# US Patent & Trademark Office
# Patent Public Search | Text View


| | |
|---|---|
| United States Patent Application Publication | 20250257738 |
| Kind Code | A1 |
| Publication Date | August 14, 2025 |
| Inventor(s) | Conrad; Wayne Ernest |


## HOUSEHOLD APPLIANCE HAVING AN IMPROVED FAN AND MOTOR ASSEMBLY AND FAN AND MOTOR ASSEMBLY FOR SAME


### Abstract

A household appliance has an air flow path extending from an air inlet to an air outlet with a fan and motor assembly. The fan and motor assembly comprises a motor drivingly connected to a first rotating fan blade subassembly and a second rotating fan blade subassembly. A first rotating fan blade subassembly provides a first level of air flow and a first level of suction and the second rotating fan blade subassembly provides a second level of air flow and a second level of suction, wherein the first level of air flow is higher than the second level of air flow and the second level of suction is higher than the first level of suction, and the fan and motor assembly is adjustable to vary amount of air entering the fan and motor assembly that is directed to each of the first and second rotating fan blade subassemblies.



| | |
|---|---|
| **Inventors:** | **Conrad; Wayne Ernest (Hampton, CA)** |
| **Applicant:** | **Omachron Intellectual Property Inc.** (Hampton, CA) |
| **Family ID:** | **96660627** |
| **Appl. No.:** | **19/194982** |
| **Filed:** | **April 30, 2025** |


### Related U.S. Application Data

parent US continuation 17911226 20220913 PENDING WO continuation PCT/CA2021/050434 20210331 child US 19194982
parent US continuation-in-part 17094330 20201110 parent-grant-document US 11517091 child US 17911226
parent US continuation-in-part 16944388 20200731 parent-grant-document US 11457713 child US 17094330
parent US continuation-in-part 16938057 20200724 parent-grant-document US 11425979 child US

16944388
parent US continuation-in-part 16837996 20200401 parent-grant-document US 11425980 child US 16938057
parent US continuation-in-part 16938057 20200724 parent-grant-document US 11425979 child WO PCT/CA2021/050434
parent US continuation-in-part 16837996 20200401 parent-grant-document US 11425980 child US 16938057
parent US continuation-in-part 16837996 20200401 parent-grant-document US 11425980 child WO PCT/CA2021/050434
us-provisional-application US 63044788 20200626
us-provisional-application US 63035282 20200605
us-provisional-application US 63027006 20200519
us-provisional-application US 63044788 20200626
us-provisional-application US 63035282 20200605
us-provisional-application US 63027006 20200519
us-provisional-application US 63044788 20200626
us-provisional-application US 63027006 20200519
us-provisional-application US 63035282 20200605
us-provisional-application US 63044788 20200626
us-provisional-application US 63035282 20200605
us-provisional-application US 63027006 20200519
us-provisional-application US 63062600 20200807
us-provisional-application US 63035282 20200605

---

## Publication Classification

**Int. Cl.:** **F04D29/46** (20060101); **A45D20/00** (20060101); **A47L11/40** (20060101); **F04D25/06** (20060101)

**U.S. Cl.:**

CPC **F04D29/462** (20130101); **A45D20/00** (20130101); **A47L11/4002** (20130101); **F04D25/06** (20130101);

---

## Background/Summary

CROSS-REFERENCE [0001] This application is a continuation of U.S. patent application Ser. No. 17/911,226 filed on Sep. 13, 2022, which is a national phase entry of International Patent Application No. PCT/CA2021/050434, filed on Mar. 31, 2021, which itself is: [0002] (1) a continuation-in-part of co-pending U.S. patent application Ser. No. 17/094,330, filed on Nov. 10, 2020, which itself [0003] a. is a continuation-in-part of U.S. patent application Ser. No. 16/944,388, filed on Jul. 31, 2020, which itself is a continuation-in-part of U.S. patent application Ser. No. 16/938,057, filed on Jul. 24, 2020, which itself is a continuation-in-part of U.S. patent application Ser. No. 16/837,996, filed on Apr. 1, 2020 and issued as U.S. Pat. No. 11,425,980 on Aug. 30, 2022, wherein said U.S. patent application Ser. Nos. 16/938,057 and 16/944,388 each also claim the benefit of U.S. Provisional Patent Application No. 63/027,006, filed on May 19, 2020; U.S. Provisional Patent Application No. 63/035,282, filed on Jun. 5, 2020; and U.S. Provisional Patent Application No. 63/044,788, filed on Jun. 26, 2020 entitled HAIR DRYER, and [0004] b. claims the benefit of U.S. Provisional Patent Application No. 63/027,006, filed on May 19, 2020;

U.S. Provisional Patent Application No. 63/035,282, filed on Jun. 5, 2020; and U.S. Provisional Patent Application No. 63/044,788, filed on Jun. 26, 2020 entitled HAIR DRYER,
and Application No. PCT/CA2021/050434 is also: [0005] (2) continuation-in-part of U.S. patent application Ser. No. 16/938,057, filed on Jul. 24, 2020, which itself is a continuation-in-part of U.S. patent application Ser. No. 16/837,996, filed on Apr. 1, 2020 and issued as patent Ser. No. 11/425,980 on Aug. 30, 2022, and said U.S. patent application Ser. No. 16/938,057 also claims the benefit of U.S. Provisional Patent Application No. 63/027,006, filed on May 19, 2020; U.S. Provisional Patent Application No. 63/035,282, filed on Jun. 5, 2020; and U.S. Provisional Patent Application No. 63/044,788, filed on Jun. 26, 2020 entitled HAIR DRYER; [0006] (3) Continuation-in-part of U.S. patent application Ser. No. 16/837,996, filed on Apr. 1, 2020 and issued as U.S. Pat. No. 11,425,980 on Aug. 30, 2022; [0007] and said Application No. PCT/CA2021/050434 also: [0008] (4) Claims benefit of priority to U.S. patent application Ser. No. 16/837,996, filed on Apr. 1, 2020 and issued as U.S. Pat. No. 11,425,980 on Aug. 30, 2022; [0009] (5) Claims benefit of priority to U.S. Provisional Patent Application No. 63/035,282, filed on Jun. 5, 2020; [0010] (6) Claims benefit of priority to U.S. patent application Ser. No. 16/938,057, filed on Jul. 24, 2020; [0011] (7) Claims benefit of priority to U.S. Provisional Patent Application No. 63/062,600, filed on Aug. 7, 2020; entitled FAN AND MOTOR ASSEMBLY FOR IMPROVED AIR FLOW; and [0012] (8) Claims benefit of priority to U.S. patent application Ser. No. 17/094,330, filed on Nov. 10, 2020; [0013] the contents of each of which are incorporated herein by reference.

## FIELD

[0014] This disclosure relates generally to fan and motor assemblies such as for use in household appliances and, optionally, portable appliances such as surface cleaning apparatuses, including carpet extractors, room air cleaners and hair dryers.

## INTRODUCTION

[0015] The following is not an admission that anything discussed below is part of the prior art or part of the common general knowledge of a person skilled in the art.

[0016] Various types of fan and motor assemblies for use in portable, lower power appliances are known. For example, fan and motor assemblies are commonly found in products such as corded and cordless vacuum cleaners, carpet extractors, hair dryers, and room air cleaners/purifiers.

[0017] Fan and motor assemblies that are commonly found in appliances are generally optimized for one of high suction or high air flow, or are designed such that they provide an acceptable level of both suction and air flow, but are not optimized to provide a maximum level of suction or air flow for the power input to the motor. For example, the fan and motor assembly within a vacuum cleaner may be optimized for high air flow, whereas the fan and motor assembly within a carpet extractor may be optimized for high suction.

[0018] It is to be understood that the term air flow refers to the volume of air (e.g., CFM) as it enters (i.e., is sucked/drawn into) an inlet of the appliance.

## SUMMARY

[0019] This summary is intended to introduce the reader to the more detailed description that follows and not to limit or define any claimed or as yet unclaimed invention. One or more inventions may reside in any combination or sub-combination of the elements or process steps disclosed in any part of this document including its claims and figures.

[0020] Portable appliances typically use a small relatively light weight motor that can produce an air flow of up to, e.g., 80 cfm. For example, a full-sized upright vacuum cleaner may have an air flow of 50-70 or 80 cfm. A stick vacuum cleaner operated by a removable hand vacuum cleaner may have an air flow of 30-40 cfm. A small hand held vacuum cleaner may have an air flow of 10-30 cfm.

[0021] As portable appliances are used in domestic residences and may be used in close proximity to a person, e.g., an air cleaner or hair dryer, noise levels produced by a motor and fan assemblies for portable appliances can be an issue.

[0022] In one aspect of this disclosure, which may be used by itself or with one or more of the other aspects disclosed herein, there is provided a fan and motor assembly, which may be used with portable appliances, that may be reconfigurable to promote one of suction or air flow, or to balance the suction force of, and air flow across, the fan and motor assembly. For example, a reconfigurable fan and motor assembly may be used within an appliance that is operable as both a vacuum cleaner and a carpet extractor. Specifically, when the appliance is used as a carpet extractor to remove (i.e., suck) water from, for example, carpet, the fan and motor assembly may be configured to promote suction; whereas, when the appliance is used as a vacuum cleaner to remove dust from, for example, a hard surface, the fan and motor assembly may be configured to promote air flow. Similarly, a vacuum cleaner may be operable in a bare floor cleaning mode wherein the fan and motor assembly may be configured to promote air flow and in a carpet cleaning mode wherein the fan and motor assembly may be configured to promote suction.

[0023] In other aspects, specific configurations of a motor and fan assembly are provided which result in enhanced characteristics (e.g., higher air flow or higher suction) for a fixed (non-reconfigurable) motor and fan assembly for use in appliances and, in particular, portable appliances.

[0024] In accordance with these broad aspects, there is provided a household appliance having an air flow path extending from an air inlet to an air outlet with a fan and motor assembly in the air flow path. The fan and motor assembly comprises a motor drivingly connected to a first rotating fan blade subassembly and a shield. The first rotating fan blade subassembly comprises a plurality of rotatable blades and a plurality of fan blade air channels. The motor has an axis of rotation. The fan and motor assembly is adjustable between a first configuration in which the first rotating fan blade subassembly provides a first level of air flow and a first level of suction and a second configuration in which the first rotating fan blade subassembly provides a second level of air flow and a second level of suction wherein the first level of air flow is higher than the second level of air flow and the second level of suction is higher than the first level of suction.

[0025] In any embodiment, the fan and motor assembly may further comprise a vortex finder. The vortex finder may have an outlet that communicates with an inlet of the first rotating fan blade subassembly. The position of the vortex finder to the inlet may be adjustable between a first position in which the fan and motor assembly is in the first configuration and a second position in which the fan and motor assembly is in the second configuration.

[0026] In any embodiment, in the second position, the vortex finder may block a portion of an entrance to the plurality of fan blade air channels.

[0027] In any embodiment, in the first position, the vortex finder may be axially spaced from the entrance to the plurality of fan blade air channels.

[0028] In any embodiment, the fan and motor assembly may further comprise a seal positioned between the first rotating fan blade subassembly and the shield whereby air entering the fan and motor assembly may be inhibited from bypassing the plurality of fan blade air channels.

[0029] In any embodiment, the fan and motor assembly may further comprise a first stationary vane subassembly. The first stationary vane subassembly may comprise a plurality of vanes and a plurality of stationary vane air channels. Each of the vanes may have a leading edge and a trailing edge in a direction of rotation of the first rotating fan blade subassembly. The alignment of the plurality of vanes may be adjustable between a first position and a second position. In the second position the leading edge of one vane may be angularly spaced apart from a trailing edge of an adjacent vane in a direction transverse to the axis of rotation of the motor. A plurality of bypass air gaps may be provided within the stationary vane subassembly that extend through the stationary vane air channels along the axis of rotation of the motor.

[0030] In any embodiment, in the first position, the leading edge of each vane may be in line with the trailing edge of the adjacent vane along the axis of rotation of the motor.

[0031] In any embodiment, the fan and motor assembly may further comprise a first stationary vane subassembly. The first stationary vane subassembly may comprise a first set of vanes, a second set of vanes and a plurality of stationary vane air channels. The stationary vane air channels may have a width in the direction of rotation of the motor. The position of the first set of vanes with respect to the second set of vanes may be adjustable whereby the width of the stationary vane air channels is adjustable.

[0032] In any embodiment, the position of the first set of vanes with respect to the second set of vanes may be adjustable between a first position and a second position. In the first position the first set of vanes may be adjacent the second set of vanes and a first number of stationary vane air channels is provided. In the second position, the first set of vanes may be spaced from the second set of vanes and a second number of stationary vane air channels is provided and the second number of stationary vane air channels is greater than the first number of stationary vane air channels.

[0033] In any embodiment, the fan and motor assembly may further comprise a first stationary vane subassembly having a first set of vanes and a first plurality of stationary vane air channels and a second stationary vane subassembly having a second set of vanes and a second plurality of stationary vane air channels. The position of the first set of vanes may be adjustable with respect to the position of the second set of vanes.

[0034] In any embodiment, the position of the first set of vanes may be adjustable with respect to the position of the second set of vanes between a first position and a second position. In the second position the first set of vanes may be angularly spaced from the second set of vanes in a direction transverse to the axis of rotation of the motor. A plurality of bypass air gaps may be provided within the first and second stationary vane subassemblies that extend through the stationary vane air channels along the axis of rotation of the motor.

[0035] In any embodiment, in the first position, the first set of vanes may be aligned with respect to the second set of vanes in a direction transverse to the axis of rotation of the motor whereby bypass of the first stationary vane subassembly and the second stationary vane subassembly is inhibited.

[0036] In any embodiment, the fan and motor assembly may further comprise a rotating dome that overlies the first rotating fan blade subassembly.

[0037] In any embodiment, the first rotating fan blade subassembly may have a first end providing an inlet to the first rotating fan blade subassembly and an axially spaced apart second end. The plurality of fan blade air channels may have channel outlets that are provided in an end wall of the second end.

[0038] In any embodiment, the first rotating fan blade subassembly may have an end spaced from and facing the shield and a gap between the end and the shield may be variable.

[0039] In any embodiment, a pitch of the plurality of rotatable blades may be adjustable.

[0040] In any embodiment, the fan and motor assembly may further comprise a vortex finder and a diameter of the vortex finder may be adjustable.

[0041] In any embodiment, the fan and motor assembly may further comprise a first stationary vane subassembly having a first set of vanes and a first plurality of stationary vane air channels and a pitch of the plurality of the vanes may be adjustable.

[0042] In any embodiment, the household appliance may be a vacuum cleaner, an extractor or a hair dryer.

[0043] In accordance with these broad aspects, there is also provided a household appliance having an air flow path extending from an air inlet to an air outlet with a fan and motor assembly in the air flow path. The fan and motor assembly comprising a motor drivingly connected to a first rotating fan blade subassembly and a second rotating fan blade subassembly. The first rotating fan blade subassembly provides a first level of air flow and a first level of suction and the second rotating fan blade subassembly provides a second level of air flow and a second level of suction. The first level of air flow is higher than the second level of air flow and the second level of suction is higher than the first level of suction. The fan and motor assembly is adjustable to vary an amount of air entering the fan and motor assembly that is directed to each of the first and second rotating fan blade subassemblies.

[0044] In any embodiment, in a first configuration, at least a majority of the air entering the fan and motor assembly may be directed to the first rotating fan blade subassembly and, in a second configuration, at least a majority of the air may be directed to the second rotating fan blade subassembly.

[0045] In any embodiment, in a first configuration, at least a majority of the air entering the fan and motor assembly may be directed to the first rotating fan blade subassembly and then subsequently through the second rotating fan blade subassembly.

[0046] In any embodiment, in a first configuration, essentially all of the air entering the fan and motor assembly may be directed to the first rotating fan blade subassembly and, in a second configuration, essentially all of the air may be directed to the second rotating fan blade subassembly.

[0047] In any embodiment, in a first configuration, essentially all of the air entering the fan and motor assembly may be directed to the first rotating fan blade subassembly and then subsequently through the second rotating fan blade subassembly.

[0048] In any embodiment, in a first configuration, the air entering the fan and motor assembly may flow in series through the first rotating fan blade subassembly and the second rotating fan blade subassembly and, in a second configuration, the air entering the fan and motor assembly may flow through only one of the first rotating fan blade subassembly and the second rotating fan blade subassembly.

[0049] In any embodiment, in the second configuration, essentially all of the air may be directed to the second rotating fan blade subassembly.

[0050] In any embodiment, the fan and motor assembly may further comprise a vortex finder. Each of the first and second rotating fan blade subassemblies may have an inlet. The position of the vortex finder with respect to the first and second rotating fan blade assemblies may be adjustable to vary the amount of air entering the fan and motor assembly that is directed to each of the first and second rotating fan blade subassemblies.

[0051] In any embodiment, the vortex finder may be adjustable between a first position in which the vortex finder directs at least a majority of the air entering the fan and motor assembly to the first rotating fan blade subassembly and a second position in which the vortex finder directs at least a majority of the air entering the fan and motor assembly to the first rotating fan blade subassembly.

[0052] In any embodiment, the fan and motor assembly may further comprise a vortex finder and a diameter of the vortex finder may be adjustable.

[0053] In any embodiment, the fan and motor assembly may further comprise a vortex finder. The vortex finder may have an outlet that communicates with an inlet of the first rotating fan blade subassembly. The position of the vortex finder to the inlet may be adjustable between a first configuration in which the first rotating fan blade subassembly provides the first level of air flow and the first level of suction and a third configuration in which the first rotating fan blade subassembly provides a third level of air flow and a third level of suction wherein the first level of air flow is higher than the third level of air flow and the third level of suction is higher than the first level of suction.

[0054] In any embodiment, the first rotating fan blade subassembly may have a first plurality of rotatable blades, the second rotating fan blade subassembly may have a second plurality of rotatable blades and a pitch of at least one of the first and second plurality of rotatable blades may be adjustable.

[0055] In any embodiment, the pitch of each of the first and second plurality of rotatable blades

may be adjustable.
[0056] In any embodiment, the fan and motor assembly may further comprise a first stationary vane subassembly having a first set of vanes and a first plurality of stationary vane air channels and a pitch of the plurality of the vanes may be adjustable.
[0057] In any embodiment, the household appliance may be a vacuum cleaner, an extractor or a hair dryer.
[0058] It will be appreciated by a person skilled in the art that an apparatus or method disclosed herein may embody any one or more of the features contained herein and that the features may be used in any particular combination or sub-combination.
[0059] These and other aspects and features of various embodiments will be described in greater detail below.

---

## Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0060] For a better understanding of the described embodiments and to show more clearly how they may be carried into effect, reference will now be made, by way of example, to the accompanying drawings in which:
[0061] FIG. **1**A is an exploded view of a fan and motor assembly;
[0062] FIG. **1**B is a perspective view of a rotating fan blade subassembly of the fan and motor assembly of FIG. **1**A;
[0063] FIG. **1**C is a perspective view of the rotating fan blade subassembly and a stationary vane subassembly of the fan and motor assembly of FIG. **1**A;
[0064] FIG. **1**D is a perspective cross-sectional view of the fan and motor assembly of FIG. **1**A;
[0065] FIG. **1**E is a cross-sectional view of the fan and motor assembly of FIG. **1**A;
[0066] FIG. **1**F is a cross-sectional view of the fan and motor assembly of FIG. **1**A and a vortex finder, the vortex finder shown positioned relative to the fan and motor assembly to promote enhanced suction;
[0067] FIG. **1**G is a cross-sectional view of the fan and motor assembly and the vortex finder of FIG. **1**F, the vortex finder shown positioned relative to the fan and motor assembly to promote enhanced air flow;
[0068] FIG. **1**H is a cross-sectional view of the rotating fan blade subassembly of FIG. **1**B, taken along line **1**H-**1**H in FIG. **1**B;
[0069] FIG. **2** is a cross-sectional view of an alternative embodiment of a fan and motor assembly and a vortex finder;
[0070] FIG. **3** is a cross-sectional view of a further alternative embodiment of a fan and motor assembly and a vortex finder;
[0071] FIG. **4**A is a perspective view of a further alternative embodiment of a rotating fan blade subassembly and a stationary vane subassembly;
[0072] FIG. **4**B is a side view of the rotating fan blade subassembly and the stationary vane subassembly of FIG. **4**A;
[0073] FIG. **4**C is a top view of the rotating fan blade subassembly and the stationary vane subassembly of FIG. **4**A;
[0074] FIG. **5**A is a perspective view of a further alternative embodiment of a rotating fan blade subassembly and a stationary vane subassembly;
[0075] FIG. **5**B is a side view of the rotating fan blade subassembly and the stationary vane subassembly of FIG. **5**A;
[0076] FIG. **5**C is a top view of the rotating fan blade subassembly and the stationary vane subassembly of FIG. **5**A;

[0077] FIG. **6**A is a side view of a further alternative embodiment of a rotating fan blade subassembly and a stationary vane subassembly, a first set of vanes of the stationary vane subassembly shown in contact with a second set of vanes of the stationary vane subassembly;
[0078] FIG. **6**B is a side view of the rotating fan blade subassembly and the stationary vane subassembly of FIG. **6**A, the first set of vanes of the stationary vane subassembly shown spaced apart from the second set of vanes of the stationary vane subassembly;
[0079] FIG. **7**A is a perspective view of a motor and fan blade assembly having a rotating fan blade subassembly, a first stationary vane subassembly, and a second stationary vane subassembly;
[0080] FIG. **7**B is a side view of the rotating fan blade subassembly, the first stationary vane subassembly, and the second stationary vane subassembly of FIG. **7**A, the first and second vane subassemblies are shown positioned relative to each other to promote enhanced suction;
[0081] FIG. **7**C is a side view of the rotating fan blade subassembly, the first stationary vane subassembly, and the second stationary vane subassembly of FIG. **7**A, the first and second vane subassemblies are shown positioned relative to each other to promote enhanced air flow;
[0082] FIG. **8**A is a side view of an alternative embodiment of a rotating fan blade subassembly, a first stationary vane subassembly, and a second stationary vane subassembly, the first and second vane subassemblies are shown positioned proximate to each other to promote enhanced suction;
[0083] FIG. **8**B is a side view of the rotating fan blade subassembly, the first stationary vane subassembly, and the second stationary vane subassembly of FIG. **8**A, the first and second vane subassemblies are shown positioned spaced from each other to promote enhanced air flow;
[0084] FIG. **9**A is a side view of a further alternative embodiment of a fan and motor assembly (without the motor) and a vortex finder, the fan and motor assembly having a first rotating fan blade subassembly and a second rotating fan blade subassembly, wherein the vortex finder positioned to direct air flow to the first rotating fan blade subassembly;
[0085] FIG. **9**B is a side view of the fan and motor assembly and the vortex finder of FIG. **9**A, wherein the vortex finder positioned to direct air flow to the second rotating fan blade subassembly;
[0086] FIG. **9**C is a side view of a further alternative embodiment of a fan and motor assembly (without the motor), a first vortex finder, and a second vortex finer, the fan and motor assembly having a first rotating fan blade subassembly and a second rotating fan blade subassembly, wherein the first and second vortex finders are positioned to direct air flow to the first rotating fan blade subassembly;
[0087] FIG. **9**D is a side view of the fan and motor assembly, the first vortex finder, and the second vortex finder of FIG. **9**C, wherein the first and second vortex finders are positioned to direct air flow to the second rotating fan blade subassembly;
[0088] FIG. **10**A is a perspective view of a further alternative embodiment of a rotating fan blade subassembly and a stationary vane subassembly;
[0089] FIG. **10**B is a cross-sectional view of the rotating fan blade subassembly and the stationary vane subassembly of FIG., taken along line **10**B-**10**B;
[0090] FIG. **10**C is a top view of the rotating fan blade subassembly and the stationary vane subassembly of FIG. **10**A;
[0091] FIG. **11**A is a perspective view of a further alternative embodiment of a rotating fan blade subassembly and a stationary vane subassembly;
[0092] FIG. **11**B is a cross-sectional view of the rotating fan blade subassembly and the stationary vane subassembly of FIG. **11**A, taken along line **11**B-**11**B;
[0093] FIG. **11**C is a top view of the rotating fan blade subassembly and the stationary vane subassembly of FIG. **11**A;
[0094] FIG. **12**A is a cross-sectional view of a hair dryer having an embodiment of a fan and motor assembly installed therein, wherein the fan and motor assembly is configured to promote enhanced suction; and,

[0095] FIG. **12**B is a cross-sectional view of the hair dryer of FIG. **12**A, wherein the fan and motor assembly is configured to promote enhanced air flow.
[0096] The drawings included herewith are for illustrating various examples of articles, methods, and apparatuses of the teaching of the present specification and are not intended to limit the scope of what is taught in any way.
DESCRIPTION OF VARIOUS EMBODIMENTS
[0097] Various apparatuses will be described below to provide an example of an embodiment of each claimed invention. No embodiment described below limits any claimed invention and any claimed invention may cover apparatuses that differ from those described below. The claimed inventions are not limited to apparatuses having all of the features of any one apparatus described below or to features common to multiple or all of the apparatuses described below. It is possible that an apparatus described below is not an embodiment of any claimed invention. Any invention disclosed in an apparatus described below that is not claimed in this document may be the subject matter of another protective instrument, for example, a continuing patent application, and the applicants, inventors or owners do not intend to abandon, disclaim or dedicate to the public any such invention by its disclosure in this document.
[0098] The terms “an embodiment”, “embodiment”, “embodiments”, “the embodiment”, “the embodiments”, “one or more embodiments”, “some embodiments”, and “one embodiment” mean “one or more (but not all) embodiments of the present invention(s),” unless expressly specified otherwise.
[0099] The terms “including”, “comprising”, and variations thereof mean “including but not limited to”, unless expressly specified otherwise. A listing of items does not imply that any or all of the items are mutually exclusive, unless expressly specified otherwise. The terms “a”, “an”, and “the” mean “one or more”, unless expressly specified otherwise.
[0100] As used herein and in the claims, two or more parts are said to be “coupled”, “connected”, “attached”, or “fastened” where the parts are joined or operate together either directly or indirectly (i.e., through one or more intermediate parts), so long as a link occurs. As used herein and in the claims, two or more parts are said to be “directly coupled”, “directly connected”, “directly attached”, or “directly fastened” where the parts are connected in physical contact with each other. As used herein, two or more parts are said to be “rigidly coupled”, “rigidly connected”, “rigidly attached”, or “rigidly fastened” where the parts are coupled so as to move as one while maintaining a constant orientation relative to each other. None of the terms “coupled”, “connected”, “attached”, and “fastened” distinguish the manner in which two or more parts are joined together.
[0101] Some elements herein may be identified by a part number, which is composed of a base number followed by an alphabetical or subscript-numerical suffix (e.g., **112***a*, or **112**.sub.1). Multiple elements herein may be identified by part numbers that share a base number in common and that differ by their suffixes (e.g., **112**.sub.1, **112**.sub.2, and **112**.sub.3). All elements with a common base number may be referred to collectively or generically using the base number without a suffix (e.g., **112**).
[0102] It should be noted that terms of degree such as “substantially”, “about”, and “approximately” as used herein mean a reasonable amount of deviation of the modified term such that the end result is not significantly changed. These terms of degree may also be construed as including a deviation of the modified term, such as by 1%, 2%, 5% or 10%, for example, if this deviation does not negate the meaning of the term it modifies.
[0103] Furthermore, the recitation of numerical ranges by endpoints herein includes all numbers and fractions subsumed within that range (e.g., **1** to **5** includes 1, 1.5, 2, 2.75, 3, 3.90, 4, and 5). It is also to be understood that all numbers and fractions thereof are presumed to be modified by the term “about” which means a variation of up to a certain amount of the number to which reference is being made if the end result is not significantly changed, such as 1%, 2%, 5%, or 10%, for example.

## General Description of a Fan and Motor Assembly

[0104] Appliances **100** are continuously becoming more versatile while the demand for efficiency and effectiveness remains consistent, if not heightened. For example, in terms of versatility, many appliances **100** may be required to operate using suction and high air flow (e.g., surface cleaning apparatus such as a vacuum cleaner for cleaning bare floors and carpet, a combined vacuum cleaner and extractor, hair dryers, etc.) and also are meant to operate in different environments that require alternative performance characteristics for optimum operation of the appliance **100** (e.g., enhanced suction vs. enhanced air flow).

[0105] For a fan and motor assembly **102** to generate an enhanced suction force, the air flow through the fan and motor assembly **102** is typically reduced; and to generate an enhanced air flow through the fan and motor assembly **102**, the suction force is typically reduced. That is, the ability of a fan and motor assembly **102** to generate suction and air flow are inversely related. Therefore, fan and motor assemblies **102** within appliances **100** are generally designed for either enhanced suction, enhanced air flow, or a balance of suction and air flow.

[0106] Described herein are systems and methods for improving the efficiency and effectiveness of static fan and motor assemblies **102** (i.e., fan and motor assemblies **102** that are non-reconfigurable and are designed for one of enhanced suction, enhanced air flow, or a balance of suction to air flow). Also described are reconfigurable fan and motor assemblies **102** (i.e., fan and motor assemblies **102** that can be reconfigured to enhance suction, enhance air flow, or balance suction and air flow based on the function and/or environment of the appliance). That is, in some examples, the fan and motor assembly **102** may adjustable between at least (a) a first configuration in which a first level of air flow and a first level of suction are produced by the fan and motor assembly **102** and; (b) a second configuration in which a second level of air flow and a second level of suction are produced by the fan and motor assembly **102**, wherein the first and second levels differ. In some examples, the first level of air flow may higher than the second level of air flow and the second level of suction may be higher than the first level of suction.

[0107] Referring now to FIG. **1**A, shown therein is an exploded view of an example of a fan and motor assembly **102**. The fan and motor assembly **102** may be of any shape and configuration. The fan and motor assembly **102** may be located in an air flow path that extends between an air inlet and an air outlet of an appliance **100**. As illustrated, the fan and motor assembly **102** may be made up of a shield **104** (which may be referred to as a cowling or an impeller housing), a rotating fan blade subassembly **106**, an optional stationary vane subassembly **108**, and a motor **110**. As is described in more detail subsequently, the fan and motor assembly **102** may include any number of rotating fan blade subassemblies **106**, any number of the optional stationary vane subassemblies **108**, and any number of motors **110** to drive rotation of any component of the fan and motor assembly **102**. In some examples, the fan and motor assembly **102** may not include any stationary vane subassemblies **108**. Further, in the example illustrated, the shield **104** and the rotating fan blade subassembly **106** are shown as separate components of the fan and motor assembly **102**. However, the shield **104** and the rotating fan blade subassembly **106** may be formed from the same monolithic work-piece.

[0108] Still referring to FIG. **1**A, the motor **110** may be any motor **110** known in the art capable of driving rotation of the rotating fan blade subassembly **106**. Further, the motor **110** may be drivingly connected to the rotating fan blade subassembly **106** by any connection means known in the art. When in use, the motor **110** may rotate the rotating fan blade subassembly about an axis of rotation **170** of the motor **110** (see FIG. **1**C). In the example illustrated, a distal end **112** of a drive shaft **114** of the motor **110** is threaded for engagement with the rotating fan blade subassembly **106**.

[0109] Referring now to FIG. **1**B, shown therein is an example embodiment of a rotating fan blade subassembly **106**. The rotating fan blade subassembly **106** may be of any shape and configuration, and may be made from a monolithic work-piece, or may be assembled from multiple components. As illustrated, the rotating fan blade subassembly **106** may include a plurality of rotatable blades

**118** for generating an air flow through the fan and motor assembly **102** when rotated by the motor **110**. Each rotatable blade **118** of the plurality of blades extends from a leading edge **120** to a trailing edge **122**. It will be appreciated that the rotatable blades may be mounted in a fixed position in the rotating fan blade subassembly **106** and are rotatable as they rotate with the rotating fan blade subassembly **106**.

[0110] With reference to FIG. **1**H, the leading edge **120** and the trailing edge **122** of each rotatable blade **118** of the plurality of blades define a chord **115** of the blade **118**. The chord **115** and a line **117** which is tangent to the normal at the leading edge **120** of the blade **118** defines a pitch **116** (i.e., blade angle). In the example illustrated in FIGS. **1**A to **1**H, the pitch **116** of each rotatable blade **118** is fixed. In some examples, the pitch **166** of each rotatable blade **118** may be adjustable. Adjusting the pitch **116** of the rotatable blades **118** may alter the performance characteristics of the rotating fan blade subassembly **106**. Any means known in the art for adjusting the pitch **116** of a blade **118** may be used.

[0111] Referring back to FIG. **1**B, in the example illustrated, the rotatable blades **118** are enclosed by an upper wall **124** and a lower wall **126**. The rotatable blades **118**, the upper wall **124**, and the lower wall **126** together define a plurality of fan blade air channels **130**. As shown, each fan blade air channel of the plurality of fan blade air channels **130** extend from a fan blade air channel inlet **132** to a fan blade air channel outlet **134**. Each of the fan blade air channel inlets **132** of the plurality of fan blade air channels **130** may collectively be referred to as an entrance to the plurality of fan blade air channels **130**. The fan blade air channels **130** are in fluid flow communication with an inlet **138** of the rotating fan blade subassembly **106**. In the example illustrated, the inlet **138** extends through the upper wall **124** of the rotating fan blade subassembly **106**, and the inlet **138** is centrally located within the upper wall **124**.

[0112] Optionally, as shown, a flange **140** may extend about the inlet **138** of the rotating fan blade subassembly **106**. The flange **140** may improve the seal between the rotating fan blade subassembly **106** and a conduit (e.g., a vortex finder which is not shown) that may connect the rotating fan blade subassembly **106** in air flow communication with the inlet and/or outlet (not shown) of the appliance **100**. In some examples, as described in detail below, a vortex finder **142** may be positioned between the conduit extending from the inlet and/or outlet of the appliance **100** and the rotating fan blade subassembly **106**. Accordingly, the flange **140** may improve the seal between the rotating fan blade subassembly **106** and the vortex finder **142**.

[0113] As described previously, in some examples, the fan and motor assembly **102** may include a stationary vane subassembly **108**. Referring now to FIG. **1**C, shown therein is an example of the rotating fan blade subassembly **106** as described previously and an example of a stationary vane subassembly **108**. The stationary vane subassembly **108** may be of any shape or configuration and may be made of a single monolithic work-piece or may be made of a plurality of components.

[0114] The rotating fan blade subassembly **106** and the stationary vane subassembly **108** may be provided as part of a motor and fan assembly by any means known in the art. Each of the rotating fan blade subassembly **106** and the stationary vane subassembly **108** may be mounted in a common housing and they may be connected to each other, e.g., by the motor shaft that drives the rotating fan blade subassembly **106** extending through the stationary vane subassembly **108**.

[0115] The stationary vane subassembly **108** may be rotatable, although at a different (e.g., slower) rate than the rotating fan blade subassembly **106**, and therefore rotatable relative to the rotating fan blade subassembly **106**. Therefore, in one aspect that may be used by itself or in combination with any one or more features set out herein, although referred to as a stationary vane subassembly **108**, the stationary vane subassembly **108** may be rotatable. For example, a second motor **110** may be included in the fan and motor assembly **102** to drive rotation of the stationary vane subassembly **108**. Alternatively, the motor **110** used to drive rotation of the rotating fan blade subassembly **106** may also drive rotation of the stationary vane subassembly **108**. That being said, when driven by the same motor **110** as the rotating fan blade subassembly **106**, a gear set, or other means (e.g., frictional rotation limited by a brake), may be implemented so that the rotational speed of the stationary vane subassembly **108** is less than that of the rotating fan blade subassembly **106**. In any embodiment, the stationary vane subassembly **108** may rotate, even at a very low RPM compared to that of the rotating fan blade subassembly **106**, as this may reduce the amount of noise produced by the fan and motor assembly **102**, when in use.

[0116] As shown, the stationary vane subassembly **108** may be positioned downstream of the rotating fan blade subassembly **106**. That is, an air flow path **148** extends through the fan and motor assembly **102**, and the air flow path **148** may extend from rotating fan blade subassembly **106** to the stationary vane subassembly **108**.

[0117] As exemplified in FIG. **1**C, the stationary vane subassembly **108** includes a plurality of vanes **150** that redirect the air flow **148** after it passes through the rotating fan blade subassembly **106**. As described below, the position, shape, and orientation of the vanes **150** may affect the performance characteristics of the fan and motor assembly **102**.

[0118] Optionally, in one aspect that may be used by itself or in combination with any one or more features set out herein, the vanes **150** can be made out of silicon or foam so they are flexible and can “move” when impacted by the air flow (i.e., materials that “absorb noise”).

[0119] Each vane **150** of the plurality of vanes has a leading edge **152** and a trailing edge **154** in a direction of rotation of the rotating fan blade subassembly **106**. Each vane **150** also has an upper face **156** extending from the leading edge **152** to the trailing edge **154**, as well as a lower face **158** extending from the leading edge **152** to the trailing edge **154**. The upper face **156** of one vane **150** and the lower face **158** of an adjacent vane **150** define, in part, a plurality of stationary vane air channels **160** that extend through the stationary vane subassembly **108**. The stationary vane air channels **160** may also be defined, in part, by an inner hub **162** and an outer hub **164** of the stationary vane subassembly **108**.

[0120] Similar to the rotating fan blade subassembly **106**, as described above, in one aspect that may be used by itself or in combination with any one or more features set out herein, in some examples of the stationary vane subassembly **108**, a pitch of each vane **150** of the plurality of vanes may be adjustable.

[0121] As exemplified, in examples of a fan and motor assembly **102** that include a stationary vane subassembly **108**, the plurality stationary vane air channels **160** are downstream of the rotating fan blade subassembly **106** and may be positioned radially outwardly of the rotating fan blade subassembly **106**. Accordingly, the leading edge **152** may be located at or radially outward of the trailing edge **122** of each rotatable blade **118**.

[0122] Optionally, in one aspect that may be used by itself or in combination with any one or more features set out herein, the leading edge **152** of each vane **150** of the plurality of vanes within the stationary vane subassembly **108** may be angularly spaced apart, along the axis of rotation **170** of the rotating fan blade subassembly **106**, in the direction of air flow **148**, from the trailing edge **122** of each rotatable blade **118** of the plurality of blades of the rotating fan blade subassembly **106**.

[0123] Optionally, in one aspect that may be used by itself or in combination with any one or more features set out herein, the distance between the leading edge **152** of the vanes **150** and the trailing edge **122** of the rotating fan blade subassembly **106**, along the rotational axis **170** of the rotating fan blade subassembly **106** may be adjustable. That is, the alignment of the plurality of vanes may be adjustable between a first position and a second position.

[0124] When the angular spacing between the rotating fan blade subassembly **106** and the stationary vane subassembly **108** is relatively small, the fan and motor assembly **102**, when in use, may be more able to generate suction force. Whereas, when the angular spacing between the rotating fan blade subassembly **106** and the stationary vane subassembly **108** is relatively large, the fan and motor assembly **102**, when in use, may be more able to generate high air flow.

[0125] Referring now to FIG. **1**D, as illustrated, the shield **104** of the fan and motor assembly **102** may direct the air flowing radially outwardly from the rotating fan blade subassembly **106** downwardly towards the stationary vane subassembly **108**.

[0126] The shield **104** may be of any shape and configuration that promotes fluid flow through the fan and motor assembly **102**. In the example illustrated, the shield **104** has an opening **172** through which a conduit or the vortex finder **142** may pass through to fluidically connect the rotating fan blade subassembly **106** to the inlet and/or outlet of the appliance **100**. As illustrated, a flange **140** (i.e., seal) may extend about the opening **172** of the shield **104**.

[0127] In some examples, a first end **136** of the rotating fan blade subassembly **106** may be spaced from and facing the shield **104**. Accordingly, as shown in FIG. **1**D, a gap may be provided between the shield **104** and the first end **136**. In some examples, as described in more detail subsequently, the gap between the first end **136** of the rotating fan blade subassembly **106** and the shield **104** may be variable. Any means known in the art for adjusting the relative position between the first end **136** of the rotating fan blade subassembly **106** and the shield **104** may be used, such as moving the motor shaft towards or away from the shield **104**.

[0128] In the example illustrated, the motor **110** of the fan and motor assembly **102** is positioned below the stationary vane subassembly **108** (i.e., the stationary vane subassembly **108** is positioned between the rotating fan blade subassembly **106** and the motor **110**). Accordingly, the drive shaft **114** of the motor may extend through the stationary vane subassembly **108**. In other embodiments, the motor **110** may be otherwise located.

General Description of a Vortex Finder

[0129] In accordance with one aspect of this disclosure, which may be used by itself or in combination with any other aspect of this disclosure, the fan and motor assembly **102** is in fluid flow communication with a vortex finder **142** which is configurable to alter the performance characteristics of the fan and motor assembly **102**.

[0130] For example, the vortex finder **142** may be reconfigurable by varying the positioning of the vortex finder **142** with respect to the inlet to the rotating fan blade subassembly **106**. Movement of the vortex finder **142** with respect to the inlet to the rotating fan blade subassembly **106** adjusts the location at which air enters the fan and motor assembly **102** and in particular the rotating fan blade subassembly **106**. The vortex finder **142** can be of any shape and configuration that allows for the entry point of the air into the fan and motor assembly **102** to be adjusted. It will be appreciated that one or both of the vortex finder and the rotating fan blade subassembly **106** may be moveable with respect to the other. Accordingly, the position of one or both may be axially adjustable. Alternately, or in addition, the vortex finder may be telescoping so that the location of the outlet of the vortex finder is adjustable.

[0131] Alternately, or in addition, the diameter of the vortex finder **142** may also be adjustable to alter the performance characteristics of the fan and motor assembly **102**. For example, the vortex finder may have a flow constrictor which opens or closes all or a portion of the air flow path through the vortex finder **142**. The flow constrictor may be a valve, an iris or the sidewall defining the vortex finder may be adjusted to increase or decrease the diameter of the vortex finder. Optionally, an adjustable iris is provided at the outlet of the vortex finder and/or the inlet to the fan and motor assembly **102**.

[0132] As described previously, the performance characteristics of the fan and motor assembly **102** may be adjusted depending on the selected function of the appliance **100**, as well as the environment in which the appliance **100** is operating. That is, in some cases, the fan and motor assembly **102** may produce enhanced suction, whereas, in other cases, the fan and motor assembly **102** may produce enhanced air flow. Alternatively, the fan and motor assembly **102** may operate such that the suction and air flow are balanced.

[0133] Referring now to FIG. **1**F, in the example illustrated, a vortex finder **142** is shown in fluid flow communication with the rotating fan blade subassembly **106**. Specifically, in the example illustrated, the vortex finder **142** has an outlet **144** in communication with the inlet **138** of the first rotating fan blade subassembly **106**.

[0134] As shown, the vortex finder **142** may be a conduit **178** which is movable from a first position, in which, when in use, the appliance **100** exhibits enhanced air flow (see FIG. **1**G wherein the outlet **144** of the vortex finder **142** is located at the upper end of the entrance to the air flow channels in the rotating fan blade subassembly **106**), to a second position, in which, when in use, the appliance **100** exhibits enhanced suction (see FIG. **1**F wherein the outlet **144** of the vortex finder blocks part of the entrance to the air flow channels in the rotating fan blade subassembly **106**). That is, when the vortex finder **142** is in the first position, the air flow generated by the fan and motor assembly **102** is greater than the air flow generated by the fan and motor assembly **102** when the vortex finder **142** is in the second position. Further, when the vortex finder **142** is in the first position, the suction generated by the fan and motor assembly **102** is lower than the suction generated by the fan and motor assembly **102** when the vortex finder **142** is in the second position. The vortex finder **142** may also be positioned at any location between the first and second positions, in which the suction force and air flow may be balanced.

[0135] As shown in FIG. **1**F, when in the second position (i.e., positioned for enhanced suction), a distal end **180** of the vortex finder **142** extends through the opening **172** of the shield **104** and the inlet **138** of the rotating fan blade subassembly **106** to a position in which the distal end **180** blocks a portion of the inlets **132** to the fan blade air channels **130** (i.e., the entrance to the plurality of fan blade air channels **130**) of the rotating fan blade subassembly **106**.

[0136] As shown in FIG. **1**G, when in the first position (i.e., positioned for enhanced air flow), the vortex finder **142** is positioned so that the distal end **180** of the vortex finder **142** does not block the inlets **132** to the fan blade air channels **130** (i.e., the entrance to the plurality of fan blade air channels **130**) of the rotating fan blade subassembly **106**.

[0137] Therefore, by varying the position of the distal end **180** of the vortex finder **142** relative to the entrance to the plurality of fan blade air channels **130**, the air flow and suction may be varied. Withdrawing the vortex finder will increase air flow while inserting the vortex finder will increase suction.

[0138] Movement of the vortex finder **142** can be controlled by any means known in the art. For example, a user of the appliance **100** may manually move the vortex finder **142** or an actuator drivingly connected to the vortex finder **142**. For example, a handle **204** may be driving connected to the vortex finder **142**. Accordingly, moving handle **204** from the position shown in FIG. **12**A to the position shown in FIG. **12**B may move the vortex finder **142**. The handle **204** may be mechanically driving connected to the vortex finder **142** by a mechanical linkage. Alternately, an actuator may be driving connected to the vortex finder **142**. The appliance **100** may sense the position of handle **204** and send a signal to the actuator, e.g., solenoid, based on the position of handle **204**.

[0139] The actuator may be, for example, a thermomechanical member (e.g., muscle wire that changes length when heated or a bimetallic strip which changes configuration), an electromechanical actuator such as a solenoid or a stepper motor or the like, a fluidic motor, or a hydraulic motor.

[0140] Alternatively, the actuator may be signaled to move the vortex finder **142** based on an input from a user. For example, when a user selects a mode on the appliance **100** (e.g., for a surface cleaning apparatus bare floor cleaning or carpet cleaning or, for a hair dryer, a suction drying mode or a blow dry mode), the actuator may automatically move the vortex finder **142** to the appropriate location so that the fan and motor assembly **102** is configured for the selected function (e.g., a function that requires higher suction or a function that requires higher air flow).

[0141] Alternatively, a sensor may be used to detect the environment in which the appliance **100** is being used, and the sensor may signal the actuator to position the vortex finder **142** accordingly. Any sensor known in the art may be used. For example, the sensor may be an optical sensor to detect the type of floor being cleaned (e.g., carpet or hardwood and to increase air flow when a hard floor surface is detected), a proximity sensor (e.g., to detect the proximity of hair to a suction inlet of a hair dryer and increase suction when hair is positioned proximate a suction inlet of a hair dryer) or a temperature sensor (e.g., to detect the temperature of air exiting a hair dryer or the temperature of hair being dried by a hair dryer and increase the air flow rate when the temperature exceeds a predetermined temperature).

[0142] Alternatively, any measurable characteristic of the fan and motor assembly **102** or the appliance **100** in which the fan and motor assembly **102** is located may be monitored by the sensor. Accordingly, the sensor may be, for example, a pressure sensor (e.g., to increase the air flow when the pressure is greater than a predetermined pressure) or a flow sensor (e.g., to increase suction when air flow is below a predetermined air flow).

[0143] As a specific example, a diaphragm or a piston may be capable of detecting a change in pressure across the fan and motor assembly **102**. Based on the pressure change, the actuator may be signaled to move the vortex finder **142** to the enhanced suction position or the enhanced air flow position.

[0144] In another embodiment, the vortex finder **142** may remain stationary, and the fan and motor assembly **102** may be moved to adjust the relative position between the vortex finder **142** and the fan and motor assembly **102**.

[0145] It will be appreciated that the actuators and/or the sensors described herein may be used to operate any reconfiguration of a motor and fan assembly described herein.

General Description of Shield Materials

[0146] In accordance with one aspect of this disclosure, which may be used by itself or in combination with any other aspect of this disclosure, a significant portion or all of the shield **104** directly adjacent to the rotating fan blade subassembly **106** may be made from a material that absorbs sound so that the noise of the fan and motor assembly **102**, when in use, is reduced.

[0147] Example materials that absorb sound include, but are not limited to, cross linked plastic foam, polyethylene, cross linked polyethylene such as closed cell cross linked polyethylene, balsa wood, woven bamboo matrix, bamboo, plastic, composite, or a combination of these, and optionally a combination of these plus metal.

[0148] Referring to FIGS. **2** and **3**, in the examples illustrated, the shield **104** of the fan and motor assembly **102** is formed of a closed cell cross linked polyethylene.

[0149] When the shield **104** is formed of a sound absorbent material, such as those described above, optionally, a thin metal or plastic or composite tube (not shown) may be bonded or mechanically affixed to the shield **104** to form the opening **172** of the shield **104** through which the conduit and/or vortex finder **142** may extend through.

[0150] The opening **172** may be made from a thin metal or plastic composite tube because the sound absorbent materials may be unable to form a proper seal between the shield **104** and the conduit and/or the vortex finder **142**. Further, the sound absorbent materials described above may wear down, and therefore form a weak seal, after continued movement of the vortex finder **142**. Accordingly, the opening **172**, i.e., the mating region between the conduit and/or the vortex finder **142**, may be formed of a material such as plastic or metal.

General Description of a Seal Between the Rotating Fan Blade Subassembly and Shield

[0151] In accordance with one aspect of this disclosure, which may be used by itself or in combination with any other aspect of this disclosure, there may be a seal **182** located between the rotating fan blade subassembly **106** and the shield **104**.

[0152] As exemplified in FIG. **3**, a seal **182** located between the rotating fan blade subassembly **106** and the shield **104** may promote air to flow from the conduit and/or vortex finder **142** through the fan blade air channels **130** as opposed to around the rotating fan blade subassembly **106**. That is, the seal **182** may be positioned between the rotating fan blade subassembly **106** and the shield **104** so that air entering the fan and motor assembly **102** is inhibited from bypassing the plurality of fan blade air channels **130**. If two rotating fan blade subassemblies are provided, then a seal **182** may be provided between a vortex finder and one or both of the fan blade subassemblies.

[0153] The seal **182** may be formed from any sealing means known in the art. For example, the seal **182** may be a bushing or a sealed bearing **184**. Specifically, the bushing **184** may be a high-speed rotatable bushing.

[0154] Referring to FIG. **3**, in the example illustrated, the rotating high-speed bushing **184** is positioned between the flange **140** extending about the inlet **138** to the rotating fan blade subassembly **106** and an inner face **186** of the shield **104**.

[0155] Alternately or in addition, the fan and motor assembly **102** may include a biasing device (not shown) which may exert a small down force pressure on the shield **104**, with respect to the rotating fan blade subassembly **106**, or vice versa, to offset wear of the seal **182** over time. That is, as the seal **182** wears due to rotation of the rotating fan blade subassembly **106**, the distance between the shield **104** and the rotating fan blade subassembly **106** may be reduced by a biasing member or an actuator to ensure a proper seal is formed by the seal **182**.

General Description of Vane Spacing within a Stationary Vane Subassembly

[0156] The spacing of the vanes **150** within the stationary vane subassembly **108** may affect the performance characteristics of the fan and motor assembly **102**. As described below, the vane spacing may be static (i.e., may be designed for enhanced suction, enhanced air flow, or a balance between suction and air flow) or may be reconfigurable based on the desired performance characteristics of the appliance **100**.

No Overlap Between Adjacent Vanes within a Stationary Vane Subassembly

[0157] In accordance with one aspect of this disclosure, which may be used by itself or in combination with any other aspect of this disclosure, there may be no overlap between adjacent vanes **150** within a stationary vane subassembly **108**.

[0158] Overlap refers to the angular distance between the trailing edge **154** of one vane **150** to the nearest leading edge **152** of an adjacent vane **150** in a direction transverse to the rotational axis **170** of the rotating fan blade subassembly **106**.

[0159] Referring to FIG. **4**B, in the example illustrated, there is no overlap between the leading edges **152** and trailing edges **154** of adjacent vanes **150**. That is, as exemplified in the top plan view of FIG. **4**C, the leading edge **152** of one vane **150** is in line with the trailing edge **154** of an adjacent vane **150** along the axis of rotation **170** of the rotating fan blade subassembly **106**.

[0160] When the vanes **150** of the stationary vane subassembly **108** are positioned so that there is no overlap, the suction force generated by the fan and motor assembly **102**, when in use, is greater than that if there was is a negative overlap as discussed subsequently.

[0161] Optionally, in one aspect that may be used by itself or with any one or more other aspects set out herein, the leading edge **152** of the vanes **150** may be curved (not shown). Specifically, in the direction of air flow **148** through the stationary vane subassembly **108**, the leading edge **152** may be concave (e.g., when view from above in a top plan view).

Negative Overlap Between Adjacent Vanes within a Stationary Vane Subassembly

[0162] In accordance with one aspect of this disclosure, which may be used by itself or in combination with any other aspect of this disclosure, there may be negative overlap between adjacent vanes **150** within a stationary vane subassembly **108**.

[0163] Referring to FIG. **5**B, in the example illustrated, there is negative overlap between the leading edges **152** and the trailing edges **154** of adjacent vanes **150**. That is, the leading edge **152** of one vane **150** is angularly spaced apart from the nearest trailing edge **154** of an adjacent vane **150** in a direction transverse to the axis of rotation **170** of the rotating fan blade subassembly **106**.

[0164] Accordingly, the negative overlap creates a plurality of bypass air gaps **190** (see FIG. **5**C) within the stationary vane subassembly **108** that extend through the stationary vane air channels **160** along the axis of rotation **170** of the rotating fan blade subassembly **106**. That is, air may flow parallel to the rotational axis **170** of the rotating fan blade subassembly **106** through the stationary vane subassembly **108** without contacting a vane **150** of the stationary vane subassembly **108**.

[0165] When the vanes **150** of the stationary vane subassembly **108** are positioned so that there is negative overlap between adjacent vanes **150**, the air flow generated by the fan and motor assembly **102**, when in use, is greater than that if there was no overlap and suction is reduced.

Adjustable Spacing Between Adjacent Vanes within a Stationary Vane Subassembly

[0166] In accordance with one aspect of this disclosure, which may be used by itself or in combination with any other aspect of this disclosure, the spacing between adjacent vanes **150** within a stationary vane subassembly **108** may be adjustable.

[0167] A stationary vane subassembly **108** may have adjustable vane spacing so that the performance characteristics of the fan and motor assembly **102** can be configured according to the function and/or operating environment of the appliance **100** in which the fan and motor assembly **102** are installed.

[0168] Any means known in the art to adjust the spacing between adjacent vanes **150** within a stationary vane subassembly **108** may be used. For example, any actuator and any sensor described herein may be used.

[0169] As exemplified in FIGS. **6**A and **6**B, the stationary vane subassembly **108** may have a first set of vanes and a second set of vanes. Each vane **150***a* of the first set of vanes is separated from an adjacent vane **150***a* of the first set of vanes by a vane **150***b* of the second set of vanes. As shown, a plurality of stationary vane air channels **160** are formed by the first set of vanes **150***a* and the second set of vanes **150***b.*

[0170] In the example illustrated, the second set of vanes **150***b* are rotatable with respect to the first set of vanes **150***a*. Accordingly, the second set of vanes may be positioned such that each vane **150***b* of the second set of vanes is in contact with or adjacent a vane **150***a* of the first set of vanes (see, FIG. **6**A). In this position, the first set of vanes and the second set of vanes may together define a stationary vane subassembly **108** with negative overlap between adjacent vanes **150**. In this configuration, a width **166** of the stationary vane air channels **160** through the stationary vane subassembly **108** is increased which enhances air flow through the stationary vane subassembly.

[0171] If the second set of vanes is rotated away from the first set of vanes, the number of air flow channels in the stationary vane subassembly is increased. In this configuration, the width **166** of the stationary vane air channels **160** through the stationary vane subassembly **108** is decreased which enhances suction.

[0172] It will be appreciated that the second set of vanes may be rotated away from the first set of vanes and the first and second set of vanes may define a stationary vane subassembly **108** with no overlap or negative overlap between adjacent vanes **150**.

[0173] As shown in FIG. **6**B, the second set of vanes may be positioned so that each vane **150***b* of the second set of vanes is positioned at an equidistance to each adjacent vane **150***a* of the first set of vanes. It is to be understood that the second set of vanes can be positioned at any distance between adjacent vanes **150***a* of the first set of vanes.

[0174] Alternately, or in addition, the axial position of the rotating fan blade assembly to the stationary vane assembly may also be adjustable.

Adjustable Spacing Between Vanes within a Dual Stationary Vane Subassembly

[0175] In accordance with one aspect of this disclosure, which may be used by itself or in combination with any other aspect of this disclosure, the fan and motor assembly **102** may include at least a second stationary vane subassembly **108***b.*

[0176] The second stationary vane subassembly **108***b* may be of any shape and configuration. The second stationary vane subassembly **108***b* may have the same shape and configuration as the first stationary vane subassembly **108**, or a different shape and/or configuration as the first stationary vane subassembly **108**.

[0177] Including a second stationary vane subassembly **108***b* may allow for the performance characteristics of the fan and motor assembly **102** to be configured based on the selected function of the appliance **100** in which the fan and motor assembly **102** is located within and/or the environment of the appliance **100**. That is, the position of the first stationary vane subassembly **108** may be adjustable with respect to the position of the second stationary vane subassembly **108***b* between a first position and a second position to alter the performance characteristics of the fan and motor assembly **102**.

[0178] For example, referring to FIG. **7**B, the first stationary vane subassembly **108** and the second stationary vane subassembly **108***b* may be angularly positioned relative to each other so that the vanes **150** of the first stationary vane subassembly **108** are in line with the vanes **150** of the second stationary vane subassembly **108***b* (i.e., the trailing edge **154** of a vane **150** of the first stationary vane subassembly **108** may be aligned with a leading edge **152** of a vane **150** of the second stationary vane subassembly **108***b*). In the example illustrated, in this position, the vanes **150** of the first stationary vane subassembly **108** and the vanes **150** of the second stationary vane subassembly **108***b* essentially form continuous vanes **150** that have no overlap. Put another way, in the example illustrated, the set of vanes of the first stationary vane subassembly **108** are aligned with respect to the set of vanes of the second stationary vane subassembly **108***b* in a direction transverse to the axis of rotation **170** of the motor **110** such that bypass of the first stationary vane subassembly **108** and the second stationary vane subassembly **108***b* is inhibited. Accordingly, the vanes **150** of the first and second stationary vane subassemblies **108**, **108***b* together may define a set of vanes **150** which increases the ability of the fan and motor assembly **102** to generate suction.

[0179] Alternatively, referring now to FIG. **7**C, the first stationary vane subassembly **108** and the second stationary vane subassembly **108***b* may be angularly positioned relative to each other so that the vanes **150** of the first stationary vane subassembly **108** positively overlap with the vanes **150** of the second stationary vane subassembly **108**.

[0180] In this position, as shown, the vanes **150** of the first and second stationary vane subassemblies **108**, **108***b* may be positioned so that a bypass air gap **190** extends through each of the first and second stationary vane subassemblies **108**, **108***b* along the axis of rotation **170** of the motor **110**.

[0181] Accordingly, the vanes **150** of the first and second stationary vane subassemblies **108**, **108***b* may together define a set of vanes **150** which increases the ability of the fan and motor assembly **102** to generate air flow.

[0182] The second stationary vane subassembly **108***b* may move with respect to the first stationary vane subassembly **108** by any means known in the art. For example, the second stationary vane subassembly **108***b* may rotate with respect to the first stationary vane subassembly **108**. Any actuator known in the art may be used to rotate the second stationary vane subassembly **108***b* with respect to the first stationary vane subassembly **108**. Further, any sensor known in the art, measuring any performance characteristic of the appliance **100** may be used to signal the actuator. Any actuator and any sensor described herein may be used. Alternatively, a user of the appliance **100** may manually reposition the second stationary vane subassembly **108***b* with respect to the first stationary vane subassembly **108** based on the desired performance characteristics of the appliance **100**.

[0183] Alternatively, or in addition, as exemplified in FIGS. **8**A and **8**B, the second stationary vane subassembly **108***b* may translate along the axis of rotation **170** of the rotating fan blade subassembly **106** with respect to the first stationary vane subassembly **108**.

[0184] As shown, when the first and second stationary vane subassemblies **108**, **108***b* are in contact, the vanes **150** of the first stationary vane subassembly **108** and the vanes **150** of the second stationary vane subassembly **108***b* may together define a set of combined vanes. As shown, a combined vane of the set of combined vanes may positively overlap with an adjacent combined vane. In some examples, a combined vane of the set of combined vanes may have no overlap with adjacent combined vanes (see, FIG. **7**A). In this position, the first and second stationary vane subassemblies **108**, **108***b* may promote suction.

[0185] Referring now to FIG. **8**B, the second stationary vane subassembly **108***b* may translate away from the first stationary vane subassembly **108** along the axis of rotation **170** of the rotating fan blade subassembly **106**. When the second stationary vane subassembly **108***b* is positioned away from the first stationary vane subassembly **108**, air may more freely flow through the first and second stationary vane subassemblies **108**, **108***b*. Therefore, in this position, the first and second stationary vane subassemblies **108**, **108***b* may promote air flow through the fan and motor assembly **102**.

[0186] It is to be understood that any number of stationary vane subassemblies **108** may be used within the fan and motor assembly **102**.

[0187] Any actuator and any sensor described herein may be used to reconfigure the axial position of the first and second stationary vane subassemblies **108**.

[0188] It will also be appreciated that the vanes of any stationary vane subassembly **108** may have any feature described herein, such as having a variable pitch or being moveable angularly with respect to each other to provide a bypass gap **190**.

General Description of a Fan and Motor Assembly Having Dual Rotating Fan Blade Subassemblies

[0189] In accordance with one aspect of this disclosure, which may be used by itself or in combination with any other aspect of this disclosure, the fan and motor assembly **102** may have more than one rotating fan blade subassembly **106**.

[0190] A fan and motor assembly **102** may have more than one rotating fan blade subassembly **106** as a first rotating fan blade subassembly **106** may be designed for generating high suction and the second rotating fan blade subassembly **106***b* may be designed for generating high air flow through the fan and motor assembly **102**. Accordingly, one rotating fan blade subassembly **106** may be selected, or may be configurable, to provide higher suction than a second rotating fan blade subassembly **106**. Therefore, each rotating fan blade subassembly **106** that is provided in a motor and fan assembly **102** may be selected to provide, or may be reconfigurable to provide, higher air flow or higher suction. The air flow through the motor and fan assembly **102** may be adjusted to vary the amount of air provided to each of the rotating fan blade subassembly **106**.

[0191] That is, for example, the first rotating fan blade subassembly **106** may have a higher number of rotatable blades **118** and/or smaller fan blade air channels **130** than the second rotating fan blade subassembly **106***b*, and may therefore, have different performance characteristics.

[0192] The fan and motor assembly **102** may be adjustable to vary an amount of air entering the fan and motor assembly **102** that is directed to each of the first and second rotating fan blade subassemblies **106**, **106***b*. That is, for example, the configuration of the fan and motor assembly **102** may be adjustable to control the amount of air being provided to each of the first rotating fan blade subassembly **106** and the second rotating fan blade subassembly **106***b*. In some examples, in a first configuration, at least 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90% or more of the air entering the fan and motor assembly **102** is directed to the first rotating fan blade subassembly **106**, and in a second configuration, at least 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90% or more of the air is directed to the second rotating fan blade subassembly **106***b*. In some examples, in a first configuration, essentially all or all of the air entering the fan and motor assembly **102** is directed to the first rotating fan blade subassembly **106**, and in a second configuration, essentially all or all of the air is directed to the second rotating fan blade subassembly **106***b*.

[0193] The second rotating fan blade subassembly **106***b* may be of any shape and configuration. It will be appreciated that each of the rotating fan blade subassemblies **106**, **106***b* may have any one or more of the aspects set out herein.

[0194] In order to selectively direct to air to one or both of the rotating fan blade subassemblies **106**, **106***b*, the portion of the air flow path through the appliance that is upstream of the motor and fan assembly **102** may be selectively connected with one or both of the rotating fan blade subassemblies **106**, **106***b*. For example, the position of one or more outlets of the vortex finder **142** with respect to an inlet of each of the rotating fan blade subassemblies **106**, **106***b* may be adjustable. Accordingly, the vortex finder **142** may be operable to direct air flow to one of the first or the second rotating fan blade subassemblies **106**, **106***b*. Further, the vortex finder **142** may be operable to direct air flow to both of the first and second rotating fan blade subassemblies **106**, **106***b*.

[0195] For example, referring to FIGS. **9**A and **9**B, the vortex finder **142** may have a slot outlet **192** in a sidewall **194** of the vortex finder **142** near its distal end **180**, through which air may exit the vortex finder **142** and flow into the first rotating fan blade subassemblies **106** (see FIG. **9**A) and the second rotating fan blade subassemblies **106***b* (see FIG. **9**B), based on the position of the vortex finder **142**.

[0196] Alternatively, referring now to FIGS. **9**C and **9**D, the fan and motor assembly **102** may include a first (i.e., inner) vortex finder **142***a* and a second (i.e., outer) vortex finder **142***b*. The inner vortex finder **142***a* may move with respect to the outer vortex finder **142***b* to direct air to one of the first or the second rotating fan blade subassemblies **106**, **106***b*. For example, as shown, when in a first position (see FIG. **9**C) the first and second vortex finders **142***a*, **142***b* cooperate to direct air to the first rotating fan blade subassembly **106**. In this configuration the outlets **192** that are closer to the distal end **180** of the inner and outer vortex finders **142***a* and **142***b* are aligned such that air exits the vortex finder **142** through outlets **192** that are provided, and enters the flow channels of the first rotating fan blade subassembly **106**. At the same time, the axially inner outlets **192** of the inner and outer vortex finders **142***a* and **142***b* are offset such that air is inhibited from exiting through the axially inner outlets **192** into the flow channels of the second rotating fan blade assembly **106***b*. In a second position (see FIG. **9**D), the first and second vortex finders **142***a*, **142***b* cooperate to direct air to the second rotating fan blade subassembly **106***b*. In this configuration each of the axially inner outlets **192** of the inner and outer vortex finders **142***a* and **142***b* are aligned such that air exits the vortex finder **142** through the axially inner outlets **192** and enters the flow channels of the second rotating fan blade subassembly **106***b*. At the same time, the outlets **192** at the distal end **180** of the inner and outer vortex finders **142***a* and **142***b* are offset such that air is inhibited from exiting through the outlets **192** at the distal end **180** of the inner and outer vortex finders **142***a* and **142***b* into the flow channels of the first rotating fan blade assembly **106**.

[0197] As shown, when using a first and second vortex finder **142***a*, **142***b* to selectively direct air to the first or the second rotating fan blade subassemblies **106**, **106***b*, the magnitude of displacement required for the vortex finder **142** to move is less than that when using a single vortex finder **142**. Accordingly, in compact appliances **100**, first and second vortex finder **142***a*, **142***b* may be used to selectively direct air to one of the first and second rotating fan blade subassemblies **106**, **106***b*.

[0198] It is to be understood that the fan and motor assembly **102** may include any number of rotating fan blade subassemblies **106** and any number of vortex finders **142** to selectively direct air to the any number of rotating fan blade subassemblies **106**.

[0199] Optionally, in accordance with an aspect which may be used by itself or in combination with any one or more aspects set out herein, as shown, a fan **198** may be positioned within the vortex finder **142** to promote airflow through the fan and motor assembly **102**.

[0200] The vortex finder(s) **142** may be axially moveable as discussed previously herein. Optionally, a user of the appliance **100** may manually move the vortex finder(s) **142**. In some examples, the vortex finder(s) **142** may automatically be moveable to direct air through the first rotating fan blade subassembly **106** or the second rotating fan blade subassembly **106***b* based on the rotational speed of the rotating fan blade subassemblies **106**, **106***b*. That is, the first and second rotating fan blade subassemblies **106**, **106***b* may both be connected to the motor **110** and therefore be rotated at the same speed, when in use. At low RPM the vortex finder(s) **142** may direct air to, for example, the first rotating fan blade subassembly **106** which may be designed for high suction whereas at high RPM, the vortex finder(s) **142** may direct air to, for example, the second rotating fan blade subassembly **106***b* which may be designed for high air flow.

[0201] It will be appreciated that the vortex finder(s) **142** may direct air to both the first and second rotating fan blade subassemblies **106**, **106***b* simultaneously.

[0202] It will also be appreciated that the air may be directed to the second rotating fan blade subassembly **106***b* and then subsequently pass through the first rotating fan blade subassembly **106**. For example, in a first configuration, at least 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90% or more of the air entering the fan and motor assembly **102** is directed to the second rotating fan blade subassembly **106***b* and then subsequently at least 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90% or more of the air is then directed through the first rotating fan blade subassembly **106**. As a second example, in a first configuration, essentially all or all of the air entering the fan and motor assembly **102** is directed to the second rotating fan blade subassembly **106***b* and then subsequently through the first rotating fan blade subassembly **106**.

[0203] In yet another example, in a first configuration, the air entering the fan and motor assembly **102** flows in series through the second rotating fan blade subassembly **106***b* and then the first rotating fan blade subassembly **106** and, in a second configuration, the air entering the fan and motor assembly **102** flows through only one of the first rotating fan blade subassembly **106** and the second rotating fan blade subassembly **106***b*.

[0204] In yet another example, the fan and motor assembly **102** may have a third configuration in which the first rotating fan blade subassembly **106** provides a third level of air flow and a third level of suction. The third level of suction may be higher than the first level of suction and the third level of airflow may be lower than the first level of air flow. The position of the vortex finder with respect to the first rotating fan blade subassembly **106** may be adjustable so that first rotating fan blade subassembly **106** may provide a first and third level of air flow and suction.

[0205] In a particular example, two rotating fan blade subassemblies may be provided. In this example, the first (upstream) rotating fan blade subassembly that the air first enters may be configured to provide higher suction and lower air flow than a second (downstream) rotating fan blade subassembly. The second (downstream) rotating fan blade subassembly may be configured to provide lower suction and higher air flow than the first (upstream) rotating fan blade subassembly. If all the air travels sequentially through both of the rotating fan blade subassemblies, then the two rotating fan blade subassemblies may provide a higher level of suction than either rotating fan blade subassembly by itself. If the air travels in parallel through both of the rotating fan blade subassemblies, then the two rotating fan blade subassemblies may provide a higher level of air flow than either rotating fan blade subassembly by itself. In such a case, the air may self-balance the amount which travels through each rotating fan blade subassembly.

[0206] Optionally, if two fan blades assemblies are provided, then the first and second rotating fan blade subassemblies **106**, **106***b* may automatically engage and disengage from the rotating drive shaft **114** of the motor **110** at different RPMs so that the fan and motor assembly **102** has the desired performance characteristics when the rotating fan blade subassemblies **106**, **106***b* are rotating within the appropriate RPM range. For example, a first inertial locking member may non-rotatably mount a first rotating fan blade subassembly **106** to the motor shaft in a first range of RPM (e.g., a low range of RPM) and a second inertial locking member may non-rotatably mount a second rotating fan blade subassembly **106** to the motor shaft in a second range of RPM (e.g., a higher range of RPM). Alternately, a single inertial locking member maybe used. Accordingly, the inertial locking member may non-rotatably mount a first rotating fan blade subassembly **106** to the motor shaft in a first range of RPM and then disengage the first rotating fan blade subassembly **106** and non-rotatably mount a second rotating fan blade subassembly **106** to the motor shaft at a second range of RPM. It will be appreciated that, at an intermediate range of RPM, both the first and second rotating fan blade subassemblies may be non-rotatably mounted to the motor shaft. It will be appreciated that this aspect may be used if no vortex finder is provided or if a non-moveable (fixed or static) vortex finder is provided.

[0207] In the example illustrated, regardless of whether air passes through the first rotating fan blade subassembly **106** or the second rotating fan blade subassembly **106***b*, after passing through the first or the second rotating fan blade subassemblies **106**, **106***b*, the air optionally passes through the same stationary vane subassembly **108**. Alternatively, in some embodiments of the fan and motor assembly **102**, each rotating fan blade subassembly **106**, **106***b* may direct air to a different stationary vane subassembly **108**. That is, there may be a first stationary vane subassembly associated with the first rotating fan blade subassembly **106** and there may be a second stationary vane subassembly associated with the second rotating fan blade subassembly **106***b*. Accordingly, in some examples, air may pass through the first rotating fan blade subassembly **106**, through a first stationary vane subassembly associated with the first rotating fan blade subassembly **106**, through the second rotating fan blade subassembly **106***b*, and then through a second stationary vane subassembly associated with the second rotating fan blade subassembly **106**. Alternately, in accordance with this aspect, a stationary vane subassembly may not be used.

General Description of a Rotating Dome

[0208] In accordance with one aspect of this disclosure, which may be used by itself or in combination with any other aspect of this disclosure, the fan and motor assembly **102** includes a rotating dome **200**. The rotating dome **200** may be of any shape and configuration, and may be connected to, or an integral component of, the rotating fan blade subassembly **106**.

[0209] As exemplified in FIGS. **10**A-**10**C, the rotating dome **200** may direct air, which exits the rotating fan blade subassembly **106** in a direction substantially perpendicular to the rotational axis **170** of the rotating fan blade subassembly **106**, downwardly in a direction substantially parallel to the rotational axis **170** of the rotating fan blade subassembly **106**.

[0210] That is, the rotating dome **200** may be used to redirect the air as opposed to, or in addition to, the shield **104**, as described previously. In some examples, the rotating dome **200** and the shield **104** are separate components of the fan and motor assembly **102**. That is, the rotating dome **200** may be housed within the shield **104**. In other examples, the rotating dome **200** and the shield **104** are the same component (i.e., the shield **104** may be configured to rotate).

[0211] A rotating dome **200** may be used to redirect the air as opposed to a stationary shield **104**, as the rotating dome **200** may reduce the amount of noise generated by the air when being redirected.

General Description of Air Flow Through the Rotating Fan Blade Subassembly

[0212] In accordance with one aspect of this disclosure, which may be used by itself or in combination with any other aspect of this disclosure, air may flow through the rotating fan blade subassembly **106** such that the direction of the air as it enters the rotating fan blade subassembly **106** is substantially parallel to the direction of the air as it exits the rotating fan blade subassembly **106**.

[0213] As described previously, air may be introduced to the rotating fan blade subassembly **106** via a conduit or a vortex finder **142** through an inlet **138** of the rotating fan blade subassembly **106**. With respect to FIG. **11**A, the air may enter the rotating fan blade subassembly **106** substantially parallel to the rotational axis **170** of the rotating fan blade subassembly **106**.

[0214] Referring now to FIG. **11**B, the fan blade air channel outlet **134** may be located in the lower wall **126** of the rotating fan blade subassembly **106** (as opposed to being located intermediate the upper wall **124** and the lower wall **126**, as shown in FIG. **1**B).

[0215] Accordingly, as shown, the direction of the air as it exits the rotating fan blade subassembly **106** may be substantially parallel to the rotational axis **170** of the rotating fan blade subassembly **106**.

[0216] In this embodiment, the stationary vane subassembly **108** may be located, at least partially, radially inward of a radial distal end wall **202** of rotating fan blade subassembly **106**. Positioning the stationary vane subassembly **108** radially inward of the radial distal end wall **202** may allow for the air to readily flow from the rotating fan blade subassembly **106** to the stationary vane subassembly **108**.

[0217] In some examples, the radial distal end wall **202** of the rotating fan blade subassembly **106** may be made of a sound absorbent material.

[0218] General Description of a Variable Gap between the Fan Blade and the Shield

[0219] In accordance with one aspect of this disclosure, which may be used by itself or in combination with any other aspect of this disclosure, the performance characteristics of the fan and motor assembly **102** may be configurable by adjusting the gap between an upstream face of the rotating fan blade subassembly **106** and the shield **104** of the fan and motor assembly **102**. Increasing the gap may increase the air flow produced by the fan and motor assembly **102** whereas decreasing the gap may increase the suction produced by the fan and motor assembly **102**.

[0220] The gap may be adjustable by manually moving the rotating fan blade subassembly **106** with respect to the shield **104**. Alternately, the rotating fan blade subassembly **106** may be moved by an electronically actuated member (e.g., a solenoid). As exemplified in FIGS. **12**A and **12**B, a handle **204** is moveably (e.g., pivotally) mounted to a main body **206** of the appliance **100** (in this example, a hair dryer). Pivoting the handle **204** adjusts the gap between the upstream face of rotating fan blade subassembly **106** and the shield **104**. Accordingly, a mechanical linkage extending between the handle **204** and the shield **104** and/or rotating fan blade subassembly **106** may be provided. As the handle **204** is pivoted, e.g., forwardly from, for example, the high suction mode position of FIG. **12**A to the, for example, high air flow mode position of FIG. **12**B, the gap between the upstream face of the rotating fan blade subassembly **106** and the shield **104** is increased thereby adjusting fan and motor assembly **102** to produce higher air flow and lower suction. Conversely, as the handle **204** is pivoted, e.g., rearwardly from the high air flow mode of FIG. **12**B to the high suction mode position of FIG. **12**A, the gap between the upstream face of the rotating fan blade subassembly **106** and the shield **104** is decreased thereby adjusting fan and motor assembly **102** to produce higher suction and lower air flow.

[0221] In the embodiment of FIGS. **12**A and **12**B, the redirecting member may be concurrently or separately moved between to adjust the air flow path from a straight through air flow path which may be used for suction drying (FIG. **12**A) to one wherein the air is redirected to exit the front of the hair dryer for, e.g., blow drying (FIG. **12**B).

[0222] Accordingly, when a user desires to change drying mode from the first mode to the second mode, the user may rotate the handle forwardly to produce higher air flow for blow drying.

[0223] It will be appreciated that any actuator and any sensor described herein may be used.

General Description of Specific Configurations of the Fan and Motor Assembly

[0224] In accordance with one aspect of this disclosure, which may be used by itself or in combination with any other aspect of this disclosure, the fan and motor assembly **102** may have a specific configuration. It will be appreciated that a reconfigurable motor and fan blade assembly may be reconfigured to any specific configuration set out herein or between any two specific configurations set out herein.

[0225] For example, referring to FIG. **1**F, the vortex finder may have an inlet diameter **210**, so that an inlet area of the vortex finder is between 0.785 to 0.950 square inches for every 50 cfm of open flow when there is no static pressure at the inlet (i.e., the inlet **138** to the rotating fan blade subassembly **106**) or outlet (i.e., the stationary vane air channel exit) of the fan and motor assembly **102**.

[0226] Alternately or in addition, still referring to FIG. **1**F, the vortex finder may be placed between 0.01 to 0.05 inches into the rotatable blades **118** of the rotating fan blade subassembly **106**, see **212** in FIG. **1**F. That is, an end wall **214** of the vortex finder **142** may be positioned 0.01 to 0.05 inches, in a direction parallel to the axis of rotation **170** of the rotating fan blade subassembly **106**, from the flange **140** extending about the inlet **138** to the fan blade air channels **130**.

[0227] Alternately or in addition, referring now to FIG. **1**B, the rotating fan blade subassembly **106** may have an air channel inlet area between 0.875 and 1.140 square inches for every 50 cfm of open flow when there is no static pressure at the inlet or outlet of the motor. The air channel inlet area of the rotating fan blade subassembly **106** is defined by the space radially inward of the inlets **132** to the fan blade air channels **130**. Accordingly, the area of the inlet **138** to the rotating fan blade subassembly **106** may be less than the area of the inlet **132** to the fan blade air channels **130** due to the flange **140**.

[0228] Alternately or in addition, still referring to FIG. **1**B, the area, measured by taking the internal height of the rotatable blades **118** at the inlet **132** to the fan blade air channels **130** multiplied by the circumference of the circle forming the air channel inlet area, may be between 1.31 to 1.93 square inches for every 50 cfm of open flow when there is no static pressure at the inlet or outlet of the fan and motor assembly **102**.

[0229] Alternately or in addition, still referring to FIG. **1**B, the height of the trailing edge **122** of rotatable blades **118** at the fan blade air channel outlet **134** multiplied by the circumference of a circle defined by the trailing edges **122** of the rotatable blades **118** at the fan blade air outlets **134** may be between 1.54 to 1.85 square inches for every 50 cfm of airflow.

[0230] Alternately or in addition, referring now to FIG. **1**C, the stationary vane subassembly **108** may have a projected annular area in a plane perpendicular to the rotational axis of the rotating fan blade subassembly **106** of 1.54 to 1.85 square inches for every 50 cfm of airflow. The projected annular area can be determined by first calculating the area between the inner hub **162** and the outer hub **164** of the stationary vane subassembly **108**, and then subtracting the area of the plurality of vanes (in the example illustrated, because each vane **150** in the plurality of vanes is identical, the area of the plurality of vanes can be determined by multiplying the number of vanes **150** by the thickness **216** of each vane **150** and by the distance between the inner hub **162** and the outer hub **164**).

[0231] Alternately or in addition, referring to FIG. **1**E, the distance between the fan blade air outlets **134** of the fan blade air channels **130** and an inner wall **218** of the shield **104** or the interior wall **220** of any vane **150** may be not less than 0.190 inches, optionally 0.265 inches and most optionally 0.375 inches for every 50 cfm of airflow.

[0232] Alternately or in addition, the ratio fan inlet area to fan outlet area may be 0.75:1 to 1.5:1 and/or the ratio fan outlet area to vane area may be 0.5:1 to 0.75:1.

[0233] While the above description describes features of example embodiments, it will be appreciated that some features and/or functions of the described embodiments are susceptible to modification without departing from the spirit and principles of operation of the described embodiments. For example, the various characteristics which are described by means of the represented embodiments or examples may be selectively combined with each other. Accordingly, an appliance may have one or more of the following: a rotating fan blade subassembly wherein the fan blades are adjustable by one or more of varying the pitch of the blades or the angular distance between the blades; a plurality of rotating fan blade subassemblies wherein one or more of the rotating fan blade subassemblies is in a fixed configuration; a plurality of rotating fan blade subassemblies wherein one or more of the rotating fan blade subassemblies is reconfigurable; a plurality of rotating fan blade subassemblies wherein air is directed selectively though one or more of the plurality of rotating fan blade subassemblies; a plurality of rotating fan blade subassemblies wherein one or more of the rotating fan blade subassemblies is reconfigurable; a plurality of rotating fan blade subassemblies wherein air is directed in series through the plurality of rotating fan blade subassemblies; a plurality of rotating fan blade subassemblies wherein air is directed in parallel through the plurality of rotating fan blade subassemblies; any of the rotating fan blade subassemblies in combination with one or more stationary vane subassembly wherein the stationary vane subassembly may be of a fixed or variable configuration and/or wherein the axial and/or angular position of the stationary vane subassembly is moveable with respect to the position of the rotating fan blade subassembly; a vortex finder wherein the position of the outlet of the vortex finder to the inlet of the rotating fan blade assembly is adjustable; a vortex finder wherein the length of the cross-sectional flow area is adjustable; a seal between the shield and a rotating fan subassembly; a rotating dome and the spacing between the shield (dome) and the rotating fan blade subassembly is variable.

[0234] Accordingly, what has been described above is intended to be illustrative of the claimed concept and non-limiting. It will be understood by persons skilled in the art that other variants and modifications may be made without departing from the scope of the invention as defined in the claims appended hereto. The scope of the claims should not be limited by the preferred embodiments and examples, but should be given the broadest interpretation consistent with the description as a whole.

## Claims

**1**. A household appliance having an air flow path extending from an air inlet to an air outlet with a fan and motor assembly in the air flow path, the fan and motor assembly comprising a motor drivingly connected to a first rotating fan blade subassembly and a second rotating fan blade subassembly, the first rotating fan blade subassembly provides a first level of air flow and a first level of suction and the second rotating fan blade subassembly provides a second level of air flow and a second level of suction, wherein the first level of air flow is higher than the second level of air flow and the second level of suction is higher than the first level of suction, and the fan and motor assembly is adjustable to vary an amount of air entering the fan and motor assembly that is directed to each of the first and second rotating fan blade subassemblies.
**2**. The household appliance of claim 1 wherein, in a first configuration, at least a majority of the air entering the fan and motor assembly is directed to the first rotating fan blade subassembly and, in a second configuration, at least a majority of the air is directed to the second rotating fan blade subassembly.
**3**. The household appliance of claim 1 wherein, in a first configuration, at least a majority of the air entering the fan and motor assembly is directed to the first rotating fan blade subassembly and then subsequently through the second rotating fan blade subassembly.
**4**. The household appliance of claim 1 wherein, in a first configuration, essentially all of the air entering the fan and motor assembly is directed to the first rotating fan blade subassembly and, in a second configuration, essentially all of the air is directed to the second rotating fan blade subassembly.
**5**. The household appliance of claim 1 wherein, in a first configuration, essentially all of the air entering the fan and motor assembly is directed to the first rotating fan blade subassembly and then subsequently through the second rotating fan blade subassembly.
**6**. The household appliance of claim 1 wherein, in a first configuration, the air entering the fan and motor assembly flows in series through the first rotating fan blade subassembly and the second rotating fan blade subassembly and, in a second configuration, the air entering the fan and motor assembly flows through only one of the first rotating fan blade subassembly and the second rotating fan blade subassembly.
**7**. The household appliance of claim 6 wherein, in the second configuration, essentially all of the air is directed to the second rotating fan blade subassembly.
**8**. The household appliance of claim 1 wherein the fan and motor assembly further comprises a vortex finder, each of the first and second rotating fan blade subassemblies has an inlet, and the position of the vortex finder with respect to the first and second rotating fan blade assemblies is adjustable to vary the amount of air entering the fan and motor assembly that is directed to each of the first and second rotating fan blade subassemblies.
**9**. The household appliance of claim 8 wherein the vortex finder is adjustable between a first position in which the vortex finder directs at least a majority of the air entering the fan and motor assembly to the first rotating fan blade subassembly and a second position in which the vortex finder directs at least a majority of the air entering the fan and motor assembly to the first rotating fan blade subassembly.
**10**. The household appliance of claim 1 wherein the fan and motor assembly further comprises a vortex finder and a diameter of the vortex finder is adjustable.
**11**. The household appliance of claim 1 wherein the fan and motor assembly further comprises a

vortex finder, the vortex finder having an outlet that communicates with an inlet of the first rotating fan blade subassembly, and the position of the vortex finder to the inlet is adjustable between a first configuration in which the first rotating fan blade subassembly provides the first level of air flow and the first level of suction and a third configuration in which the first rotating fan blade subassembly provides a third level of air flow and a third level of suction wherein the first level of air flow is higher than the third level of air flow and the third level of suction is higher than the first level of suction.

**12**. The household appliance of claim 1 wherein the first rotating fan blade subassembly has a first plurality of rotatable blades, the second rotating fan blade subassembly has a second plurality of rotatable blades and a pitch of at least one of the first and second plurality of rotatable blades is adjustable.

**13**. The household appliance of claim 12 wherein the pitch of each of the first and second plurality of rotatable blades is adjustable.

**14**. The household appliance of claim 1 wherein the fan and motor assembly further comprises a first stationary vane subassembly having a first set of vanes and a first plurality of stationary vane air channels and a pitch of the plurality of the vanes is adjustable.

**15**. The household appliance of claim 1 wherein the household appliance is a vacuum cleaner, an extractor or a hair dryer.

---