A blower having a housing, a blower wheel disposed within the housing, and an outlet. The outlet is partially bound by an outlet cut off is disclosed. The distance between an edge of the outlet cut off and a leading edge of a blade positioned on the blower wheel varies along the length of the cut off. The blower may be incorporated into a tower fan or other air circulating device.
Blower Cut Off

Background

This disclosure relates to blowers. More specifically, this disclosure relates to an improved air cut off for including within the housing of a blower.

Blowers are used in a variety of applications including cooling units, HVAC systems, and consumer products such as leaf blowers and air circulators. In general, these blowers include a motor, a blower wheel mounted to a motor drive shaft, a housing, and a cut off which may be integral to the housing. In centrifugal blowers, the motor rotates the blower wheel which is configured to draw air into the housing through an inlet positioned axially to the motor drive shaft. As the blower wheel rotates, the air drawn in is pushed radially out from the axis of the blower wheel into an annular area between the blower wheel and the housing. The crossectional area of the annular region may start relatively small near the cut off and grow along the circumference of the blower wheel towards the outlet. The air is then expelled through the outlet in a direction that is roughly tangential to the blower wheel.

In a cross flow blower, air may be drawn into an inlet extending, at least partially, axially along the blower wheel. Air may be drawn into the interior of the blower wheel through the spaces between the vanes. The air is thee expelled through the spaces between the vanes at a position on the other side of the blower wheel.

Cut offs are generally plates mounted to the blower housing or a projection mounted to or fabricated as part of the housing. The cut offs generally have a strait edge extending along
and parallel to the blades of the blower wheel. The cut off serves to significantly reduce the
crossectional area of the annular region and force the air driven through the annular region
out through the outlet.

Blower cut offs must be optimized for the spacing from the leading edge of the vanes. The
cut off separates the region of the inlet area from the outlet area. The cut off creates enough
back pressure for the blower wheel to operate effectively at a steady state. If the cut off gap
is too large, variations in air speed and volumetric flow can result. If the cut off gap is too
small, the blower wheel may generated unwanted sound due to fluctuations in back pressure.

However, the area available for air flux to travel away from the outlet and remain in the
annular region cannot be reduced to zero. This is because of the gaps between blower blades.
When the blower wheel is positioned with a blade directly opposing the cut off, the area
available for air flow is at its lowest. However, the area available for air flow increases when
the wheel rotates and the gap between two blades is disposed opposite of the cut off. This
results in cyclic variations of back pressure and can cause an increase in the noise signature
of a device operating with the blower.

Accordingly, there is a need for an improved blower cut off configured to reduce noise levels
while maintaining satisfactory performance. There is yet a further need to provide a blower
configured to reduce variations in pressure and airflow that can result in heightened noise
levels.
Summary

Some embodiments relate to a blower having a housing, a blower wheel disposed within the housing, and an outlet. The outlet is partially bound by an outlet cut off. The distance between an edge of the outlet cut off and a leading edge of a blade positioned on the blower wheel varies along the length of the cut off.

Other embodiments relate to a tower fan including a blower having a housing, a blower wheel disposed within the housing, and an outlet. The outlet is partially bound by an outlet cut off. The distance between an edge of the outlet cut off and a leading edge of a blade positioned on the blower wheel varies along the length of the cut off.

Brief Description of the Figures

FIG. 1 is a perspective view of a spiral tower fan.

FIG. 2 is an elevation view of the spiral tower fan of FIG. 1.

FIG. 3 is another perspective view of the spiral tower fan of FIG. 1.

FIG. 4 is a cross-sectional view of the spiral tower fan of FIG. 1, taken along line B—B.

FIG. 5 is an overlay of two cross-sectional views of the spiral tower fan of FIG. 1 taken along lines A—A and B—B, respectively.

FIG. 6 is a perspective view of a spiral blower suitable for use in the tower fan of FIG. 1.

FIG. 7 is a perspective view of a blower cut off mounted to a vertical outlet rib.

FIG. 8 is another perspective view of a blower cut off mounted to a vertical outlet rib.
Detailed Description

Referring to FIGS. 1-3, a tower fan 10 includes a column 12 mounted to a base 14. In general, a tower fan is shown with a vertically oriented crossflow blower wheel. The blower wheel is mounted to a drive shaft that is turned by the motor. When the blower wheel is turned and the tower fan is assembled, air is drawn into the region interior to the blower wheel through a inlet in the tower fan housing. As the blower wheel rotates, the air is pushed radially into an annular region between the tower fan housing and the blower wheel. With the tower fan housing removed, the placement of the cut off relative to the blower wheel can be seen. Column 12 extends generally vertically about a longitudinal axis. The column 12 may be a distinct component or, alternatively, column 12 and base 14 may be formed as a single unitary body by molding or other manufacturing process. The base may include, as shown, two halves 16 and 18 to facilitate manufacturing and assembly. Feet 20 may be coupled to base 14 to allow for tower fan to be placed level on a surface such as a floor. A handle 19 may be disposed or coupled to column 12 to facilitate selective positioning of tower fan 10 by a user. A variable speed blower is disposed within region 22 of column 12 is coupled to cross flow blower blades 24 (shown in FIG. 4) and extend vertically through a blower height 26. A blower inlet 28 is covered by cross guards shown as slats 30 that may be horizontal. In some embodiments, the slats may be louvered to obscure view of the interior of the column 12. Cross guards 30 may be coupled to vertical supports 32. Cross guards 30 and vertical supports 32 may be configured to restrict access to the blower fan blades 24. An outlet is provided and shown as having generally vertical slats 31 for directing the air flow out of the blower and away from the column 12. Vertical slats 31 may be coupled to cross ribs 33. Vertical slats 31 and cross ribs 33 may be configured to limit access to the blower fan blades 24. Controls may be provided on a control panel 34. On a tower fan 10, the
controls may be positioned on a top surface of the column 12. In other embodiments, the controls may be disposed on a side of the column 12, or on the base 14. Indicator lights may also be provided that visually indicate the blower speed or other parameter. Exemplary controls and indicators may include a power button 36, speed selector 38, timer 40, and indicator lights 42 for visually displaying the operating status of tower fan 10.

A recessed area 44 may be disposed on a top surface of tower fan 10 and be configured to receive and retain a remote control (not shown) for operating tower fan 10. The remote may be an infrared type remote, in which case, remote sensor window 46 may be positioned near the top of tower fan 10 on its side. In other embodiments, the remote may be an ultrasonic, radio frequency, or other alternative, suitable type of remote.

In some embodiments tower fan 10 is envisioned to be positioned with the base 14 on the floor and the column 12 extending upward therefrom. The blower height 26 may extend along about half to two thirds, or up to three fourths or more of the overall height of column 12. In some such embodiments the blower height 26 may extend along a greater or lesser portion of the overall column height. The inlet 28 and outlet of the blower are twisted about a longitudinal (vertical) axis of the tower fan 10. This allows for the blower to direct air over a wider blower range along the height of the tower fan 10 / column 12. This provides for greater air circulation without the use of an oscillating design.

A power supply for the motor may be supplied by a cord and be disposed in base 14 and/or region 22. Wire route 46 provides a conduit for wiring to connect control panel 34 to the motor and power supply.
In the present disclosure, the cut off is show having a twisting geometry for use in a twisted spiral fan such as those described herein and in WO201 1-1 12928. However, the cut off disclosed herein may be equally useful with other tower fan configurations and other blowers including centrifugal blowers.

Referring to FIG. 4, a cross-section of tower fan 10 along line B—B of FIG. 2 shows certain aspects of tower fan 10 in more detail. Tower fan 10 is shown as further including column 12 which is shown as being formed of two pieces, back portion 13 and inlet portion 48. This construction may be selected for ease of manufacture, or another suitable configuration may be selected. As blower or fan blades 24 rotate, air is drawn in along the path generally indicated by the arrows. The air passes through the inlet 28 by way of the space interstitial to cross guards 30 and vertical supports 32. The air flows past inlet air cut off 50 and is directed around the interior of column 12. The airflow exits between vertical slats 31, which are generally shown as having an air-foil shape. The air flow is partially restricted from passing back to inlet 28 by the outlet air cut off assembly 52. Outlet air cut off assembly 52 is shown as being molded with wire route 46, however, these components could alternatively be formed separately. The leading edge of vertical slats 31 may be provided with a blunt portion 54 to create appropriate back pressure to reduce noise and/or vibration.

Referring to FIGS. 5 and 6, a blower cut off assembly 52 is shown having a cut off 154 mounted to a tower fan rib, vertical slat 158. Cut off 154 comprises a plurality of segments 160, each coupled to a flange 156. Flange 156 is coupled to vertical slat 158 by any of sever means. For example, flange 156 may interface with one or more mounting slots 162 which may also mount to cross ribs 33 shown in FIGS. 1 and 2. Vertical slat 158 includes a mounting notch 164 for indexing vertical slat 158 onto a fan base 14 (shown in FIGS. 1-3).
In the embodiment shown, the vertical rib 158 is configured to twist about a vertical axis of the tower fan.

Cut off segments 160 are used such that shorter sections of cut off can be mounted, via flanges 156, to vertical slat 158. This allows for mounting a plurality of straight cut off sections that are relatively easy to manufacture. Coupling of the various components may be accomplished by a variety of means including the use of ultrasonic welding, adhesives, or forming the components as a single unitary body.

The cut off has a scalloped profile along its edge. This leaves openings along the length of the cut off when the the blades of the blower wheel pass the cut off. When the blower wheel blades pass by the cut off, there will still be an increase in pressure, but that increase may be at least partially relieved by the passage of air through the openings provided. This can substantially reduce the noise signature of the fan. However, the passage of air through the cut off displaces air that would be drawn into the blower wheel and pushed to the annular region. Thus, the net volume of air moved by the blower may be lowered. By optimizing the cut off geometry to allow just enough flow through the cut off so noise is reduced to a desired level can be accomplished with only an acceptable loss of performance.

Referring to FIG. 7, blower 24 may be a spiral blower having blades 60 that are helically arranged in a similar manner to vertical slats 31 shown in the previous figures. Blower 24 may further include a plurality of support members 62 that are fixedly coupled to blades 60. In some embodiments, a plurality of sub-units comprised of blades 60 bounded by two support members 62 may be joined end-to-end to form the bulk of blower 24. Two end caps 64 and 66 are also provided. End cap 66 is shown as positioned at the top of blower 24 and
may be coupled to an interior structure within column 12 to align blower 24. End plate 64 may be positioned at the base of blower 24, proximate to the drive motor. End plate 64 includes fins 68, apertures 70, and center opening 72. Center opening 72 may be configured to receive a collar or other device to couple blower 24 to a drive shaft. Fins 68 are provided to dissipate heat from the drive motor during use. Apertures 70 are placed between fins 68 and allow for warm air above the motor housing to be drawn into blower 24. This further aids in motor cooling and allows for the use of smaller and less expensive motors to drive blower 24.

Because the cut off profile is scalloped, the distance from blade edge to the cut off will vary with height along blower 24. The precise geometry of the scallop may be adjusted to achieve satisfactory results in specific implementations. For example, the profile may generally be sinusoidal in geometry, having roughly equal areas open and closed to airflow. Alternatively, the peaks and valleys of the scallop profile may be laterally spaced such that the ratio of closed area to open area is not equal to one. For example, in some design experiments, it has been found that a ratio of closed area to open area of about 2:1 was better for noise attenuation than a ratio of 1:1. Blower height, diameter, and relationship with the blower housing and wheel all appear to impact the optimal scallop design. Accordingly, it may be beneficial to set these various parameters consistent with a design objective and then adjust the cut off geometry to determine the optimal shape for noise attenuation.

Although a few exemplary embodiments of the present invention have been shown and described, the present invention is not limited to the described exemplary embodiments. Instead, it would be appreciated by those skilled in the art that changes may be made to these exemplary embodiments without departing from the principles and spirit of the invention, the
scope of which is defined by the claims and their equivalents.

The terminology used in the description of the invention herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the invention. As used in the description of the embodiments of the invention and the appended claims, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise.

Unless otherwise defined, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. All publications, patent applications, patents, and other references mentioned herein are incorporated by reference in their entirety.

It will be further understood that the terms "comprises" and/or "comprising," when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof. It will be understood that relative terms are intended to encompass different orientations of the device in addition to the orientation depicted in the Figures.

Moreover, it will be understood that although the terms first and second are used herein to describe various features, elements, regions, layers and/or sections, these features, elements, regions, layers and/or sections should not be limited by these terms. These terms are only used to distinguish one feature, element, region, layer or section from another feature, element, region, layer or section. Thus, a first feature, element, region, layer or section
discussed below could be termed a second feature, element, region, layer or section, and similarly, a second without departing from the teachings of the present invention.

It will also be understood that when an element is referred to as being "connected" or "coupled" to another element, it can be directly connected or coupled to the other element or intervening elements may be present. In contrast, when an element is referred to as being "directly connected" or "directly coupled" to another element, there are no intervening elements present. Further, as used herein the term "plurality" refers to at least two elements. Additionally, like numbers refer to like elements throughout.

Thus, there has been shown and described several embodiments of a novel invention. As is evident from the foregoing description, certain aspects of the present invention are not limited by the particular details of the examples illustrated herein, and it is therefore contemplated that other modifications and applications, or equivalents thereof, will occur to those skilled in the art. The terms "having" and "including" and similar terms as used in the foregoing specification are used in the sense of "optional" or "may include" and not as "required". Many changes, modifications, variations and other uses and applications of the present construction will, however, become apparent to those skilled in the art after considering the specification and the accompanying drawings. All such changes, modifications, variations and other uses and applications which do not depart from the spirit and scope of the invention are deemed to be covered by the invention which is limited only by the claims which follow. The scope of the disclosure is not intended to be limited to the embodiments shown herein, but is to be accorded the full scope consistent with the claims, wherein reference to an element in the singular is not intended to mean "one and only one" unless specifically so stated, but rather "one or more." All structural and functional equivalents to the elements of the various
embodiments described throughout this disclosure that are known or later come to be known to those of ordinary skill in the art are expressly incorporated herein by reference and are intended to be encompassed by the claims.
What is Claimed is:

1. A blower comprising:
   a housing;
   a blower wheel disposed within the housing;
   an outlet, the outlet partially bound by an outlet cut off; and
   wherein the distance between an edge of the outlet cut off and a leading edge of a blade positioned on the blower wheel varies along the length of the cut off.

2. The blower of claim 1, wherein the cut off has a scalloped profile.

3. The blower of claim 2, wherein the blower is a crossflow blower.

4. The blower of claim 3, wherein a ratio of the closed area of the cut off to the open area of the cut off is at least 1:1.

5. The blower of claim 3, wherein a ratio of the closed area of the cut off to the open area of the cut off is at least 2:1.

6. A tower fan comprising:
   base;
   a column coupled to the base;
   a blower positioned within the column, the blower having an inlet and an outlet;
   an outlet cut off positioned within the housing and running along the length of the
outlet; and

wherein the cut off has a geometry such that the distance between an edge of the outlet cut off and a leading edge of a blade positioned on the blower wheel varies along the length of the cut off.

7. The blower of claim 6, wherein the cut off has a scalloped profile.

8. The blower of claim 7, wherein a ratio of the closed area of the cut off to the open area of the cut off is at least 1:1.

9. The blower of claim 7, wherein a ratio of the closed area of the cut off to the open area of the cut off is at least 2:1.
FIG. 7