A rotary fan arrangement mounted on a structure such as a smokestack creates a plume of ambient air concentric with the pollutants rising upwardly from the stack, the plume of air serving both to dilute the pollutants and to carry the pollutants aloft. In one embodiment, the fan arrangement includes hinged blades and, in another, centrifugally erected sail rotors.

14 Claims, 12 Drawing Figures
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FAN ARRANGEMENT FOR POLLUTION CONTROL

FIELD OF THE INVENTION

The present invention relates to the control of pollutants in the air and more particularly to a fan arrangement for effecting such control.

Background of the Invention

The problem of air pollution, particularly in urban areas, has drastically increased in seriousness in recent years and a great deal of national attention, both public and private, has been focused thereon. A significant cause of air pollution is smoke and other air pollutants discharged into the atmosphere from factories and other sources. Relatively "normal" pollution conditions in the atmosphere can be greatly exacerbated by a phenomenon known as an atmospheric inversion.

To explain, it is noted that there is a concept in meteorology of "adiabatic" lapse rate which refers to the rate of decrease with altitude of the temperature of an ideal bubble of air moving from one altitude to another without mixing or heat exchange. This rate is 5.4°F per 1,000 feet of height for dry air and somewhat less for moist air, the exact value depending on the humidity. An atmosphere with an adiabatic lapse rate is roughly neutrally stable with respect to vertical mixing. Steeper temperature drops—referred to as superadiabatic lapse rates—are unstable whereas shallower drops are stable, the stability increasing as the lapse rate decreases from adiabatic. Lapse rates less than adiabatic have been referred to as inversions although such rates may perhaps be more accurately referred to as inversions of the potential temperature, the term inversion being more commonly used to refer to an increase in temperature with altitude. Such a meteorological condition is extremely stable and resists the upward flow of stack effluents. Thus noxious effluents from various sources in the area are not able to penetrate the atmosphere as well as under normal conditions and hence pollution of the atmosphere overlying the area is caused. As a consequence of such atmospheric inversions severe pollution problems, such as occur for example almost continuously in the Los Angeles basin, may result.

One approach taken in attempting to alleviate such conditions is the utilization of very tall stacks. Such stacks may actually carry the wastes to altitudes above the inversion and thus when the wastes are dumped into the atmosphere they cannot return to altitudes just overlying the area because of the superstability of the air in the vicinity of the inversion and thus mixing of the waste with the air of the atmosphere takes place above the inversion layer. There are a number of obvious drawbacks to the use of such stacks among which is the rather prohibitive cost thereof.

Another related problem in which very tall stacks have been used in an attempted solution is that of providing dilution of poisonous stack effluents so that when these materials reach ground level again after circulating in the surrounding air they are of sufficiently low concentration that any untoward effects are avoided. This problem occurs, for example, in fertilizer plants wherein during processing fluorides are generated in the stack effluents. When these fluorides return to earth in agricultural areas even very low concentrations thereof can kill crops. For this reason such plants are generally located in very isolated regions and employ very tall stacks to ensure adequate mixing of the stack effluents with the ambient air before the plume from the stack can touch the ground.

SUMMARY OF THE INVENTION

In accordance with the present invention a stream of pollutants issuing from a smokestack or the like is controlled by means for creating an envelope of air around the pollutants the cross-sectional area of the air envelope being greater than the cross-sectional area of the stream of pollutants. The air envelope or plume so created, by surrounding the plume of pollutant, will ensure that the pollutant has risen to a relatively high altitude before diffusing through the air plume into the atmosphere. Further, the pollutant will be diluted as it diffuses through the air plume.

In a relatively simplified embodiment of the invention a fan arrangement of generally conventional form is provided which includes a series of blades rigidly secured to a rotor hub. However, the blades of fans so constructed will experience large bending moments which may cause the arrangement to be unsatisfactory for many applications. Moreover, fan blades advancing into the wind during rotation will be subject to a greater than average aerodynamic force while the retracting blades are subject to a lesser force. The asymmetry of the aerodynamic forces on the blade will produce a moment which will be transmitted to the stack. In addition, because each blade is alternately advancing and retracting, the load on the individual blades oscillates between a maximum and a minimum value.

It has been found that the effectiveness of the fan plume in diluting the stack plume increases as the size of the fan plume increases and thus for optimum effectiveness fan arrangements of very large diameter are desirable. However, all of the effects discussed above, the root bending moment, the asymmetry of the air forces on the fan blades and the oscillatory load thereon, increases rapidly with increasing fan diameter. For this reason the use of one of the more specialized fan arrangements of the invention discussed hereinbelow is generally to be preferred.

In one embodiment the fan blades are hinged in a manner similar to the blades of a helicopter and a number of the problems discussed hereinabove are eliminated. This embodiment may still present drawbacks in providing stowage of the blades, it being desirable to stow the blades during high wind conditions when the fan is not needed and damage may result to the blades or to the stack because of the presence of the fan, where the diameter of the fan blades is to be very large. In another embodiment the rotor blades are flexible and are deployed and tensioned by the centrifugal force on tip weights affixed to the ends of the blades. In a stowed position the blades are wrapped around a motor-driven spool and the tip weights are released to deploy the blades upon rotation of the spool.

In yet another embodiment of the invention an auxiliary stack arranged concentrically with the main stack is used in place of the fan-type devices discussed hereinabove to create the plume or jet of air which surrounds the plume of pollutants.

The control arrangement of the invention will provide penetration of the inversion layer in a manner similar to a tall stack. The use of the control arrangement obviates the need for stacks of great height and relatively short stacks may be utilized therewith. As stated, the outer plume of air created thereby serves both to carry the waste plume aloft as well as to dilute this plume and thus the control arrangement of the invention may be used advantageously in situations such as those described above where it is desired to prevent poisonous effluents from returning to earth in other than a very dilute form. By carrying the waste plume aloft and by diluting the waste plume through mixing the control arrangement of the present invention provides a means for handling poisonous stack effluents in a satisfactory manner.

It is noted that certain stacks eject material that has little or no buoyancy in the atmosphere and thus propulsion of the effluents must be accomplished by mechanical means. Such a process can be made more economical and more effective by use of the control arrangement of the invention.

It is noted that in accordance with a further feature of the present invention the directionality of the waste plume can be controlled by tilting of the plane of the blades of a fan arrangement so that the plume is ejected in a favorable direction, so that in calm weather, for example, the plume can be aimed in the least objectionable direction and in windy weather the untoward effects of winds can be reduced through selective orientation of the plume.

Other features and advantages of the present invention will be set forth in or apparent from the detailed description found hereinbelow.
FIG. 1 is a schematic representation of a control arrangement in accordance with the present invention illustrating the operation thereof; FIG. 2 is a perspective view of an arrangement similar to that of FIG. 1 wherein wind protection is provided; FIG. 3 is a view similar to FIG. 1 wherein the fan blades are hinged to provide stowage thereof; FIG. 4 is a top view of a presently preferred embodiment of the invention wherein the details of a hinging arrangement for one of the fan blades is shown; FIG. 5 is a side view partially in section of the embodiment of FIG. 4; FIG. 6 is a top view of a further preferred embodiment of the present invention wherein the fan blades are flexible and are shown in a stowed position; FIG. 7 is a side view, partially in section and partially broken away, of the embodiment of FIG. 6 with one of the blades shown in an unfurled position; FIG. 8 is an overall view of the embodiment of FIGS. 6 and 7 with two of the fan blades being shown in an unfurled position; FIGS. 9 and 10 are top and side elevational views of a further embodiment of the invention; and FIGS. 11 and 12 are top and side elevational views of yet another embodiment of the invention wherein a fan arrangement is not used, a portion of FIG. 12 being shown in section.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1, a schematic representation of the invention, as incorporated in an environment including a factory complex denoted F having a smokestack S, is shown. In accordance with the invention a fan device 10 is mounted atop stack S for controlling a stack plume, generally denoted 12, issuing therefrom. Fan 10 is preferably constructed in accordance with the embodiments of FIGS. 4 and 5 or of FIGS. 6 and 8 discussed hereinbelow but may in a simplified form thereof merely comprise a series of rigid blades 14 mounted for rotation about the stack opening. A motor 16, also conveniently mounted atop stack S, may be used to drive a central hub 18 from which the blades 14 extend. The motor 16 and hub 18 may be interconnected as described hereinbelow regarding FIGS. 4 and 5. Reference is also made to FIGS. 9 and 10 which illustrate in more detail a suitable rigid blade arrangement. Blades 14 rotate in a plane generally perpendicular to the longitudinal axis of the stack S and thereby create a generally upwardly directed plume of ambient air denoted 20 which surrounds stack plume 12. Thus stack plume 12 is enveloped by the outer cylindrical plume of air 20 and is carried aloft thereby. As discussed hereinbefore by carrying the stack plume aloft in this manner the deleterious effects thereof can be significantly decreased.

The use of rigid blades such as blades 14 of FIG. 1 presents a number of problems as was discussed above. Certain of these problems, specifically, those caused by or heightened by the presence of wind, can be combatted to some extent through the addition of a wind protection shroud such as that shown in FIG. 2. In FIG. 2, wherein elements corresponding to similar elements in FIG. 1 have been given like numbers, there is shown a shroud 19 which comprises an open cylinder concentric with the stack S and surrounding the blades 14. The shroud 19 is connected to the stack S through spindles 19a so that the blades 14 can rotate within the protective walls of the shroud. 19. Although such an arrangement serves to reduce the wind effects and improve the performance of the fan as well as reduce the size of fan required a number of disadvantages result from the use of a shroud. For example, as the size of the fan required increases the cost and weight of the shroud increase correspondingly. It will be appreciated that the wind load of the shroud itself on the stack becomes prohibitive for larger diameter fan blades.

FIG. 3 shows what may be regarded as a second embodiment of the invention wherein the fan blades are hinged to permit stowage thereof. In high winds such as those of hurricane force a fan is unnecessary because of the rapid dilution of the stack plume by the tremendous amounts of air circulated by the high velocity wind. Under these circumstances the blades are preferably stowed out of the wind to decrease the forces the fan and the stack must withstand and thus to improve the overall safety of the installation. The embodiment of FIG. 3 is generally similar to that of FIG. 1 and corresponding elements that have been given the same reference numerals with primes attached. Blades 14' are hinged at 21 to permit folding thereof to stowed positions alongside stack S' as shown. In the stowed positions thereof, blades 14' may be secured to stack S', by suitable means such as a clamp 22 extending outwardly from the stack S', to prevent fluttering of the blades in high winds.

Although simple hinges providing pivoting of the blades between the horizontal, operative positions and the vertical, stowed positions may be utilized, hinge 21 is preferably of the form shown in FIGS. 4 and 5. The helicopter-type mounts of FIGS. 4 and 5 provide pivoting of the blades in both vertical and horizontal planes and thus eliminate the bending moment at the root of the blades and reduce the oscillatory load due to wind.

Referring to FIGS. 4 and 5 a stack 24 includes an upper stack opening 26 about which is mounted a fan arrangement generally denoted 28. A generally cylindrical hub 30 is mounted for rotation by bearings indicated at 32 and includes a plurality of blades 34 (one of which is shown) extending outwardly therefrom. A motor 36 mounted on stack 24 by suitable means (not shown) drives a pinion 38 which engages a gear track 40 located around the internal circumference of a lower portion of hub 30. Thus rotation of pinion 38 will cause rotation of hub 30 and, consequently of blades 34.

Blade 34 is attached to hub 30 through a “flapping” hinge 42 and a “lagging” hinge 44. Flapping hinge 42 is formed by a pin 46 which extends through a tongue member 48 received in an outwardly extending yoke member 50 of hub 30. Pin 46 permits pivoting of blade 34 about the axis formed thereby in a vertical plane. Lagging hinge 44 is similarly formed by a pin 52 which joins upper and lower portions of a yoke member 54 to an end portion of blade 34 received therewithin. Yoke member 54 and tongue member 48 are both part of an intermediate connecting member 56 and extend outwardly from opposite sides of member 56 as shown. Lagging hinge 44 provides pivoting of blades 34 in a horizontal plane.

Damper devices 58 and 60 may be utilized under certain circumstances to damp oscillations about hinges 42 and 44. Damper 58 is mounted on the side of yoke member 50 of hub 30 and includes an arm 62 attached to intermediate member 56 as shown. Similarly, damper 60 is mounted atop intermediate member 56 and includes an arm 64 attached to blade 34.

Although the embodiment of FIGS. 4 and 5 provides a number of advantages as compared with a rigid blade or a simple hinged blade arrangement, such an arrangement may be undesirable where large radius fans are to be used. For example, the height of the stack required can, as stated, be reduced by the use of a fan and in some instances may be less than the radius of the fan. It is obvious that where the radius of the blades is greater than the height of the stack the blades cannot be stowed alongside the stack as shown in FIG. 3. The embodiment of FIGS. 6 to 8 provides ready stowage of the blades without regard to length as well as the advantages of the embodiment of FIGS. 4 and 5.

Referring to FIGS. 6 to 8 a stack 70 includes a central opening 72 about which is mounted a flexible fan blade arrangement generally denoted 74. The fan blades are formed by flexible members 76 which are preferably constructed of a fabric such as sail material and thus the blades 76 may be conveniently referred to as “sail rotors.” Blade 76 is secured to a spool member 78 directly mounted on a motor-driven rotor 80.
Bearings indicated at 82 and 84 permit rotation of blade-carrying rotor 80 with respect to stack 70. Rotor 80 may also be driven by a pinion and gear track arrangement such as described hereinbefore in connection with the embodiment of FIGS. 3 and 4. As shown, rotor 80 is part of a motor drive arrangement which includes a stator 81 affixed to the stack.

An outer shield 86 is journaled to stack 70 by means of bearings indicated at 88 and 90 so that the shield 86 is may also rotate with respect to stack 70. Shield 86 is generally cylindrical in form although rounded at both ends and includes an upper central opening 92 to permit passage of gaseous wastes issuing from the stack 70 therethrough.

Sail rotor blades 76 are preferably formed with a straight leading edge 76a and a trailing edge which may be straight, convex or concave, a convex trailing edge 76b being shown. A tip weight 94 individual to each blade 76 aids in deploying the blades upon rotation of spool 78. Details of the construction of the sail rotor blades and the tip weights and the manner of attachment of the tip weights to the blades and of the blades to the spool may be found in my copending application Ser. No. 789,328 entitled Improvements in Flexible Rotor Devices and filed concurrently with the present application. Tip weights 94 are located outside shield 86 and slots in shield 86 permit blades 76 to be affixed to the weights 94. Weight 94 is brokend away in FIG. 7 to show slot 96. Blades 76 are wrapped around spool 78 in their inoperative or rest states as indicated in FIG. 6. Under these conditions tip weights 94 are each clamped to the shield 86 by a clamp 98. The clamps 98 can take a number of forms but as shown merely comprise first and second opposed spring members 100 and 102 which capture the tip weight 94 therebetween. The biasing force of springs 100, 102 is such that upon rotation of spool 78 the centrifugal force on tip weight 94 will cause release of the weight and consequent unwinding of the sail rotor blades 76 from the spool 78. In an alternate form the clamp 98 could be pivoted and weighted such that inertia forces thereon generated upon rotation of spool 78 would cause pivoting thereof to release the associated tip weight 94. In yet another form, a solenoid-operated clamp could be utilized to provide more precise control of the release of the tip weight 94.

As mentioned hereinabove, rotation of spool 78 and of shield 86 causes the release of tip weights 94 which fly out radially to serve in deploying blades 76 by causing unreeling thereof from spool 78. Blades 76 are tensioned by the centrifugal force on weights 94 in their end positions and thus function in the same manner as rigid fan blades. The blades 76 are shown in the extended, operative positions thereof in FIG. 8 with two of the blades being removed for purposes of clarity of illustration. The number of blades utilized is a matter of design although FIGS. 6 to 8 are intended to show a four-blade arrangement. As shown in FIG. 8, the blade angle, that is, the angle between the rotor blade or airfoil section and the plane of rotation, increases along the length of blade 76 from tip to root. At the tip end of blade 76 this angle should be small (on the order of 5 or 10 degrees) whereas at the root end, that is, at spool 78, the angle should be large, with a limit, for large radius blades mounted on small radius hubs, approaching 90°.

A clock motor in the form of an elongate coiled spring 104 (partially broken away in FIG. 6 to show spool 78 and blade 76) surrounding stack 70 aids in rewinding the blades onto the spool 78 when the fan 74 is to be stopped and the blades to be stowed. Spring 104 is connected to the shield 86 as indicated at 106 and to spool 78 as indicated at 108 (see FIG. 7). Spring 104 is loaded such that shield 86 is urged thereby in the same direction as spool 78 rotates. Spring 104 is not fully wound until blades 76 are fully extended by weights 94. To stop fan operation and stow blades 76 the drive motor and consequently, the rotation of spool 78, is slowed down. The inertia of the tip weights 94 will urge blades 76 forward with respect to spool 78 and thus the blades will tend to wind or wrap themselves around outer shield 86. However, at this time shield 86 is also being urged forward by the release of the stored energy in spring 104 as the spring 104 unwinds so that each blade 76 will retract through its associated slot 96 in shield 86 and wrap around spool 78. The rate at which retraction of the blade 76 takes place is controlled by the speed at which the spool 78 is driven and the force exerted by coil spring 104. At the end of rotation of spool 78 tip weight 94 will be positioned in the openings between springs 100 and 102 of clamp 98 and the natural inward velocity of the weights will cause the weights to snap into position within clamps 98.

It is noted that for more positive control over reeling and unreeling of the blade 76 the shield 86 can be positively driven with respect to the spool 78. A gearing arrangement (not shown) can be employed so that the shield 86 may be driven in the same direction as or in an opposite direction to the direction in which the spool 78 is driven. In such an arrangement engagement of the drive gears for determining the direction of rotation of the shield 86 can be conveniently controlled through control of the axial positioning of the gears.

In addition to the advantages in storing of the blades afforded by the arrangement of FIGS. 6 to 8 this arrangement also permits the use of blades of a very large radius, this use, among other advantages, further aiding in diffusing of the pollutant plume by providing a more extensive outer envelope of air.

It is noted that the angle of attack of the blades of the various fan arrangements may be controlled to permit directional control of the plume of pollutant. Reference is made to my copending application Ser. No. 789,328 discussed hereinabove for details of a blade angle control system for a flexible blade arrangement such as that shown in FIGS. 6 to 8. By tilting the plane of the blades the plume can be made to flow upwardly from the stack at a favorable angle with respect to the wind direction such that upwind effects of the winds can be reduced by selective orientation of the plume. Further, the stack plume can be controlled in this manner to “aim” the plume into the less objectionable direction.

FIGS. 9 and 10 illustrate a simplified arrangement wherein the direction of the stack plume can be controlled. This arrangement, which is generally denoted 106, includes a drive ring 108 which is mounted atop a conventional stack 110 and is adapted to rotate with respect thereto through upper and lower bearings 112 and 114. A downwardly depending portion of drive ring 108 has mounted thereon a ring gear 116 (see FIG. 10) which is adapted to mesh with a pinion 118 driven by a motor 120. Motor 120 is mounted on stack 110 by means of suitable support members 122. It will be appreciated that rotation of motor-driven pinion 118 will cause rotation of ring gear 116 and thus of drive ring 108.

First and second pins 130 and 132 are affixed to and extend outwardly of drive ring 108 on opposite sides thereof as shown. Pins 130 and 132 are journaled in and thus provide pivots for an inner gimbal ring 128. First and second pins 130 and 132 are affixed to gimbal ring 128 and extend outwardly therefrom as shown, the axis determined by or common to pins 130 and 132 lying perpendicular to the axis determined by pins 124 and 126. Pins 130, 132, similarly to pins 124, 126, are journaled in an outer gimbal ring 134 which supports first and second rotor blades 136 and 138. Gimbal 134 is connected to blades 136 and 138 through rigid blade root or shaft members 140 and 142, respectively, outer gimbal ring serving as a hub as described hereinbefore. It will be appreciated that hinged rotor blades such as those shown in FIGS. 4 and 5 could be utilized and that in such an embodiment outer gimbal 138 would serve to anchor the inner hinge in the same way as does hub 30 of FIGS. 4 and 5.

A control ring 144 is positioned adjacent outer gimbal 134 inwardly thereof, outer gimbal 134 being mounted for rotation with respect to control ring 144 by means of a bearing arrangement indicated at 146. Control ring 144 fixedly mounted by first and second control actuators 148 and 150 which are affixed to the stack 110 at points located 90 degrees apart on the peripheral surface of the stack 110. Actuators 148 and
150 include connecting members 148a and 150a which are longitudinally adjustable to increase or decrease the length of the connection between the control ring 144 and the stack 110. Increasing or decreasing the effective length of either of the connecting members 148a, 150a from the lengths shown in FIGS. 9 and 10 will result in tilting from the horizontal of outer gimbal 134, and consequently of blades 136 and 138, through the pivoting arrangement provided by pins 124, 126 and 130, 132. Hence the direction of the plume of ambient air and the stack plume which it surrounds can be controlled, through control arrangement 106, in any direction by controlling the axis of rotation of the hub 134 and blades 136 and 138.

Referring to FIGS. 11 and 12, there is shown an embodiment of the invention wherein a fan arrangement is not used. Although one of the embodiments discussed hereinabove is generally to be preferred from an economical standpoint, the embodiment of the invention shown in FIGS. 11 and 12 is readily adaptable to existing stacks which might not accommodate a fan-type arrangement.

In FIGS. 11 and 12, a conventional smokestack 160, referred to hereinafter as the "primary stack," is positioned centrally of and surrounded by a concentric secondary stack 162. Primary stack 160 is fed in a conventional manner through a duct 164 so that a plume of pollutants to be controlled will issue from stack 160 as described hereinabove. Secondary stack 162 is fed from an air blower arrangement 166 through a diffuser 168, the purpose of the diffuser being to improve the efficiency of the system. A grid structure 170 is located in the upper end of secondary stack 162 providing "straightening" of the airflow from the stack and thus also improves the efficiency of the system. It is noted that a single secondary stack corresponding to stack 162 can be used in a multiple primary stack arrangement.

It will be appreciated that the operation of the embodiment of FIGS. 11 and 12 is similar to that described hereinabove, that is, secondary stack 162 creates an outer plume or jet of air which surrounds the plume of pollutants issuing from stack 160 to ensure that the plume of pollutants is carried aloft before diffusing into the atmosphere and to provide dilution of the pollutants.

It will be understood by those skilled in the art that the embodiments of the invention shown and described herein are subject to various modifications without departing from the scope and spirit of the invention. Accordingly, it should be understood that the invention is not limited by the exemplary embodiments shown and described but rather only by the subjoined claims as construed in light of the spirit of the invention.

Having thus described my invention in accordance with the Patent Statutes, I claim:

1. In combination with a structure having a stream of pollutants issuing therefrom, an air pollution control arrangement comprising positive-acting antipollution means associated with the structure for, when actuated, actively and continuously providing an envelope of ambient air the cross-sectional area of which is greater than the cross-sectional area of the stream of pollutants and which continuously surrounds the stream of pollutants for carrying said pollutants aloft, and means for selectively controlling actuation of said antipollution means.

2. An arrangement as claimed in claim 1 wherein the structure comprises at least one primary stack and said means comprises a secondary stack for producing a plume of air surrounding the pollutants issuing from the at least one primary stack.

3. An arrangement as claimed in claim 2 further comprising a blower and a diffuser, said secondary stack further including a flow straightening grid.

4. In combination with a structure having a stream of pollutants issuing therefrom, an air pollution control arrangement comprising antipollution means associated with the structure for providing an envelope of ambient air the cross-sectional area of which is greater than the cross-sectional area of the stream of pollutants and which continuously surrounds the stream of pollutants for carrying said pollutants aloft, said antipollution means comprising rotary means including a plurality of blade members extending outwardly of the structure and lying in a generally horizontal plane in the operative positions thereof.

5. An arrangement as claimed in claim 1 wherein the structure comprises means defining an upwardly extending passage and said blade members are stowable in an inoperative position adjacent said passage-defining means.

6. An arrangement as claimed in claim 5 wherein said blade members are hinged to permit movement thereof in a vertical plane and in a horizontal plane.

7. An arrangement as claimed in claim 6 wherein means are provided for damping movement of said blade members in a vertical direction and in a horizontal direction.

8. An arrangement as claimed in claim 4 wherein said blade members are flexible and said rotary means includes spool means on which said flexible blade members may be wound.

9. An arrangement as claimed in claim 8 wherein said rotary means includes means for rotatably driving said spool means and wherein each of said flexible blade members includes a tip body located at one end thereof, said rotary means further comprising means for releasably retaining said blade members in a stowed position wound about said spool until the speed of rotation of said spool is such that the centrifugal forces acting on said tip body cause release of said retaining means.

10. An arrangement as claimed in claim 9 wherein said rotary means further comprises a rotatable shield arranged concentrically with said spool and including slots therein for permitting extensions of said blade members therethrough and spring means arranged between said shield and said spool for causing rotation of said shield in the direction of rotation of said spool means when said blade members are being unwound, said spring means being wound as said blade members are assuming the operative positions thereof, the stored energy of said wound spring driving said shield in the same direction as said spool as the speed of rotation of said blade members is decreased to enable said blade members to wind themselves around said spool means and to prevent said blade members form winding themselves about said shield.

11. An arrangement as claimed in claim 4 wherein said blade members are flexible, said blade members being attached at one end thereof to a rotor member and at the other end thereof to a tip body.

12. An arrangement as claimed in claim 4 wherein said blade members are rigidly secured to a hub member, said arrangement further comprising means for shielding said blade members from wind effects.

13. An arrangement as claimed in claim 4 further comprising a hub for supporting blade members and means for controlling the angle between the axis of rotation of the hub and the axis of the structure to thereby control the direction of the plume of ambient air and the plume of pollutants contained therein.

14. An arrangement as claimed in claim 4 further comprising means for controlling the angle of the plane of said blade members with respect to the horizontal thereby to control the direction of the plume of ambient air and the plume of pollutants contained therein.