AIR MOVING DEVICE

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ABSTRACT

An air moving device can include a housing and an impeller assembly positioned at least partially within the housing. The impeller assembly can be connected to the housing via one or more support ribs having sharp trailing edges. The impeller blades can be spaced from an inlet to the impeller housing to reduce risk of injury due to contact with the impeller blades during operation of the air moving device.
FIG. 4
AIR MOVING DEVICE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Patent Application No. 62/083,106, filed Nov. 21, 2014 and entitled AIR MOVING DEVICE, the entire disclosure of which is hereby incorporated by reference.

TECHNICAL FIELD

[0002] Certain embodiments discussed herein relate to devices, methods, and systems for moving air that are particularly suitable for creating air temperature stratification within a room, building, or other structure.

DISCUSSION OF THE RELATED ART

[0003] Air moving devices are widely used to move air within enclosures. In some cases, the air moving devices are positioned at or near the ceiling of an enclosure to move warmer air from the vicinity of the ceiling toward the ground.

SUMMARY

[0004] An air moving device according to the present disclosure can include a primary housing having an inlet end, an outlet end, and a center axis extending through the inlet end and the outlet end. The primary housing can define a primary housing interior. In some embodiments, the air moving device includes one or more stator vanes positioned at least partially within the primary housing interior. An impeller can be positioned within the primary housing interior between the inlet end and the one or more stator vanes. In some embodiments, a motor housing is connected to the impeller. The motor housing can be positioned at least partially within the primary housing interior on a side of the impeller opposite the one or more stator vanes. In some embodiments, one or more support ribs are connected to the motor housing and to the primary housing. The one or more support ribs can be configured to hold the motor housing in position with respect to the primary housing.

[0005] According to some variants, each of the one or more support ribs has a trailing edge on a side of the support rib facing the outlet end of the primary housing and a leading edge on an opposite side of the support rib. In some embodiments, the trailing edge has a smaller radius of curvature than the leading edge when measured through a cross-section of the support rib perpendicular to a length of the support rib. In some cases, the trailing edge of each of the one or more support ribs is thinner than the leading edge of each of the one or more support ribs.

[0006] In some embodiments, each of the one or more support ribs comprises a first lateral surface and a second lateral surface, wherein the first lateral surface meets the second lateral surface at both a leading edge and a trailing edge of the one or more support ribs. In some cases, an angle between the first lateral surface and the second lateral surface at the trailing edge is less than 20°. According to some variants, an angle between the first lateral surface and the second lateral surface at the trailing edge is less than an angle between the first lateral surface and the second lateral surface at the leading edge.

[0007] In some embodiments, the air moving device includes four support ribs evenly circumferentially distrib-
In some embodiments, an angle between the first lateral surface and the second lateral surface at the trailing edge is less than an angle between the first lateral surface and the second lateral surface at the leading edge.

In some embodiments, the impeller comprises one or more impeller blades, each impeller blade having an inlet edge and an outlet edge positioned between the inlet edge of the impeller blade and the outlet of the primary housing.

In some embodiments, the inlet edge of each impeller blade is spaced from the inlet of the primary housing by a distance equal to or greater than 15% of a diameter of the impeller, as measured parallel to a rotational axis of impeller.

In some embodiments, each of the one or more support ribs has a first end connected to the impeller assembly and a second end connected to the primary housing, each support rib having a trailing edge extending between the first end and the second end on a side of the support rib facing the outlet end of the primary housing and a leading edge extending between the first end and the second end on an opposite side of the support rib, and the inlet edge of each impeller blade is spaced from the trailing edge at the first end of each support rib by a distance equal to or greater than 35% of a diameter of the impeller, as measured parallel to the central axis of the primary housing.

In some embodiments, the air moving device comprises an outer housing having a substantially cylindrical shape. In some embodiments, the primary housing is positioned at least partially within the outer housing.

In some embodiments, the air moving device includes one or more stator vanes positioned within the primary housing between the impeller and the outlet end.

In some embodiments, the air moving device comprises a motor housing positioned at an upstream end of the impeller assembly which is supported from a side of the motor housing opposite an impeller hub of the impeller assembly.

In some embodiments, the inlet end is unobstructed except for the motor housing and support ribs.

According to some variants, an air moving device includes a primary housing. The primary housing can include an inlet end, an outlet end, and a center axis extending through the inlet end and the outlet end. In some embodiments, the primary housing defines a primary housing interior. In some embodiments, the air moving device includes an impeller. The impeller can be positioned within the primary housing interior between the inlet end and the outlet end. In some embodiments, the air moving device includes a motor housing. The motor housing can be connected to the impeller and positioned upstream of the impeller. In some embodiments, the air moving device includes one or more support ribs. The one or more support ribs can be connected to the motor housing and to the primary housing. In some embodiments, the one or more support ribs are configured to hold the motor housing in position with respect to the primary housing. In some embodiments, the air moving device includes one or more stator vanes. The one or more stator vanes can be positioned at least partially within the primary housing interior downstream of the impeller.

In some embodiments, the air moving device includes four support ribs. The support ribs can be evenly circumferentially distributed between the motor housing and the primary housing.

In some embodiments, the air moving device includes a motor in the motor housing.
The inner housing 22 can be positioned at least partially within the outer housing 26. In some embodiments, the entire inner housing 22 is positioned within the outer housing 26. In some embodiments, a portion of the inner housing 22 extends beyond a downstream end of the outer housing 26.

[0042] An impeller assembly 30 can be positioned at least partially within the inner housing volume. The impeller assembly 30 can be supported from above (e.g., upstream of) the impeller assembly 30 (e.g., from a side of the impeller assembly 30) opposite the outlet end 18 of the primary housing 22). In some embodiments, the impeller assembly 30 is attached to the inner housing 22 and/or the outer housing 26 via one or more support ribs 34. For example, as illustrated in FIG. 3, the impeller assembly 30 can be attached to the inner housing 22 and/or to the outer housing 26 via four support ribs 34. In some cases, two, three, five, six, seven, eight, or any other number of support ribs 34 may be used. The support ribs 34 can be distributed equally about the perimeter (e.g., circumference) of the inlet end 14 of the air moving device 10. In some embodiments, the impeller assembly 30 is supported entirely by the support ribs 34. For example, the impeller assembly 30 and every subcomponent thereof can be unattached from every other portion of the air moving device 10 other than the support ribs 34.

[0043] As illustrated in FIG. 5, the impeller assembly 30 can include one or more impeller blades 38. For example, the impeller assembly 30 can include at least one, two, three, four, five, six, seven, and/or eight impeller blades 38. The impeller blades 38 can be sized and shaped to draw air into the inlet end 14 of the air moving device 10 via a pressure differential created through the impeller assembly 30. The impeller blades 38 can be constructed from a low density polymer or other light material to reduce the weight of the air moving device 10 and/or to reduce the rotational inertia of the impeller 30.

[0044] FIG. 6 illustrates the outlet end 18 of the air moving device 10. As illustrated, the air moving device 10 can include one or more stator vanes 42. The stator vanes 42 can be planar (e.g., flat) in shape. In some embodiments, the stator vanes 42 include one or more curved portions along an axial length of the stator vanes 42. The stator vanes 42 can include interior flange portions 46 configured to facilitate assembly of the stator vanes 42 as explained in U.S. patent application Ser. No. 12/724,799, now U.S. Pat. Nos. 8,626,842, issued Dec. 31, 2013 and entitled DEUMMARY AIR MOVING DEVICES, SYSTEMS AND METHODS, the entire disclosure of which is hereby incorporated by reference in its entirety herein. In some embodiments, the air moving device 10 includes a first set of stator vanes integral with the primary housing (e.g., with a nozzle portion of the primary housing). In some such embodiments, the air moving device 10 includes a second set of stator vanes upstream of the first set of stator vanes. The second set of stator vanes may include one or more curved portions. In some embodiments, the second set of stator vanes are configured to be installed into the primary housing.

[0045] As illustrated in FIG. 7, the impeller assembly 30 can include an impeller hub 40. The impeller blades 38 can extend radially from the impeller hub 40. In some embodiments, the impeller blades 38 are evenly distributed about the circumference of the impeller hub 40. In some cases, the impeller blades 38 and impeller hub 40 form a monolithic part. In some embodiments, the impeller blades 38 are attached to the impeller hub 40 via adhesives, fasteners, welding, and/or some other attachment mechanism or method.

[0046] In some embodiments, the impeller assembly 30 includes a motor housing 48. The impeller hub 40 can be connected to the motor housing 48. For example, the impeller hub 40 can be connected to the motor housing 48 between the motor housing 48 and the outlet end 18 of the air moving device 10. The motor housing 48 can define a motor housing interior 50. A motor 52 (shown in phantom in FIGS. 7-8) and/or other mechanical or electrical components can be housed within the motor housing interior 50. The motor 52 can be operably coupled with the impeller hub 40 and can impart a rotational force (e.g., torque) upon the impeller hub 40 to drive rotation of the impeller hub 40. In some embodiments, the motor 52 has sufficient power output to operate the air moving device 10 at an air flow rate between 200-1000 cubic feet per minute, between 300-800 cubic feet per minute, between 750 and 1400 cubic feet per minute, between 1300 and 1750 cubic feet per minute, and/or between 400-600 cubic feet per minute. In some cases, the air moving device 10 operates at an air flow rate of at least 200, at least 300, at least 400, at least 500, and/or at least 600 cubic feet per minute.

[0047] The motor housing 48 and motor 52 can be positioned above (e.g., upstream of) the impeller hub 40. The motor housing 48 can be connected to the inner housing 22 and/or to the outer housing 26 via one or more support ribs 34. Positioning the motor 52 and motor housing 48 above the impeller hub 40 can reduce the structural support necessary to stabilize the motor 52 (e.g., other than the support provided by the ribs 34). For example, the motor housing 48 can be directly connected to the support ribs 34 without the need for support from the impeller hub 40 or from any other components within the housing interior of the device 10. In some embodiments, the impeller hub 40 and blades 38 can be constructed from lighter materials than may be needed if the impeller hub 40 is used to stabilize the motor housing 48.

[0048] As illustrated in FIGS. 7 and 8, the support ribs 34 can have an arcuate shape with a convex leading edge 54 and a concave trailing edge 58. In some cases, the leading edge 54 is concave and the trailing edge 58 is convex. In some embodiments, the leading edge 54 and/or trailing edge 58 of the support ribs 34 are straight.

[0049] The one or more support ribs 34 can be connected to the motor housing 48 via adhesives, welding, fasteners, and/or any other suitable mechanism or method of fastening. In some embodiments, the support ribs 34 are formed as a monolithic part with a motor housing cap 62. The motor housing cap 62 can be connected to another portion of the motor housing 48 via adhesives, welding, fasteners, and/or any other suitable mechanism or method of fastening.

[0050] A first end 66 of each support rib 34 can be connected to the inner and/or outer housings 22, 26 at or near a perimeter of the inlet end 14 of the air moving device. A second end 70 of each support rib 34 can connect to the motor housing 48 at a position further from the outlet end 18 of the device 10 than the first end 66 of each support rib 34. In some embodiments, the support ribs 34 connect to the motor housing 48 such that at least a portion of the motor housing 48 is positioned outside of both the inner housing volume and the outer housing volume at a position further from the outlet end 18 than from the inlet end 14 of the device 10.

[0051] As illustrated in FIGS. 5 and 7, the inlet end 14 of the inner housing 22 can be unobstructed except for the support ribs 34 and the motor housing 48. Minimizing obstruction of the inlet end 14 of the inner housing 22 can improve operation of the air moving device 10. For example, minimized obstruc-
tion can reduce turbulence in the air drawn into the inlet end 14. In some cases, minimized obstruction can increase the inlet area of the inlet end 14 to permit increased air flow rate into the air moving device 10 per power output of the motor 52.

[0052] As illustrated in FIGS. 7 and 8, the impeller blades 38 have an inlet edge 74 and an outlet edge 78. The inlet edge 74 of each impeller blade 38 can be the edge of the impeller blade 38 nearest the inlet end 14 of the inner housing 22. In some cases, the inlet edge 74 of each impeller blade 38 is the edge of the impeller blade 38 which first contacts incoming air flow into the air moving device 10 via the inlet end 14. As illustrated in FIGS. 5 and 7, the inlet edges 74 of the impeller blades 38 are the edges which first contact incoming air flow into the air moving device 10 when the impeller hub 40 rotates in the counterclockwise direction in the frame of reference of FIG. 5.

[0053] The impeller hub 40 and blades 38 can be positioned within the inner housing volume. In some embodiments, the impeller blades 38 are spaced from the inlet end 14 of the air moving device 10 such that the distance 82 (e.g., as measured parallel to an axis of rotation of the impeller hub 40) between the inlet edge 74 of the impeller blades 38 and the inlet end 14 is at least 15% of the diameter 84 of the impeller 30. In some embodiments, the distance 82 between the inlet edge 74 of the impeller blades 38 and the inlet end 14 is at least 10%, at least 20%, at least 30%, at least 35%, at least 45%, at least 55% and/or at least 65% of the diameter 84 of the impeller 30. Many variations are possible while still providing certain advantages. The diameter 84 of the impeller 30 can be greater than 12 inches, greater than 15 inches, greater than 25 inches, greater than 35 inches, greater than 45 inches, and/or greater than 60 inches. In some embodiments, the diameter 84 of the impeller 30 is between 35 inches and 55 inches. Positioning the impeller blades 38 away from the inlet end 14 of the air moving device 10 can reduce the risk of injury due to contact between a person (e.g., an installer) and the impeller blades 38. Reducing the risk of injury from the impeller blades 38 can reduce or eliminate a need for a grill or other protective feature on the inlet end 14 of the air moving device 10.

[0054] In some embodiments, the distance 88 between the inlet edges 74 of the impeller blades 38 and the second ends 70 of the support ribs 34 is at least 25%, at least 30%, at least 35%, at least 40%, at least 45% and/or at least 50% of the diameter 84 of the impeller 30. Many variations are possible while still providing certain advantages. Spacing the impeller blades 38 away from the support ribs 34 can reduce the impact of any turbulence created by the support ribs 34 on the operation of the impeller 30.

[0055] As illustrated in FIG. 8A, each of the support ribs 34 can include a first rib surface 92 and a second rib surface 96. The first and second rib surfaces 92, 96 can meet each other at the leading and trailing edges 54, 58 of the support ribs 34. In some embodiments, the leading edges 54 of the support ribs 34 have radii of curvature that are greater than the radii of curvature of the trailing edges 58 of the support ribs.

[0056] In some embodiments, the first and second rib surfaces 92, 96 meet at an angle a at the trailing edge 58 of the support ribs 34. The angle a can be less than 40 degrees, less than 35 degrees, less than 30 degrees, less than 25 degrees, less than 20 degrees, less than 15 degrees, and/or less than 10 degrees. Many variations are possible while still providing certain advantages (e.g., reduced turbulence in the device 10).

[0057] Each of the first and second rib surfaces 92, 96 can include a trailing surface portion 92a, 96a (e.g., the portions of the surfaces 92, 96 which meet at the trailing edge 58). The first and second rib surfaces 92, 96 can include a leading surface portions 92b, 96b which meet the trailing surface portions 92a, 96a at a maximum width 100 of the support ribs 34 (e.g., as measured horizontally in the perspective of FIG. 8A). In some embodiments, all or a portion of the trailing surface portions 92a, 92b are flat (e.g., straight) as measured in the cut plane C-C of FIG. 8. In some cases the trailing edges 58 of the support ribs 34 (e.g., where the trailing portions 92a, 92b meet) can have a radius of curvature of zero or substantially zero. It can be advantageous for the support ribs 34 to have “sharp” trailing edges 58 to minimize turbulence generation (e.g., boundary layer separation from the surfaces of the support ribs 34) in the air entering the inlet end 14 of the air moving device 10. In some embodiments, the leading edges 54 of the support ribs 34 are blunted and/or rounded to encourage laminar flow across the support ribs 34.

[0058] For expository purposes, the term “horizontal” as used herein is defined as a plane parallel to the plane or surface of the floor of the area in which the system being described is used or the method being described is performed, regardless of its orientation. The term “floor” floor can be interchanged with the term “ground.” The term “vertical” refers to a direction perpendicular to the horizontal as just defined. Terms such as “above,” “below,” “bottom,” “top,” “side,” “higher,” “lower,” “upper,” “over,” and “under” are defined with respect to the horizontal plane. In some cases, the term “above” can refer to a position upstream and the term “below” can refer to a position downstream. Upstream and downstream can refer to the direction of flow through the air moving device 10.

[0059] As used herein, the terms “attached,” “connected,” “mated,” and other such relational terms should be construed, unless otherwise noted, to include removable, moveable, fixed, adjustable, and/or releasable connections or attachments. The connections/attachments can include direct connections and/or connections having intermediate structure between the two components discussed.

[0060] The terms “approximately,” “about,” “generally” and “substantially” as used herein represent an amount close to the stated amount that still performs a desired function or achieves a desired result. For example, the terms “approximately”, “about”, “generally,” and “substantially” may refer to an amount that is within less than 10% of the stated amount.

[0061] While the preferred embodiments of the present disclosure have been described above, it should be understood that they have been presented by way of example only, and not of limitation. It will be apparent to persons skilled in the relevant art that various changes in form and detail can be made therein without departing from the spirit and scope of the disclosure. Thus the present disclosure should not be limited by the above-described exemplary embodiments, but should be defined only in accordance with the following claims and their equivalents. Furthermore, while certain advantages of the disclosure have been described herein, it is to be understood that not necessarily all such advantages may be achieved in accordance with any particular embodiment of the disclosure. Thus, for example, those skilled in the art will recognize that the disclosure may be embodied or carried out in a manner that achieves or optimizes one advantage or group of advantages as taught herein without necessarily achieving other advantages as may be taught or suggested herein.
What is claimed is:

1. An air moving device comprising:
   a primary housing having an inlet end, an outlet end, and a center axis extending through the inlet end and the outlet end, the primary housing defining a primary housing interior;
   an impeller assembly positioned within the primary housing interior between the inlet end and the outlet end; one or more support ribs connected to the impeller assembly and to the primary housing, the one or more support ribs configured to hold the impeller assembly housing in position with respect to the primary housing.

2. The air moving device of claim 1, wherein each of the one or more support ribs has a trailing edge on a side of the support rib facing the outlet end of the primary housing and a leading edge on an opposite side of the support rib, and wherein trailing edge has a smaller radius of curvature than the leading edge when measured through a cross-section of the support rib perpendicular to a length of the support rib.

3. The air moving device of claim 2, wherein the trailing edge of each of the one or more support ribs is thinner than the leading edge of each of the one or more support ribs.

4. The air moving device of claim 1, wherein each of the one or more support ribs comprises a first lateral surface and a second lateral surface, wherein the first lateral surface meets the second lateral surface at both a leading edge and a trailing edge of the one or more support ribs.

5. The air moving device of claim 4, wherein an angle between the first lateral surface and the second lateral surface at the trailing edge is less than 20°.

6. The air moving device of claim 4, wherein an angle between the first lateral surface and the second lateral surface at the trailing edge is less than an angle between the first lateral surface and the second lateral surface at the leading edge.

7. The air moving device of claim 1, wherein the impeller comprises one or more impeller blades, each impeller blade having an inlet edge and an outlet edge positioned between the inlet edge of the impeller blade and the outlet of the primary housing.

8. The air moving device of claim 7, wherein the inlet edge of each impeller blade is spaced from the inlet of the primary housing by a distance equal to or greater than 15% of a diameter of the impeller, as measured parallel to a rotational axis of impeller.

9. The air moving device of claim 7, wherein each of the one or more support ribs has a first end connected to the impeller assembly and a second end connected to the primary housing, each support rib having a trailing edge extending between the first end and the second end on a side of the support rib facing the outlet end of the primary housing and a leading edge extending between the first end and the second end on an opposite side of the support rib, and wherein the inlet edge of each impeller blade is spaced from the trailing edge at the first end of each support rib by a distance equal to or greater than 35% of a diameter of the impeller, as measured parallel to the central axis of the primary housing.

10. The air moving device of claim 1, comprising an outer housing having a substantially cylindrical shape, wherein the primary housing is positioned at least partially within the outer housing.

11. The air moving device of claim 1, comprising one or more stator vanes positioned within the primary housing between the impeller and the outlet end.

12. The air moving device of claim 1, comprising a motor housing positioned at an upstream end of the impeller assembly and which is supported from a side of the motor housing opposite an impeller hub of the impeller assembly.

13. The air moving device of claim 12, wherein the inlet end is unobstructed except for the motor housing and support ribs.

14. An air moving device comprising:
   a primary housing having an inlet end, an outlet end, and a center axis extending through the inlet end and the outlet end, the primary housing defining a primary housing interior;
   an impeller positioned within the primary housing interior between the inlet end and the outlet end;
   a motor housing connected to the impeller and positioned upstream of the impeller;
   one or more support ribs connected to the motor housing and to the primary housing, the one or more support ribs configured to hold the motor housing in position with respect to the primary housing; and
   one or more stator vanes positioned at least partially within the primary housing interior downstream of the impeller.

15. The air moving device of claim 14, comprising four support ribs evenly circumferentially distributed between the motor housing and the primary housing.

16. The air moving device of claim 14, comprising a motor in the motor housing.

17. The air moving device of claim 14, wherein the motor housing is supported from a side of the motor housing opposite the impeller hub.

18. The air moving device of claim 14, wherein the motor housing is supported by the support ribs only.

19. The air moving device of claim 14, wherein the inlet is unobstructed except for the motor housing and support ribs.