 is spaced upwardly from the baffle 78. The diameter of the cover 83 is preferably slightly less than the outside diameter of the baffle 78 so that gas or air discharged between the rim 85 and flange 82 is deflected upwardly by said flange 82. The spacing between the rim 85 and the flange 82 is such that the area defined therebetween is preferably at least equal to the cross-sectional area of the inner passageway 73, so that the movement of air upwardly through said passageway 73 is not obstructed as it is discharged between the rim 85 and flange 82.

The motor mounting pad 87 (FIGURES 2 and 4) has a pair of flanges 88 at the opposite ends thereof, which flanges are secured rigidly to the outside wall of the casing 23 so that said pad 87 is substantially tangent to said casing 23. A motor 89 is mounted upon the pad 87 by means, such as the bolts 92, so that its shaft extends downwardly for support of the pulley 93, which is in alignment with the belt openings 52, 53 and 54 in the casing 23 and walls 29 and 38, respectively. A plurality, here two, of belts 94 extend through said belt openings and around the pulleys 93 and 49, whereby the motor 89 can rotate the impeller 13. The motor 89 may, if desired, be encased within a removable cover 96, which may be supported upon the casing 23 and/or the base 12.

In this particular embodiment of the invention, as shown in FIGURE 2, the lower end of the intermediate wall 27 is connected to the exhaust duct 34 through which air or gas is drawn into the annular passageway 73 from, in this particular embodiment, a space directly below the dual fan construction 10. However, the duct 34 can be extended, within the limits of the fan performance, so that it communicates with an air space located away from the space directly below the dual fan. A wall, which is indicated by broken lines at 97 in FIGURE 2, may be provided to direct the supply of air sidewardly away from the space directly below the dual fan. Obviously, other arrangements for specific conditions of circulation and the like may be provided.

Operation

The operation of the dual fan construction 10 of the invention is probably apparent from the above detailed description. However, to summarize, energization of the motor 89 effects rotation of the pulleys 93 and 49 and the shaft 44 whereby the impeller 13 is rotated in a counterclockwise direction, as appearing in FIGURE 4, so that the blades 64 and 67 cause the gas, such as air, to move upwardly through the inner passageway 73 and downwardly through the outer passageway 72. It will be recognized that the blades 64 and 67 can be arranged so that they move the air through the passageways 73 and 72, respectively, in the same axial directions, if such is desired. The blades 64, in this particular embodiment, are designed to develop a higher total pressure and to be more efficient than the outer blades 67. This tends to compensate for the fact that the cross-sectional area of the outer passageway 72 is greater than the cross-sectional area of the inner passageway 73. Moreover, it insures a more positive removal of the air from within the zone communicating with the duct 34.

By virtue of the described shapes of the baffles 74 and 78, the exhaust air discharged by the impeller 13 is positively directed upwardly as it departs from the housing 11. The fresh air drawn into the inlet passage 86 by impeller 13 is received from a position below said baffles. The convection currents normally tend to augment this positive separation between the flow patterns of supply and exhaust gases. This combination is very important since it prevents the recircualtion of the exhaust gas which may be contaminated or otherwise undesirable for reuse.

The end caps 42 and 43 not only tend to streamline the flow of air or gas into and out of the inner passageway 73, but also help to house the bearing assembly 47, the pulley 49 and the center structure 57 within the chamber 46 where they cannot create turbulence in the air flow through the housing 11. By radially offsetting the upper wall portion 28 outwardly with respect to the lower wall portion 29 of the intermediate wall 27, the inner passageway 73 is, in effect, expanded upwardly from a point between the axial sides of the blades 64, and the outer passageway 72 is expanded below the blades 67. This tends to reduce not only the resistance to flow of the air as it departs the two sets of blades but also the velocity head thereof so that the losses incident to friction and turbulence are further reduced. The overlap of the blades 64 by the lower end of the wall portion 28 reduces turbulence and minimizes bleeding from the passageway 73 into the passageway 72, due to the opening between the wall members 28 and 29. Moreover, this offsetting of the two wall portions 28 and 29 places their opposing, adjacent edges where their effect upon the air flow through the passageways 72 and 73 is minimized. Accordingly, the fan 10 has been designed so that those losses resulting from friction and turbulence, which tend to reduce the efficiency of the air movement, have been reduced to a minimum for the dual type of fan construction.

Although a particular preferred embodiment of the invention has been described in detail above for illustrative purposes, it will be understood that variations or modifications of such disclosure, which come within the scope of the appended claims, are fully contemplated.

What is claimed is:

1. A power ventilator for effecting the simultaneous flow of gas in opposite parallel directions through two adjacent paths therein, comprising:

a casing having a substantially circular cross section and being open at the axial ends thereof;

an intermediate, substantially cylindrical wall structure coaxially disposed within and spaced from said casing to define a first annular passageway extending axially of said casing, said wall structure including first and second, axially spaced wall members;

an inner, substantially cylindrical wall structure disposed coaxially within and radially spaced from the intermediate wall structure to define therewith a second annular passageway extending axially of said intermediate structure and being independent of said first passageway, said inner wall structure including first and second axially spaced wall members;

an axial flow impeller disposed between the first and second wall members of said inner wall structure and of said intermediate wall structure, said impeller having a first set of blades located within said second annular passageway, said blades being arranged and shaped to effect a flow of gas through said second annular passageway in one axial direction, said impeller having a second set of blades located within said first annular passageway, said second set of blades being arranged and shaped to effect the flow of gas through said first annular passageway in the opposite axial direction, said second set of blades being of greater radial extent than, and having about one half of the axial extent of, said first set of blades, and said first set of blades being capable of developing during rotation of said impeller at substantially normal operating speed, a higher total pressure than the total pressure developed by the second set of blades; and

means supporting said impeller for rotation coaxially within said casing whereby the gas flow is effected, said support means being disposed within and secured to said inner wall structure.

2. A power ventilator for effecting the simultaneous flow of air in opposite parallel directions through two adjacent paths therein, comprising:

a substantially cylindrical casing;

a substantially cylindrical, intermediate wall structure coaxially disposed within and spaced radially from said casing to define therewith a first annular passageway opening through the opposite axial ends of said casing, said wall structure including first and second axially spaced, cylindrical members rigidly mounted in said casing;

a substantially cylindrical, inner wall structure coaxially disposed within and radially spaced from said intermediate wall structure to define therewith a second annular passageway opening through the opposite axial ends of said intermediate wall structure, said inner wall structure including first and second, axially spaced, cylindrical wall members firmly mounted in said intermediate wall structure;

an impeller hub structure including a coaxial, cylindrical rim disposed between and adjacent the opposing axial ends of said wall members so that said rim forms a part of the peripheral surface of said inner wall structure;

shaft means engaging said hub structure and support means disposed within said inner wall structure for rotatably supporting said shaft means coaxially within and upon said inner wall structure;

a first set of axial flow blades secured to said cylindrical rim and extending radially from said rim at uniform intervals therearound, said blades being arranged to effect the flow of air along said second passageway in one axial direction, approximately one half of the axial extent of each blade being encircled by the adjacent end of said first cylindrical member of said intermediate wall structure;

an annular element secured to and encircling the peripheral ends of said first set of blades, said annular element being located between the opposing axial ends of said cylindrical members of said intermediate wall structure, the axial extent of said annular element being such that substantially all the remaining axial extent of said first set of blades is encircled by said annular element;

a second set of axial flow blades secured to said annular element and extending radially therefrom at

uniform intervals therearound, said second set of blades being of lesser axial extent and of greater radial extent than said first set of blades, said second set of blades being arranged to effect the flow of air along said first passageway in the other axial direction; and

drive means connected to said shaft means for effecting unidirectional rotation thereof, whereby said first and second sets of blades effect said axial flow of air through said passageways.

3. A structure according to claim 2 wherein said annular element and the second cylindrical member of said intermediate wall structure are downstream of said first cylindrical member along said first passageway and have smaller diameters than the diameter of said first cylindrical member.

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