

PIVOTAL DIRECT DRIVE MOTOR FOR EXHAUST ASSEMBLY

[0001]

BACKGROUND OF THE INVENTION

[0002] The present invention relates generally to exhaust fans, and more particularly to exhaust fans of the type that draw contaminated air from one or more fume hoods dispersed throughout a building, mix the contaminated air with ambient air to dilute the contaminants, and vent the diluted air from the building into the ambient environment.

[0003] There are many different types of exhaust systems for buildings. In most of these the objective is to simply draw air from inside the building in an efficient manner. In building such as laboratories, fumes are produced by chemical and biological processes, which may have an unpleasant odor, is noxious or toxic. One solution is to exhaust such fumes through a tall exhaust stack which releases the fumes far above ground and roof level. Such exhaust stacks, however, are expensive to build and are unsightly.

[0004] Another solution is to mix the fumes with fresh air to dilute the contaminated air, and exhaust the diluted air upwards from the top of the building at a high velocity. The exhaust is thus diluted and blown high above the building. Examples of such systems are described in U.S. Pat. Nos. 4,806,076; 5,439,349 and 6,112,850. Unfortunately, prior systems are expensive, difficult to maintain and not easily adaptable to meet a wide range of performance specifications.

BRIEF SUMMARY OF THE INVENTION

[0005] In accordance with one aspect of the present invention, an exhaust assembly is provided including an outer wall that defines a cavity therein having an air inlet formed at its bottom end, and an inner wall fastened to the outer wall and positioned in the cavity to divide it into a centrally located chamber and a surrounding annular space. A fan chamber is disposed at the bottom of the cavity and retains a fan coupled to a fan shaft to draw exhaust air in through the air inlet and blow it upward through the annular space. A drive chamber is disposed inside the outer wall and adjacent the fan chamber. A motor is pivotally mounted in the drive chamber. The motor is pivotable between a first engaged position in which a motor shaft is coupled to the fan shaft for driving the fan, and a second disengaged pivoted position.

[0006] In accordance with another aspect of the invention, an exhaust assembly is mounted onto a roof of a building for removing contaminated air from one or more building exhaust vents. The exhaust assembly includes an air inlet receiving the contaminated air, at least one ambient air entrainment zone mixing ambient air with the contaminated air to produce diluted air, and an air outlet exhausting the diluted air. A fan is coupled to a fan shaft to draw the contaminated air through the air inlet and blow it towards the air outlet. A pivotally mounted motor drives a motor shaft that is removably coupled to the fan shaft.

[0007] In accordance with yet another aspect of the invention, an exhaust assembly includes a housing separating a drive chamber from a fan chamber. A motor is pivotally mounted in the drive chamber, and includes a motor shaft. The housing defines an inlet end and an outlet end. A fan is disposed in the fan chamber and coupled to a fan shaft that is, in turn, coupled to the motor shaft to draw air through the air inlet and blow it towards the outlet. At least one passageway extends through the housing. The passageway provides access to the motor.

[0008] In the following description, reference is made to the accompanying drawings, which form a part hereof, and in which there is shown by way of illustration, and not limitation, a preferred embodiment of the invention. Such embodiment also does not define the scope of the invention and reference must therefore be made to the claims for this purpose.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] Reference is hereby made to the following drawings in which like reference numerals correspond to like elements throughout, and in which:

[0010] Fig. 1 is a schematic perspective view of a building ventilation system constructed in accordance with principles of the present invention;

[0011] Fig. 2 is a side elevation view of an exhaust assembly constructed in accordance with the preferred embodiment;

[0012] Fig. 3 is a perspective view with parts cut away of the plenum which forms part of the exhaust assembly of Fig. 2;

[0013] Fig. 4 is a perspective view of a housing which forms part of the plenum of Fig. 3;

[0014] Figs. 5A-5E are views of the plenum which forms part of the exhaust assembly of Fig. 2;

[0015] Figs. 6A-6B are exploded views of the plenum of Figs. 5A-5E showing the dampers therein.

- [0016] Fig. 7 is a sectional side elevation view of the exhaust assembly illustrated in Fig. 2;
- [0017] Fig. 8 is an exploded perspective view of the fan assembly of Fig. 7;
- [0018] Fig. 9 is an enlarged sectional side elevation view similar to Fig. 7 but illustrating the fan motor in a pivoted position;
- [0019] Fig. 10 is a partial view of the fan assembly of Fig. 7 with parts cut away;
- [0020] Fig. 11 is a view in cross-section taken along the plane 11-11 shown in Fig. 7;
- [0021] Fig. 12 is a view in cross-section taken along the plane 12-12 shown in Fig. 7;
- [0022] Fig. 13 is a view in cross-section taken along the plane 13-13 shown in Fig. 7;
- [0023] Fig. 14 is a view in cross-section taken along the plane 14-15 shown in Fig. 7;
- [0024] Fig. 15 is a schematic diagram of the fan assembly showing the parameters which determine the desired performance;
- [0025] Fig. 16 is a pictorial view with parts cut away of a second embodiment of the exhaust assembly of the present invention; and
- [0026] Fig. 17 is an elevation view of the exhaust assembly of Fig. 16.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0027] Referring initially to Fig. 1, a building ventilation system 20 includes one or more fume hoods 22 of the type commonly installed in commercial kitchens, laboratories, manufacturing facilities, or other appropriate locations throughout a building that create noxious or other gasses that are to be vented from the building. In particular, each fume hood 22 defines a chamber 28 that is open at a front of the hood for receiving surrounding air. The upper end of chamber 28 is linked to the lower end of a conduit 32 that extends upwards from the hood 22 to a manifold 34. Manifold 34 is further connected to a riser 38 that extends upwards to a roof 40 or other upper surface of the building. The upper end of riser 38 is, in turn, connected to an exhaust assembly 42 that is mounted on top of roof 40 and extends upwards away from the roof for venting gasses from the building.

[0028] Referring also to Fig. 2, exhaust assembly 42 includes a plenum 44 disposed at the base of the assembly that receives exhaust from riser 38 and mixes it with fresh air. A fan assembly 46 is connected to, and extends upwards from, plenum 44. Fan assembly 46 includes a fan wheel that draws exhaust upward through the plenum 44 and blows it out through a windband 52 disposed at its upper end. Each of these components is described in more detail below. During operation, exhaust assembly 42 draws an airflow that travels from each connected fume hood 22, through chamber 28, conduits 32, manifold 34, riser 38 and plenum 44. This exhaust air is mixed with fresh air before being expelled upward at high velocity through an opening in the top of the windband 52.

[0029] The control of this system typically includes both mechanical and electronic control elements. A conventional damper 36 is disposed in conduit 32 at a location slightly above each hood 22, and is automatically actuated between a fully open orientation (as illustrated) and a fully closed orientation to control exhaust flow through the chamber 28. Hence, the volume of air that is vented through each hood 22 is controlled.

[0030] The building can be equipped with more than one exhaust assembly 42, each such assembly 42 being operably coupled either to a separate group of fume hoods 22 or to manifold 34. Accordingly, each exhaust assembly 42 can be responsible for venting noxious gasses from a particular zone within the building 26, or a plurality of exhaust assemblies 42 can operate in tandem off the same manifold 34. In addition, the manifold 34 may be coupled to a general room exhaust in building 26. An electronic control system (not shown) may be used to automatically control the operation of the system.

[0031] Referring now to Figs. 3-5E, plenum 44 includes a rectangular housing having a horizontal upper wall 54 that includes an exhaust outlet 92 from the plenum 44, and an opposing lower wall 56 that includes an exhaust inlet 64. A pair of opposing vertical side

walls 58 and an integrally connected vertical rear wall 60 extend between the upper and lower walls 54 and 56 to define an internal mixing chamber 59.

[0032] Plenum 44 further includes a vertical front wall 62 disposed opposite the rear wall 60. A hood 66 extends outwardly from front wall 62 to provide a bypass air inlet extending through an opening 82 extending through wall 62, and into chamber 59. The hood 66 includes opposing vertical side walls 68, a horizontal lower wall 72, and an opposing angled upper wall 70 that together define a front opening that can be covered by a front porous screen 74 that enables ambient (bypass) air to flow through and into plenum 44. Upper wall 70 is angled down from the upper end of the plenum front wall 62, and extends out a distance beyond lower hood wall 27 to provide a rain hood that protects the interior plenum components from entrainment of snow, water, and debris. An upward-turned lip 79 that surrounds the outer periphery of upper wall 70 (See Fig. 5C) prevents water from spilling into the bypass air stream.

[0033] A damper 84 is mounted in an opening 82 formed in the plenum front wall 62 and beneath the hood 70. Damper 84 includes damper blades 86 that are controlled to regulate the flow rate of fresh air into plenum 44. This flow of fresh air is indicated by Arrow B in Fig. 3. Damper 84 can be controlled electronically to enable a flow of bypass air into plenum 44, which ensures that the total air flow through the fan assembly 46 remains constant despite fluctuations in the flow rate of exhaust air to be removed from the building via exhaust assembly 42.

[0034] The exhaust air and bypass air mix inside chamber 59 to produce once-diluted exhaust air that travels upwards through exhaust outlet 92 to the fan assembly 46 as indicated in Fig. 3 by Arrow C. A support bracket 88 extends horizontally across the inner surfaces of walls 58, 60, and 62 at the upper end of chamber 59, and collectively support an isolation damper 90 that isolates the outdoor ambient air entering through the fan assembly 46 when the fan is not in operation. As shown best in Figs. 6A and 6B the isolation damper 90 is slidably attached to the plenum 44. The damper 90 may be activated by gravity backdraft or it may be activated by a shaft as well known by a skilled artisan.

[0035] In an alternative embodiment the riser 38 (Fig. 1) may be extended above the roof 40 and connected to an inlet opening formed in a side wall 58 of the plenum 44.

[0036] Referring particularly to Fig. 4, a gutter is formed around the interior base perimeter of the plenum chamber 59 to collect and drain liquid. The gutter is formed by a flange 89 that extends inward from walls 58, 60, and 62 at the lower end of chamber 59, and a lip 91 that extends up from the inner edge of flange 89. Gutter is linked to a drain 95 extending through side wall 58 to provide for the transport of condensate that forms in chamber 59.

[0037] As shown best in Figs. 5A-5C, all four side walls of the plenum 44 are constructed with identical panels 61 that can be selectively removed to orient the plenum 44 in any desired direction. When a panel 61 is removed, a large opening is formed in the plenum wall. A panel 61 is removed on one wall to form the front wall 62 to which hood 66 is attached. The panels 61 and hole patterns are the same on all four sides of the plenum 44, which enables complete freedom to place the hood 66 in the desired orientation.

[0038] As shown best in Figs. 5D and 5E, the removable panels 61 on the sides of the plenum 44 also enable multiple plenums 44 to be combined with a single riser 38. The plenums 44 are mounted adjacent one another and the panels 61 in their abutting walls are removed to form a single, enlarged chamber 63. Any number of plenums 44 may be combined in this manner with complete flexibility in their orientation. The location of their hoods 66 is provided by the same removable panels 61 and mounting holes on all four walls of the plenum 44 in the manner described above.

[0039] The removable panels 61 also enable access to the interior of the plenum 44 from any direction. This enables routine maintenance and repairs to be made without having to remove the entire exhaust assembly 42 from the riser 38 or the fan assembly 46 from the plenum 44.

[0040] Referring to Figs. 7, 8, and 10 fan assembly 46 sits on top of the plenum 44 and includes a cylindrical outer wall 100 that is welded to a rectangular base plate 102. A set of eight gussets 104 is welded around the lower end of the outer wall 100 to help support it in an upright position. Supported inside the outer wall 100 is a cylindrical shaped inner wall 106 which divides the chamber formed by the outer wall 100 into three parts: a central drive chamber 108, a surrounding annular space 110 located between the inner and outer walls 106 and 100, and a fan chamber 112 located beneath drive chamber 108.

[0041] A fan shaft 114 is disposed in drive chamber 108 and is rotatably fastened by a bearing 118 to a bottom plate 116 that is welded to the bottom end of inner wall 106. Fan shaft 114 extends down into the fan chamber 112 to support a fan wheel 120 at its lower end, and extends up into drive chamber 108 where it is connected to a motor shaft 152 via a conventional coupling 122. Motor shaft 152 extends through a horizontal plate 124 that extends across the interior of the drive chamber 108 and is supported from below by a set of gussets 126 spaced around the interior of the drive chamber 108.

[0042] As best illustrated in Fig. 10, fan wheel 120 includes a dish-shaped wheelback 130 having a set of main fan blades 132 fastened to its lower surface that support a frustum-shaped rim 136 that extends around the perimeter of the fan blades. The lower edge of this rim 136 fits around a circular-shaped upper lip of an inlet cone 138 that fastens to, and extends upward from the base plate 102. The fan wheel 120 is a mixed flow fan wheel such

as that sold commercially by Greenheck Fan Corporation under the trademark MODEL QEI and described in pending U.S. Pat. Appln. No. 10/297,450 which is incorporated herein by reference. When the fan wheel 120 is rotated, exhaust air from the plenum 44 is drawn upward through the air inlet formed by the inlet cone 138 and blown radially outward and upward into the annular space 110 as shown by arrows 140 (Fig. 11).

[0043] Wheelback 130 can also include, if desired, a set of auxiliary fan blades 134 fastened to its upper surface that produce a radially outward directed air flow. Because shaft 114 and lower bearing 118 should provide a good seal with the bottom plate 116, no source of air should be available and this air flow is not well defined. However, if a leak should occur, an air flow pattern is established in which air is drawn from the drive chamber 108 and directed radially outward through a gap formed between the upper rim of the fan wheel 130 and the bottom plate 116. As a result, exhaust air cannot escape into the drive chamber 108 even if a leak should occur.

[0044] As best illustrated in Figs. 7 and 8, access to drive chamber 108 from outside the fan assembly 46 is provided by two passageways formed on opposite sides. Each passageway is formed by aligned elongated openings formed through the outer wall 100 and inner wall 106 which are connected by a passage wall 144. The passage wall 144 encircles the passageway and isolates it from the annular space 110 through which it extends. As shown best in Fig. 11 one can look through either of the passageways and see a fan drive motor 150 and its associated components, fan shaft 114, and coupling 122. Maintenance personnel thus have easy access to these elements for inspection and repair.

[0045] Referring now to Figs. 7 and 9, and 11, fan drive motor 150 is located in drive chamber 108 and is mounted to horizontal support plate 124. Specifically, motor 150 is affixed to the upper surface of a mounting bracket 154, which is fastened to the upper surface of plate 124 via bolts 156 or like fasteners in order to provide structural integrity during operation. Mounting bracket 154 includes a flat horizontally extending rectangular plate 160 and a pair of strengthening flanges 168 extending up from opposing outer ends of the plate. Flanges 168 extend in a direction substantially parallel to an axis extending perpendicular between the passageways.

[0046] Motor shaft 152 extends down through mounting bracket 154, and is connected directly to the fan shaft 114 via coupling 122 such that motor rotatably drives fan wheel 120 during operation. When maintenance operations are to be performed on motor 150 or its associated components inside drive chamber 108, bolts 156 can be removed, and coupling 122 can be loosened such that motor shaft 152 becomes disengaged from fan shaft 114.

[0047] Advantageously, one edge of mounting bracket 154 is connected to horizontal plate 124 via a hinge 158 that permits mounting bracket 154 to pivot relative to horizontal plate 124 once fastener(s) 156 have been removed. Preferably hinge 158 is oriented perpendicular to an axis extending perpendicular between through the passageways. In this regard, hinge extends perpendicular to flanges 168. Hinge 158 permits mounting bracket 154 and motor 150 to be pivoted between a first position in which shafts 152 and 114 can be engaged by coupling 122 and fasteners 156 can connect bracket 154 to plate 124, and towards one of the passageways in the direction of Arrow A to a second position whereby inspection and maintenance can be performed. Wedge-shaped flanges 168 provide additional structural support for bracket at locations proximal hinge 158 where increased forces result from motor pivoting.

[0048] Motor 150 can be manually pivoted about hinge 158 at any angle between 0° and 180° (with respect to bracket 154 and plate 124) to provide the needed access to the components inside chamber 18. In one aspect of the invention, motor 150 pivots at an angle of about 90° such that the vertical surfaces of flanges 168 proximal hinge 158 provide a stop with respect to motor 150 pivoting beyond 90° . Alternatively, the vertical flange surfaces could be positioned to provide additional clearance with respect to plate 124, thereby allowing the motor to pivot beyond 90° . In this instance, a stop in the form of flange 145 could extend from wall 144 (Fig. 9) and protrude a desired distance to engage upper surface of bracket once motor 150 has pivoted to the desired angle. Once pivoted, a portion of motor 150 can extend through one of the passageways while access to components inside drive chamber 108 can be achieved via the other passageway.

[0049] It should be appreciated that hinge 158 can be disassembled in the usual manner (e.g., by removing the hinge pin) in order to facilitate removal of motor 150 from assembly 42.

[0050] Referring also to Fig. 8, the exhaust air moves up through the annular space 110 and exits through an annular-shaped nozzle 162 formed at the upper ends of walls 100 and 106 as indicated by arrows 164. The nozzle 162 is formed by flaring the upper end 166 of inner wall 106 such that the cross-sectional area of the nozzle 162 is substantially less than the cross-sectional area of the annular space 110. As a result, exhaust gas velocity is significantly increased as it exits through the nozzle 162. As shown best in Figs. 11 and 13, vanes 170 are mounted in the annular space 110 around its circumference to straighten the path of the exhaust air as it leaves the fan and travels upward. The action of vanes 170 has been found to increase the entrainment of ambient air into the exhaust as will be described further below.

[0051] Referring particularly to Figs. 8 and 11, a windband 52 is mounted on the top of fan assembly 46 and around nozzle 162. A set of brackets 54 is attached around the perimeter of the outer wall 100. Brackets 54 extend upward and radially outward from the top rim of outer wall 100, and fasten to the windband 52. Windband 52 is essentially frustum-shaped with a large circular bottom opening coaxially aligned with the annular nozzle 162 about a central axis 56. The bottom end of the windband 52 is flared by an inlet bell 58 and the bottom rim of the inlet bell 58 is aligned substantially coplanar with the rim of the nozzle 162. The top end of the windband 52 is terminated by a circular cylindrical ring section 60 that defines the exhaust outlet of the exhaust assembly 42.

[0052] Referring particularly to Fig. 11, the windband 52 is dimensioned and positioned relative to the nozzle 162 to entrain a maximum amount of ambient air into the exhaust air exiting the nozzle 162. The ambient air enters through an annular gap formed between the nozzle 162 and the inlet bell 58 as indicated by arrows 62. It mixes with the swirling, high velocity exhaust exiting through nozzle 162, and the mixture is expelled through the exhaust outlet at the top of the windband 52.

[0053] A number of features on this system serve to enhance the entrainment of ambient air and improve fan efficiency. The flared inlet bell 58 at the bottom of the windband 52 has been found to increase ambient air entrainment by several percent. This improvement in air entrainment is relatively insensitive to the angle of the flare and to the size of the inlet bell 58. The same is true of the ring section 60 at the top of the windband 52. In addition to any improvement the ring section 60 may provide by increasing the axial height of the windband 52, it has been found to increase ambient air entrainment by 5% to 8%. Testing has shown that minor changes in its length do not significantly alter this performance enhancement.

[0054] It has been discovered that ambient air entrainment is maximized by minimizing the overlap between the rim of the nozzle 162 and the bottom rim of the windband 52. In the preferred embodiment these rims are aligned substantially coplanar with each other such that there is no overlap.

[0055] Another feature which significantly improves fan system operation is the shape of the nozzle 162. It is common practice in this art to shape the nozzle such that the exhaust is directed radially inward to "focus" along the central axis 56. This can be achieved by tapering the outer wall radially inward or by tapering both the inner and outer walls radially inward to direct the exhaust towards the central axis 56. It is a discovery of the present invention that ambient air entrainment can be increased and pressure losses decreased by shaping the nozzle 162 such that exhaust air is directed radially outward rather than radially inward towards the central axis 56. In the preferred embodiment this is achieved by

flaring the top end 166 of the inner wall 106. Air entrainment is increased by several percent and pressure loss can be reduced up to 30% with this structure. It is believed the increase in air entrainment is due to the larger nozzle perimeter that results from not tapering the outer wall 100 radially inward. It is believed that the reduced pressure loss is due to the fact that most of the upward exhaust flow through the annular space 110 is near the outer wall 100 and that by keeping this outer wall 100 straight, less exhaust air is diverted, or changed in direction by the nozzle 162.

[0056] Referring particularly to Fig. 7, ambient air is also drawn in through the passageways and mixed with the exhaust air as indicated by arrows 170. This ambient air flows out the open top of the flared inner wall 100 and mixes with the exhaust emanating from the surrounding nozzle 162. The ambient air is thus mixed from the inside of the exhaust.

[0057] As shown in Figs. 7, 8, 11 and 12, to protect the fan drive elements in the drive chamber 108 from the elements, a sloped roof 172 is formed above the top end of the fan shaft 114. The roof 172 seals off the drive chamber 108 from the open top end of the inner wall 106, and it is sloped such that rain will drain out the passageways. The slope of roof 172 also provides additional clearance to enable unobstructed pivoting of motor 150. In another aspect of the invention, roof 172 can be eliminated to more easily facilitate the removal of motor 150 from assembly 42, which can be easily achieved by lifting motor 150 up through windband 52.

[0058] In addition to the performance enhancements discussed above, the structure of the exhaust assembly lends itself to customization to meet the specific needs of users. Such user specifications include volume of exhaust air, plume height, amount of dilution with ambient air, and assembly height above roof top. User objectives include minimizing cost. Such customization is achieved by selecting the size, or horsepower, of the fan motor 150, and by changing the four system parameters illustrated in Fig. 15.

[0059] Nozzle Exit area:

Increasing this parameter decreases required motor HP, decreases ambient air entrainment, decreases plume rise. Decreasing this parameter increases required motor HP, increases ambient air entrainment, increases plume rise.

[0060] Windband Exit Area:

Increasing this parameter increases ambient air entrainment, does not significantly affect plume rise or fan flow. Decreasing this parameter decreases ambient air entrainment, does not significantly affect plume rise or fan flow.

[0061] Windband Length:

Increasing this parameter increases ambient air entrainment, increases plume rise,

does not affect fan flow. Decreasing this parameter decreases ambient air entrainment, decreases plume rise, does not affect fan flow.

[0062] Windband Entry Area (minor effect)

Increasing this parameter increases ambient air entrainment, increases plume rise, does not affect fan flow. Decreasing this parameter decreases ambient air entrainment, decreases plume rise, does not affect fan flow.

[0063] For example, for a specified system, Table 1 illustrates how windband length changes the amount of entrained ambient air in the exhaust and Table 2 illustrates how windband exit diameter changes the amount of ambient air entrainment.

TABLE 1	
<u>Windband Length</u>	<u>Dilution</u>
39 inch	176%
49 inch	184%
59 inch	190%

TABLE 2	
<u>Windband Exit Diameter</u>	<u>Dilution</u>
17 inch	165%
21 inch	220%
25 inch	275%

[0064] Table 3 illustrates how the amount of entrained ambient and changes as a function of nozzle exit area and Table 4 illustrates the relationship between the amount of entrained ambient air and windband entry area.

TABLE 3	
<u>Nozzle Exit Area</u>	<u>Dilution</u>
.79 ft ²	120%
.52 ft ²	140%
.43 ft ²	165%

TABLE 4	
<u>Windband Entry Area</u>	<u>Dilution</u>
10.3 ft ²	176%
12.9 ft ²	178%

[0065] In Tables 1-4 the dilution is calculated by dividing the windband exit flow by the flow through the fan assembly.

[0066] Referring particularly to Figs. 16 and 17, an alternative embodiment of the invention is substantially the same as the preferred embodiment described above except the nozzle end of the fan assembly 46 is modified to add an additional, second nozzle assembly

50. In this second embodiment the outer wall 100 of the fan assembly is tapered radially inward at its upper end to form a first nozzle 53 with the inner wall 106 which extends straight upward, beyond the nozzle 53. The second nozzle assembly 50 is a frustum-shaped element which is fastened to the extended portion of the inner wall 106 by brackets 55. It is flared around its bottom end to form an inlet bell 57 similar to that on the windband 52. The second nozzle assembly 50 is concentric about the inner wall 106, and its top end is coplanar with the top end of the inner wall 106 to form an annular-shaped second nozzle 59 therebetween. Brackets 61 fasten around the perimeter of the second nozzle assembly 50 and extend upward and radially outward to support the windband 52. The windband 52 is also aligned coaxial with the inner wall 106 and second nozzle assembly 50 and its lower end is substantially coplanar with the top end of the second nozzle 59. In this alternative embodiment it is also possible to form the first nozzle 53 by flaring the inner wall 106 outward rather than tapering the outer wall 100.

[0067] Referring particularly to Fig. 17, the annular space between the lower end of the second nozzle assembly 50 and the outer wall 100 forms a first gap through which ambient air enters as indicated by arrows 63. This air is entrained with the swirling exhaust air exiting the first nozzle 53 to dilute it. Similarly, the annular space between the lower end of the windband 52 and the second nozzle assembly 50 forms a second gap through which ambient air enters as indicated by arrows 65. This air is entrained with the once diluted exhaust air exiting the second nozzle 59 to further dilute the exhaust. As with the first embodiment, further ambient air which enters through the passageways and flows out the top end of the inner wall 106 as shown in Fig. 16 by arrow 67 also dilutes the exhaust before it is expelled at high velocity out the exhaust outlet at the top of the windband 52.

[0068] The above description has been that of the preferred embodiment of the present invention, and it will occur to those having ordinary skill in the art that many modifications may be made without departing from the spirit and scope of the invention. In order to apprise the public of the various embodiments that may fall in the scope of the present invention, the following claims are made.

CLAIMS

We claim:

1. An exhaust assembly which comprises:
an outer wall that defines a cavity therein having an air inlet formed at its bottom end;
5 an inner wall fastened to the outer wall and positioned in the cavity to divide it into a centrally located chamber and a surrounding annular space;
a fan chamber disposed at the bottom of the cavity, the fan chamber retaining a fan coupled to a fan shaft to draw exhaust air in through the air inlet and blow it upward through the annular space;
10 a drive chamber disposed inside the outer wall and adjacent the fan chamber; and
a motor pivotally mounted in the drive chamber, the motor pivotable between a first engaged position in which a motor shaft is coupled to the fan shaft for driving the fan, and a second disengaged pivoted position.
2. The exhaust assembly as recited in claim 1 in which the motor is mounted to a plate supported in the drive chamber by a mounting bracket.
3. The exhaust assembly as recited in claim 2 in which the mounting bracket is fastened to the plate by a hinge that permits pivotal movement of the mounting bracket relative to the plate.
4. The exhaust assembly as recited in claim 3 in which the mounting bracket is further fastened to the plate by removable fasteners.
5. The exhaust assembly as recited in claim 3 in which a passageway is formed into the drive chamber from outside the assembly by a passage wall that extends through the annular space between the inner and outer walls to provide access to the motor for inspection or repair.
6. The exhaust assembly as recited in claim 5 in which a second passageway is formed into the drive chamber from outside the assembly by a second passage wall that extends through the annular space between the inner and outer walls.
7. The exhaust assembly as recited in claim 6 in which the motor is pivotable towards one of the passageways.

8. The exhaust assembly as recited in claim 6, wherein the hinge extends in a direction substantially perpendicular to an axis extending between the passageways.

9. The exhaust assembly as recited in claim 1 in which a passageway is formed into the drive chamber from outside the assembly by a passage wall that extends through the annular space between the inner and outer walls to provide access to the motor for inspection or repair.

10. The exhaust assembly as recited in claim 9 in which a second passageway is formed into the drive chamber from outside the assembly by a second passage wall that extends through the annular space between the inner and outer walls, and ambient air is drawn into the passageways and flows out the top end of the inner wall to mix with the exhaust air.

11. The exhaust assembly as recited in claim 1 in which a roof is disposed in the drive chamber and above the motor to protect the same from substances entering the top end of the inner wall.

12. The exhaust assembly as recited in claim 11 in which the roof is sloped.

13. The exhaust assembly as recited in claim 1 in which the inner wall is spaced upward from the air inlet to form the fan chamber.

14. The exhaust assembly as recited in claim 1, wherein the drive chamber is disposed above the fan chamber.

15. An exhaust assembly as recited in claim 1, the annular space being constricted at the top of the outer wall to form a nozzle.

16. The exhaust assembly as recited in claim 1 which includes a plenum fastened to the outer wall and disposed beneath the air inlet, the plenum includes:

a housing having an upper housing wall with an exhaust outlet that aligns with the air inlet and a bottom housing wall with an exhaust inlet for receiving exhaust air from a building; and

a bypass air inlet formed in one wall of the housing for receiving ambient air.

17. The exhaust assembly as recited in claim 16 in which a damper is mounted in the plenum to control the amount of ambient air entering through the bypass air inlet.
18. The exhaust assembly as recited in claim 16 in which the outer wall is removably fastened to the plenum to enable removal thereof for repair or replacement.
19. The exhaust assembly as recited in claim 18 which includes a removable access panel formed in one side wall of the plenum housing.
20. The exhaust assembly as recited in claim 1 in which the upper end of the inner wall is flared radially outward to form said nozzle.
21. The exhaust assembly as recited in claim 1 which includes a windband mounted to the upper end of the outer wall, the windband having a frustum-shape with a circular opening at its lower end which is coaxial with said nozzle and the lower end is substantially coplanar with a nozzle formed by a constriction at the top of outer wall.
22. The exhaust assembly as recited in claim 21 in which the lower end of the windband is flared radially outward to form an inlet bell.
23. The exhaust assembly as recited in claim 21 in which a cylindrical ring is formed at the upper end of the windband.
24. The exhaust assembly as recited in claim 1 in which the inner wall extends upward above a nozzle formed from a constriction of the top of the outer wall, and which includes:
a second nozzle assembly mounted to the inner wall and having a frustum shape with a circular opening at its top end which is coaxial with the inner wall and coplanar with the top end of the inner wall; and
a windband mounted to the second nozzle assembly and having a frustum shape with a circular opening at its lower end which is coaxial with the inner wall and coplanar with the top end of the inner wall.
25. The exhaust assembly as recited in claim 23, in which the second nozzle assembly has a circular opening at its lower end which is coaxial with the inner wall and coplanar with the nozzle.

26. An exhaust assembly mounted onto a roof of a building for removing contaminated air from one or more building exhaust vents, the exhaust assembly comprising:
an air inlet receiving the contaminated air, at least one ambient air entrainment zone mixing ambient air with the contaminated air to produce diluted air, and an air outlet
5 exhausting the diluted air;
a fan coupled to a fan shaft to draw the contaminated air through the air inlet and blow it towards the air outlet; and
a pivotally mounted motor driving a motor shaft removably coupled to the fan shaft.
27. The exhaust assembly as recited in claim 26 further comprising a housing is formed from an outer wall defining a cavity and an inner wall disposed in the cavity and spaced from the outer wall to divide the cavity into a central chamber and a surrounding annular space.
28. The exhaust assembly as recited in claim 27 in which the central chamber is divided into a fan chamber housing the fan, and a drive chamber housing the motor.
29. The exhaust assembly as recited in claim 28 in which the drive chamber is disposed above the fan chamber.
30. The exhaust assembly as recited in claim 27 in which a pair of opposing passageways extend through the inner and outer walls to enable access to the motor.
31. The exhaust assembly as recited in claim 30 in which the motor is pivotable towards and away from at least one of the passageways.
32. The exhaust assembly as recited in claim 31 in which ambient air is drawn into the passageways and flows out the top end of the inner wall to mix with the exhaust air.
33. The exhaust assembly as recited in claim 30 in which the motor is supported on a housing plate by a mounting bracket connected to the plate by a hinge.
34. The exhaust assembly as recited in claim 33 in which the hinge extends in a direction substantially perpendicular to an axis extending between the passageways.
35. The exhaust assembly as recited in claim 33 in which the mounting bracket is further fixed to the plate by at least one removable fastener.

36. An exhaust assembly which comprises:
a housing separating a drive chamber from a fan chamber, the housing defining an inlet end and an outlet end;
a motor pivotally mounted in the drive chamber, the motor including a motor shaft;
5 a fan disposed in the fan chamber and coupled to a fan shaft that is, in turn, coupled to the motor shaft to draw air through the air inlet and blow it towards the outlet, and
at least one passageway extending through the housing, the passageway providing access to the motor.
37. The exhaust assembly as recited in claim 36 in which the motor is pivotal towards and away from the passageway.
38. The exhaust assembly as recited in claim 36 in which the motor is supported on a plate in the drive chamber.
39. The exhaust assembly as recited in claim 38 in which the motor is supported on the plate by a mounting bracket that is connected to the plate by a hinge.
40. The exhaust assembly as recited in claim 39 in which the hinge extends in a direction substantially perpendicular to an axis extending between the passageways.
41. The exhaust assembly as recited in claim 39 in which the mounting bracket is further fixed to the plate by at least one removable fastener.