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(54) **COMPACT VANE-AXIAL FAN WITH MODULAR COMPONENTS**

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(52) **U.S. Cl.**

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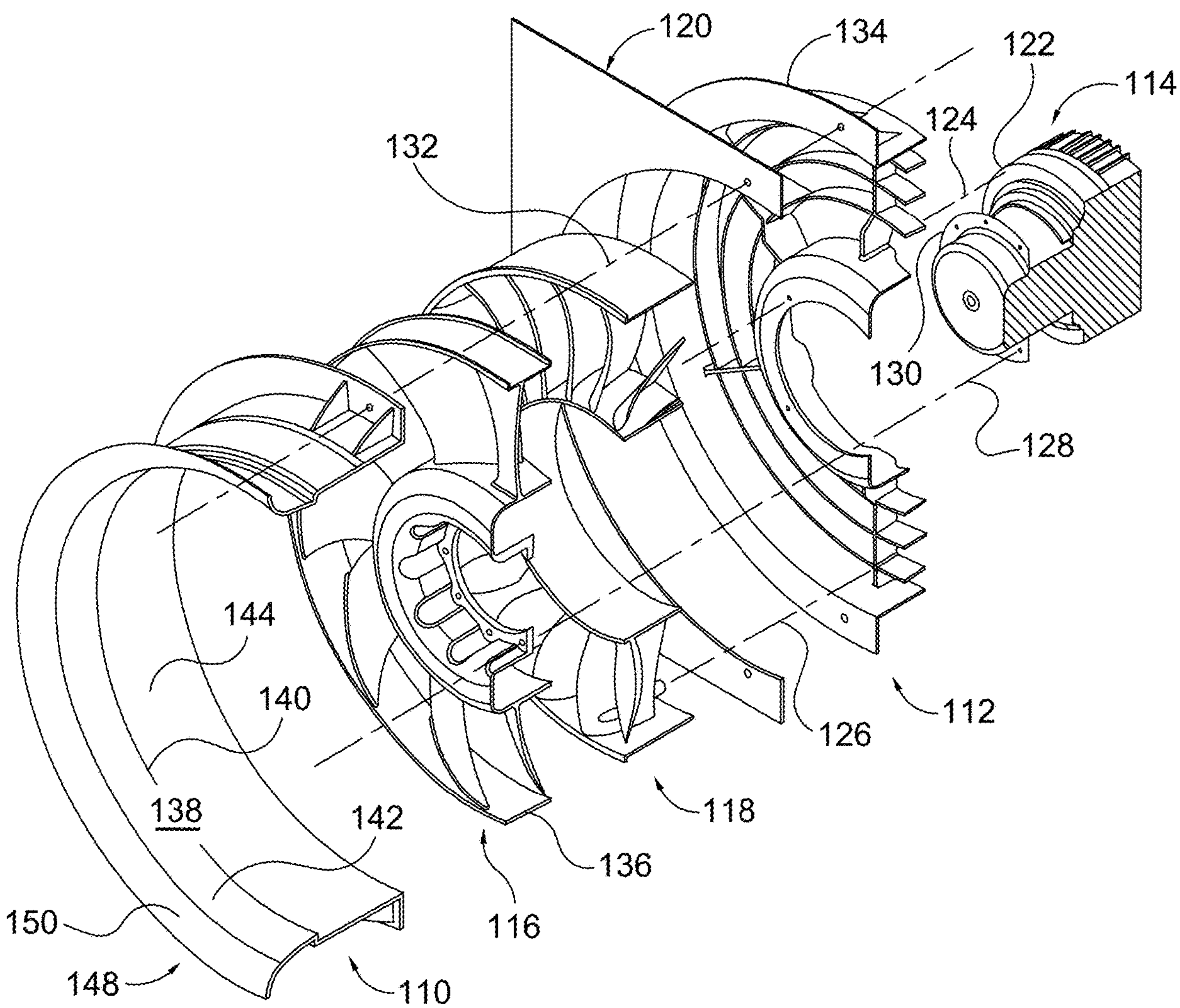
(57) **ABSTRACT**

A compact vane-axial fan with includes modular components and is associated with improved efficiency and can operate with a variety of differently configured impellers and vanes to allow for customization to a particular application. The fan can include a base set of components, including a fan housing with motor and stator vane. The base set of components can be modularly assembled with an impeller and a vane insert, which is positioned inline between the impeller and the stator. The configuration(s) of the impeller, the vane insert, and/or the stator contribute to a compact design. In addition, configurations of the impeller and the vane insert can be tailored to one another to contribute to improved performance. Furthermore, a variety of different combinations of impellers and vane inserts can be selectively assembled with the base set of components to tailor fan operations for a use case and still achieve high efficiency.



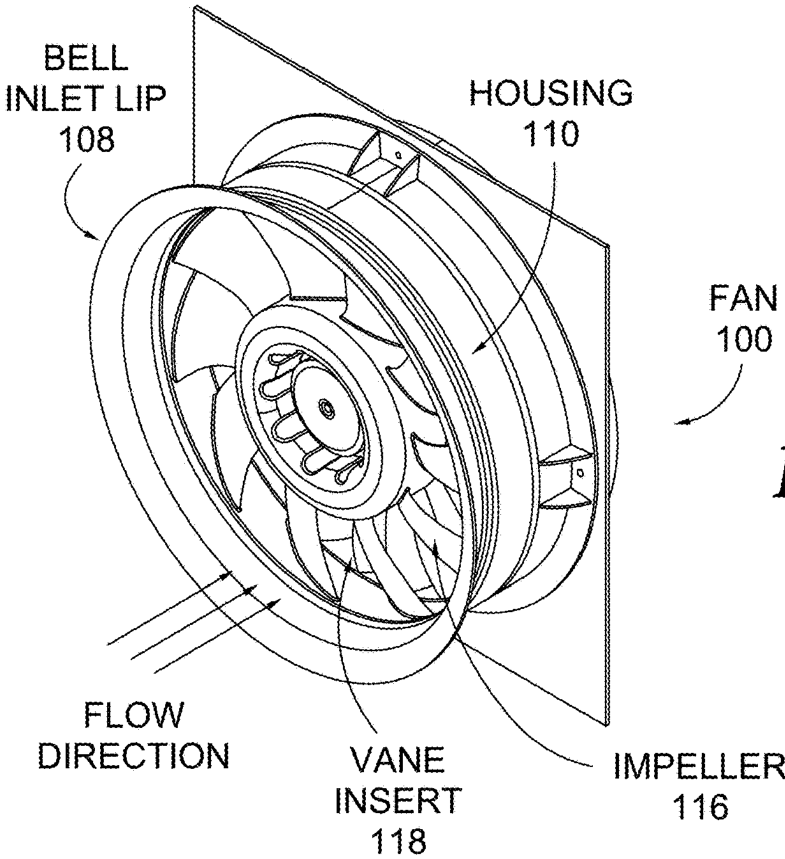

BELL
INLET LIP
108
HOUSING
110
FAN
100
FLOW
DIRECTION
VANE
INSERT
118
IMPELLER
116

FIG. 1

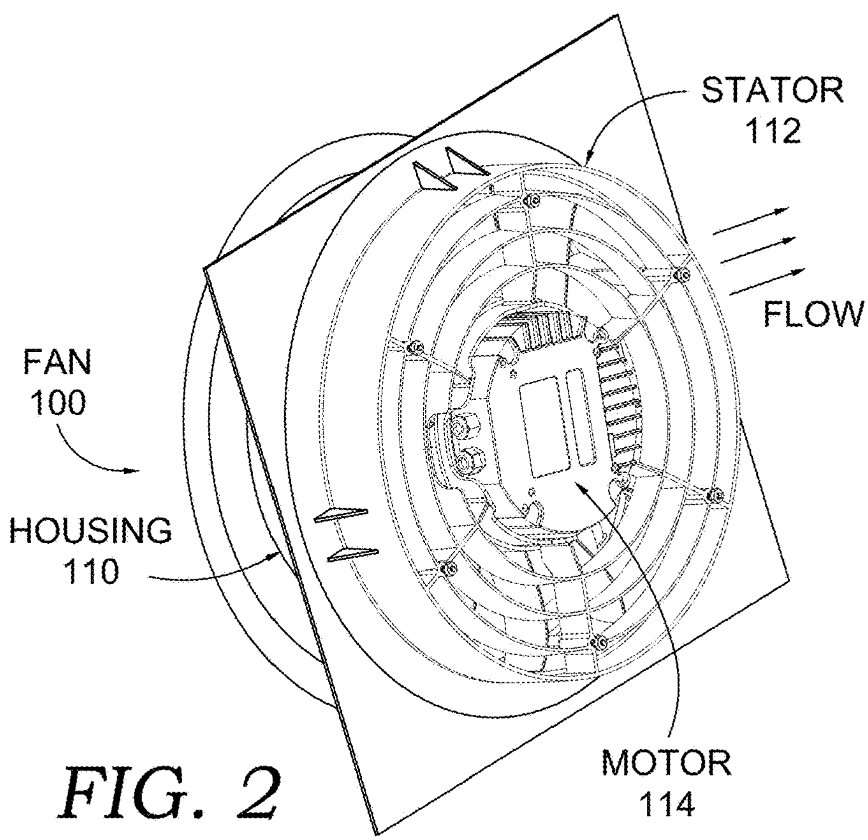

STATOR
112
FLOW
FAN
100
HOUSING
110
MOTOR
114

FIG. 2

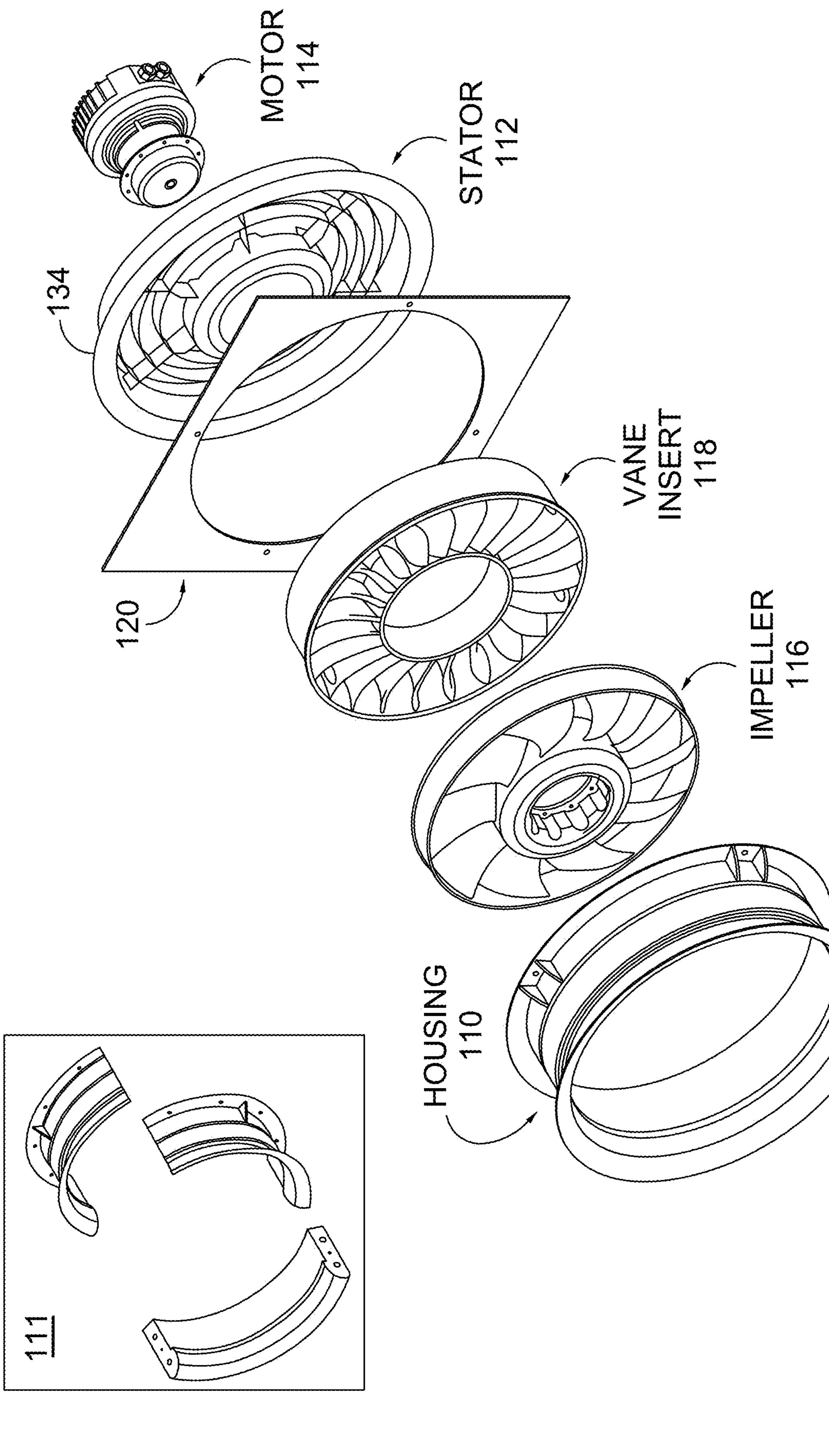

MOTOR
114
STATOR
112
134
VANE
INSERT
118
120
IMPELLER
116
HOUSING
110
111

FIG. 3

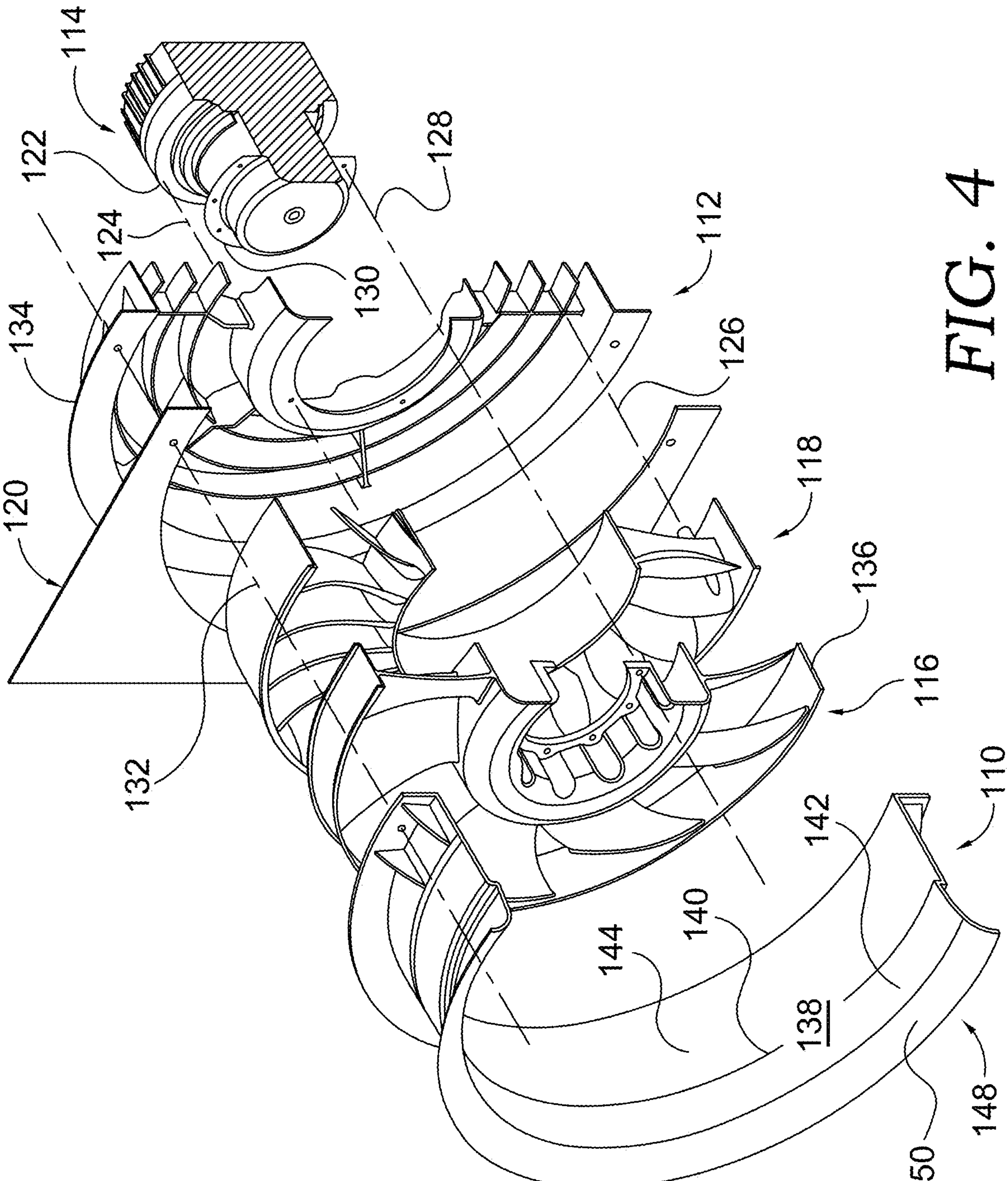

114
122
124
128
130
134
112
126
120
118
136
132
116
110
142
140
144
138
150
148

FIG. 4

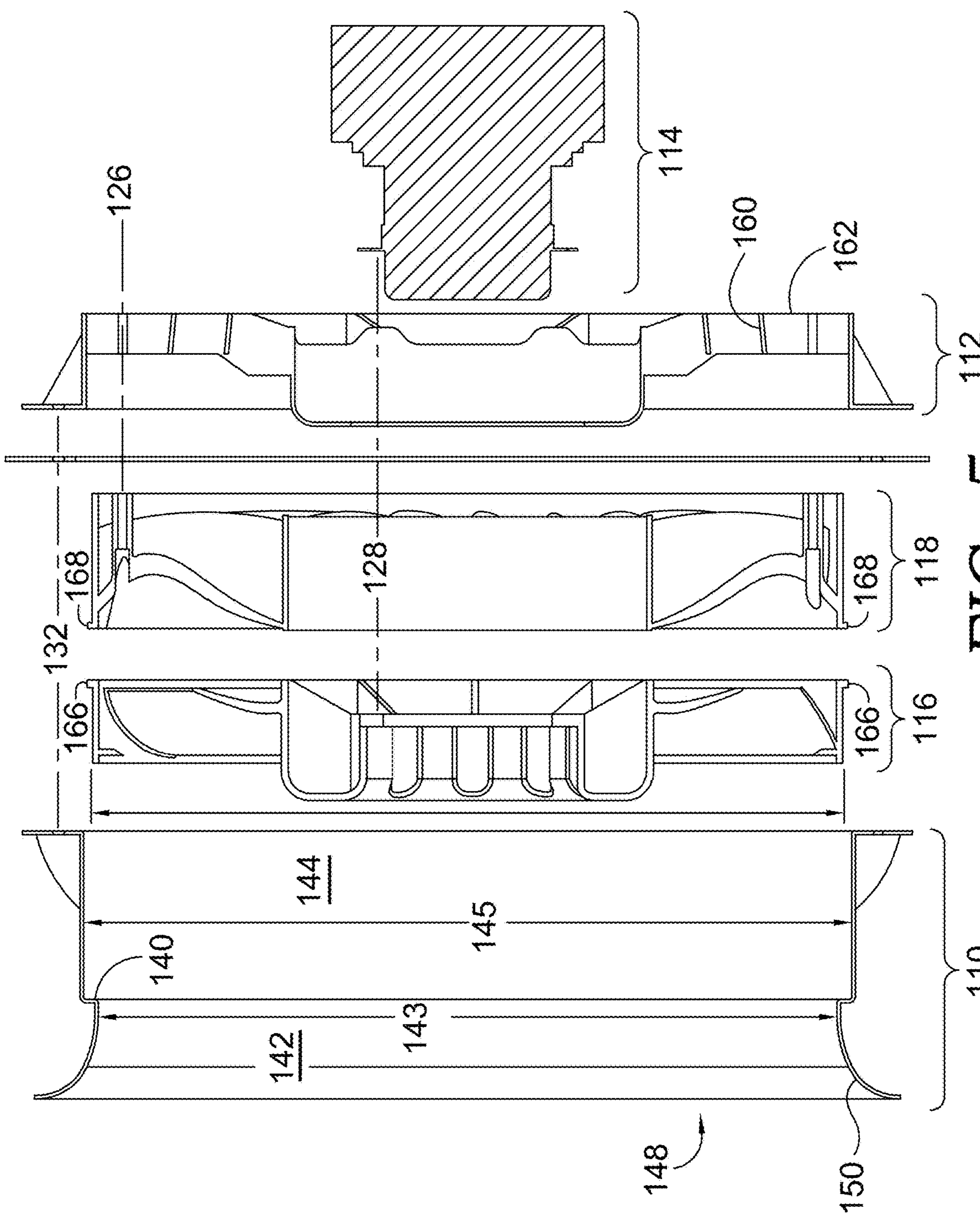

114
126
160
162
112
118
128
168
168
132
166
166
116
144
145
140
110
143
142
148
150

FIG. 5

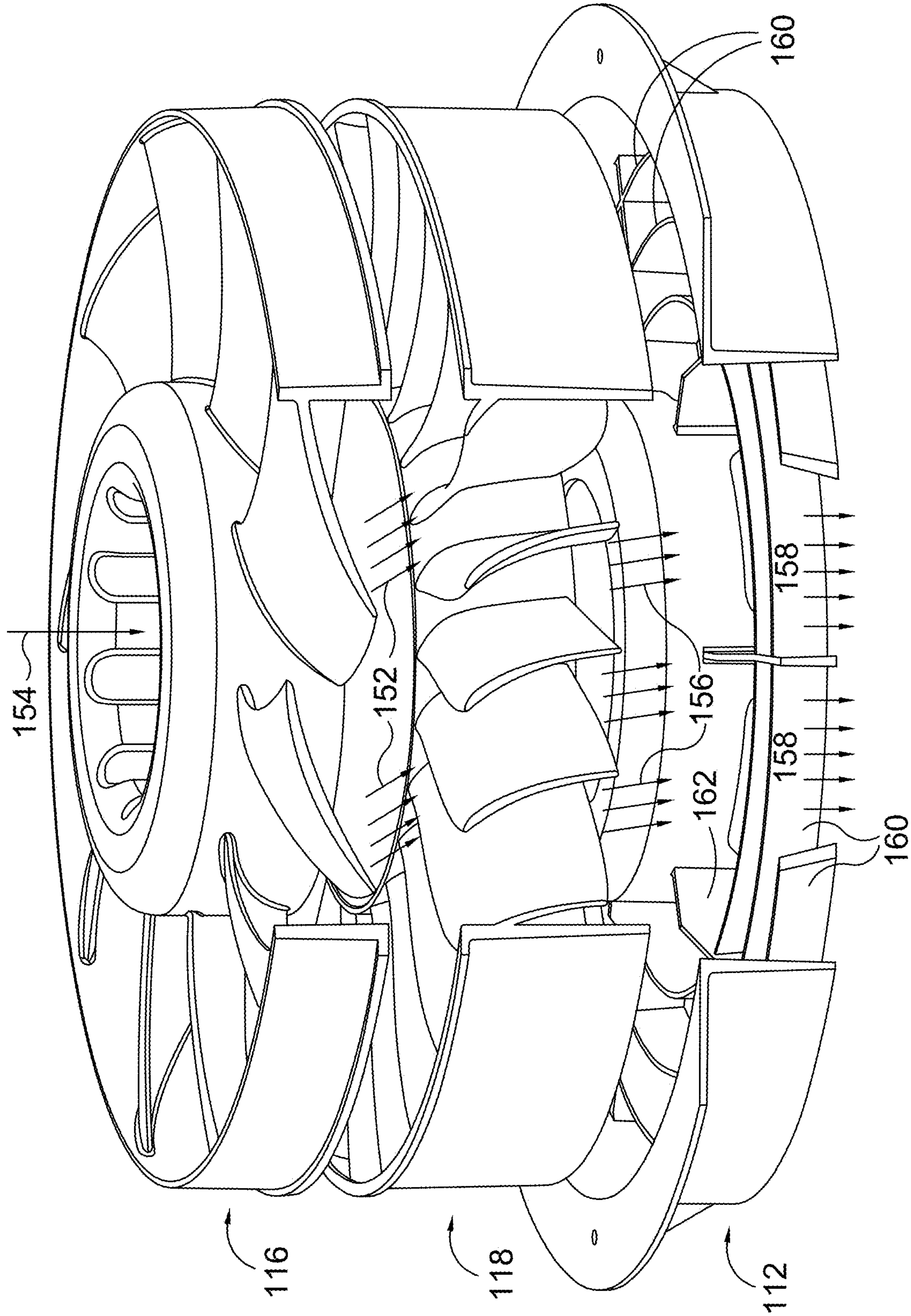


FIG. 6

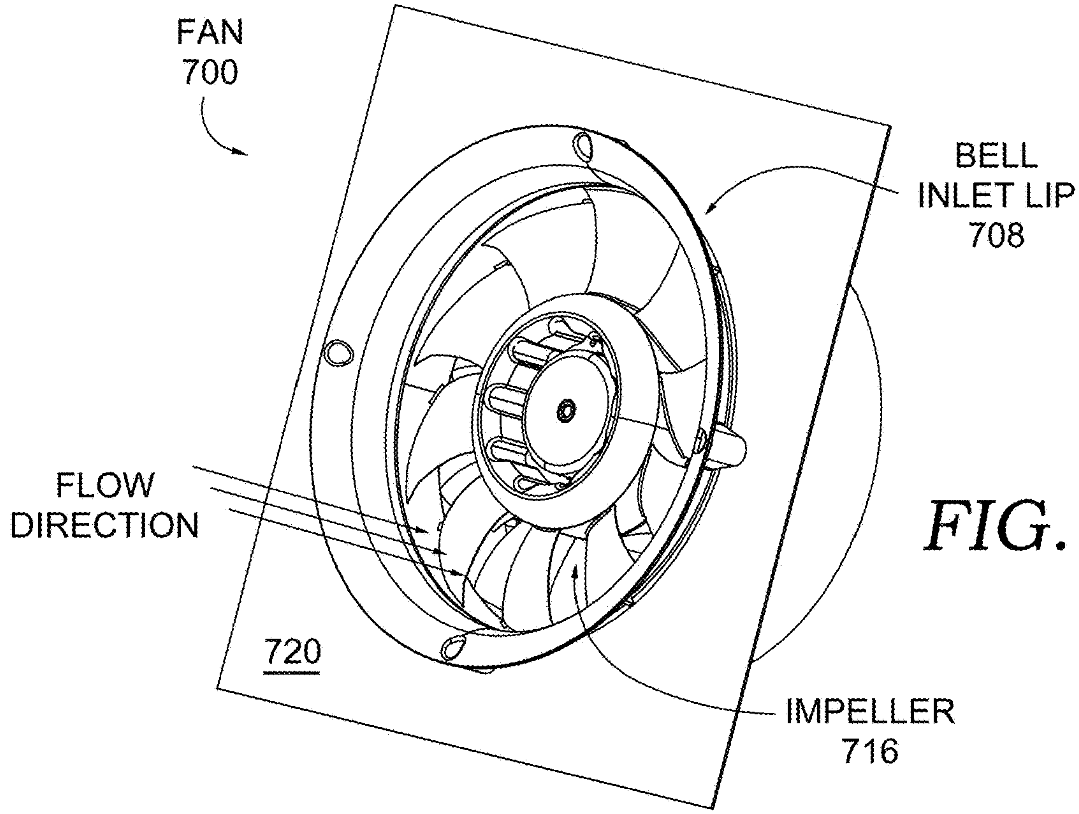

FAN
700
BELL
INLET LIP
708
FLOW
DIRECTION
720
IMPELLER
716

FIG. 7

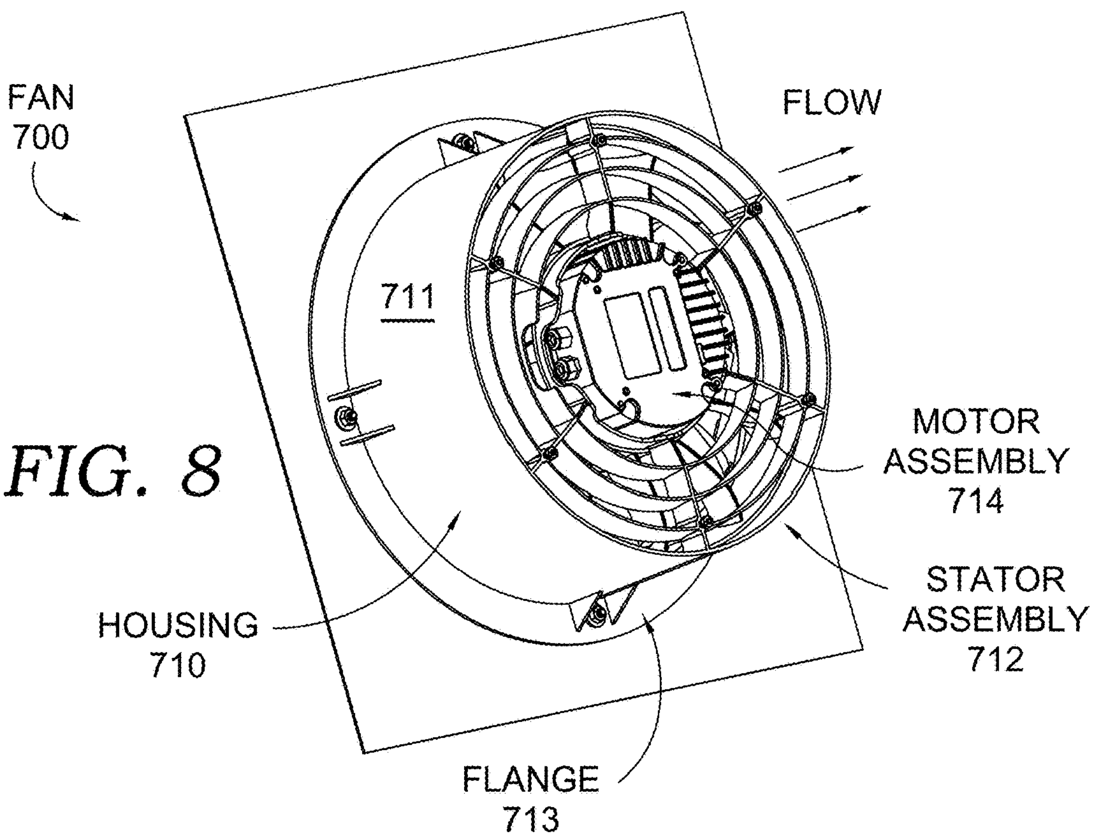

FAN
700
FLOW
711
MOTOR
ASSEMBLY
714
HOUSING
710
STATOR
ASSEMBLY
712
FLANGE
713

FIG. 8

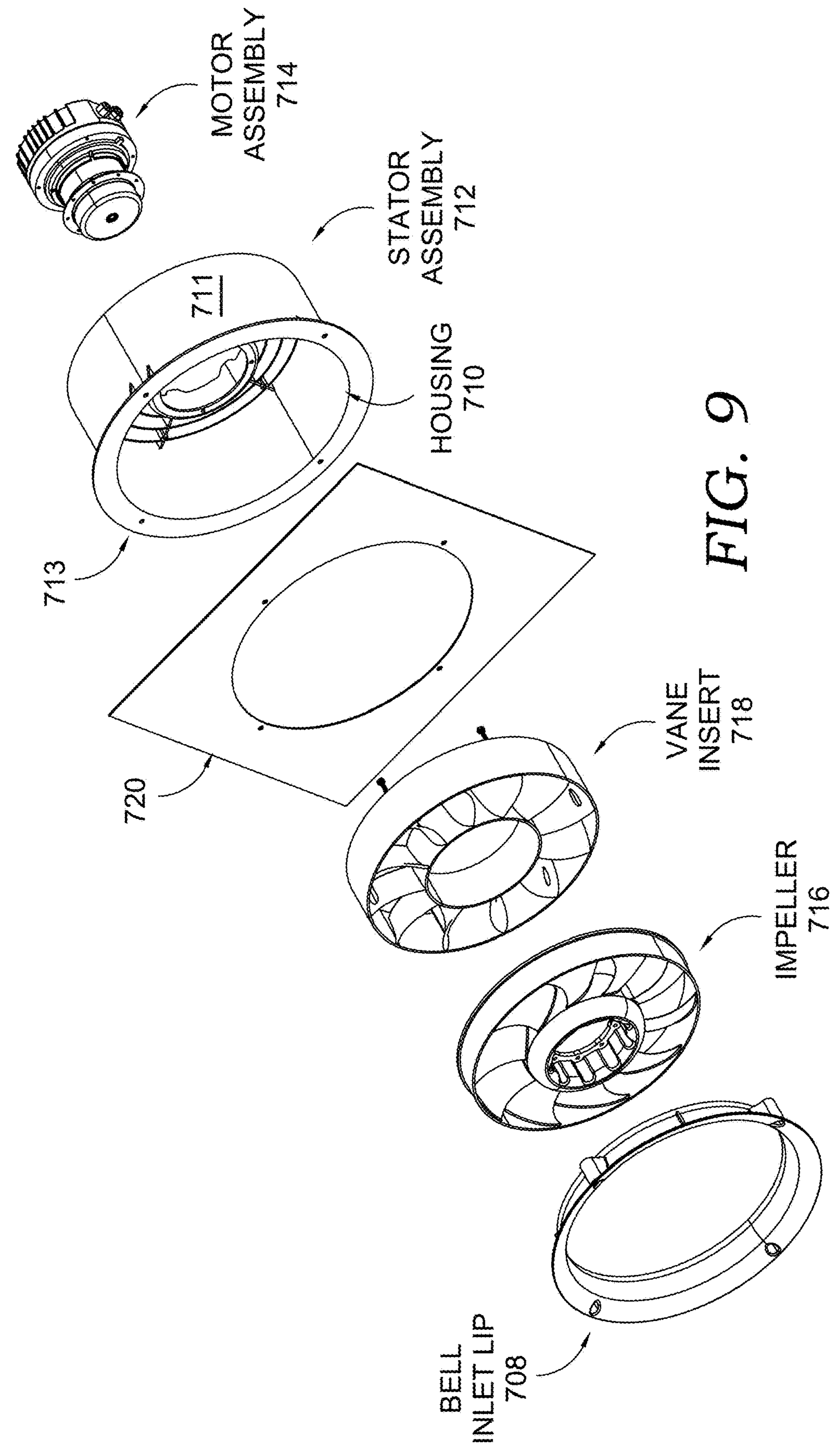

MOTOR ASSEMBLY 714
STATOR ASSEMBLY 712
711
HOUSING 710
713
720
VANE INSERT 718
IMPELLER 716
BELL INLET LIP 708

FIG. 9

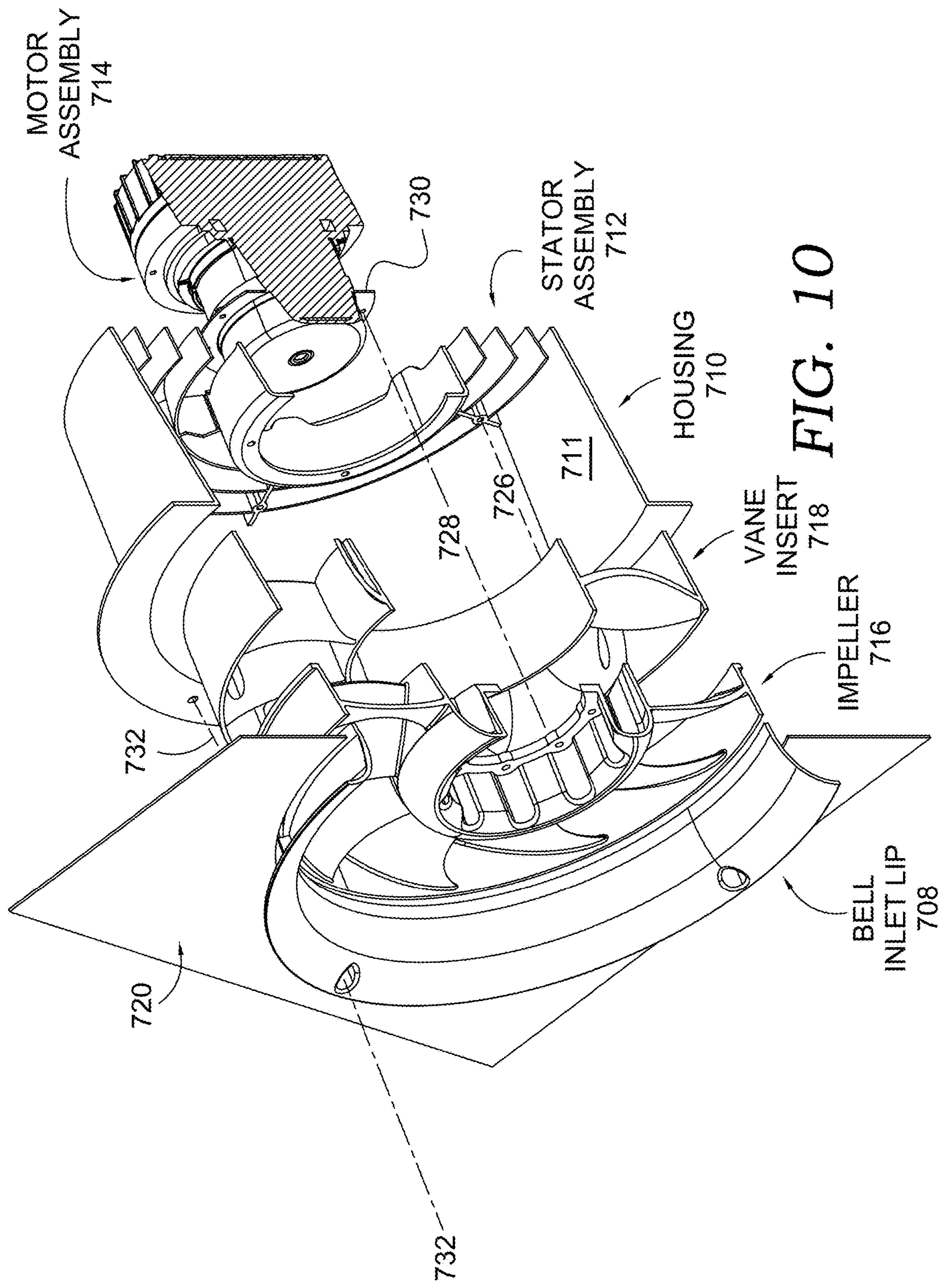

MOTOR ASSEMBLY 714
730
STATOR ASSEMBLY 712
HOUSING 710
711
726
728
VANE INSERT 718
IMPELLER 716
732
BELL INLET LIP 708
720
732

FIG. 10

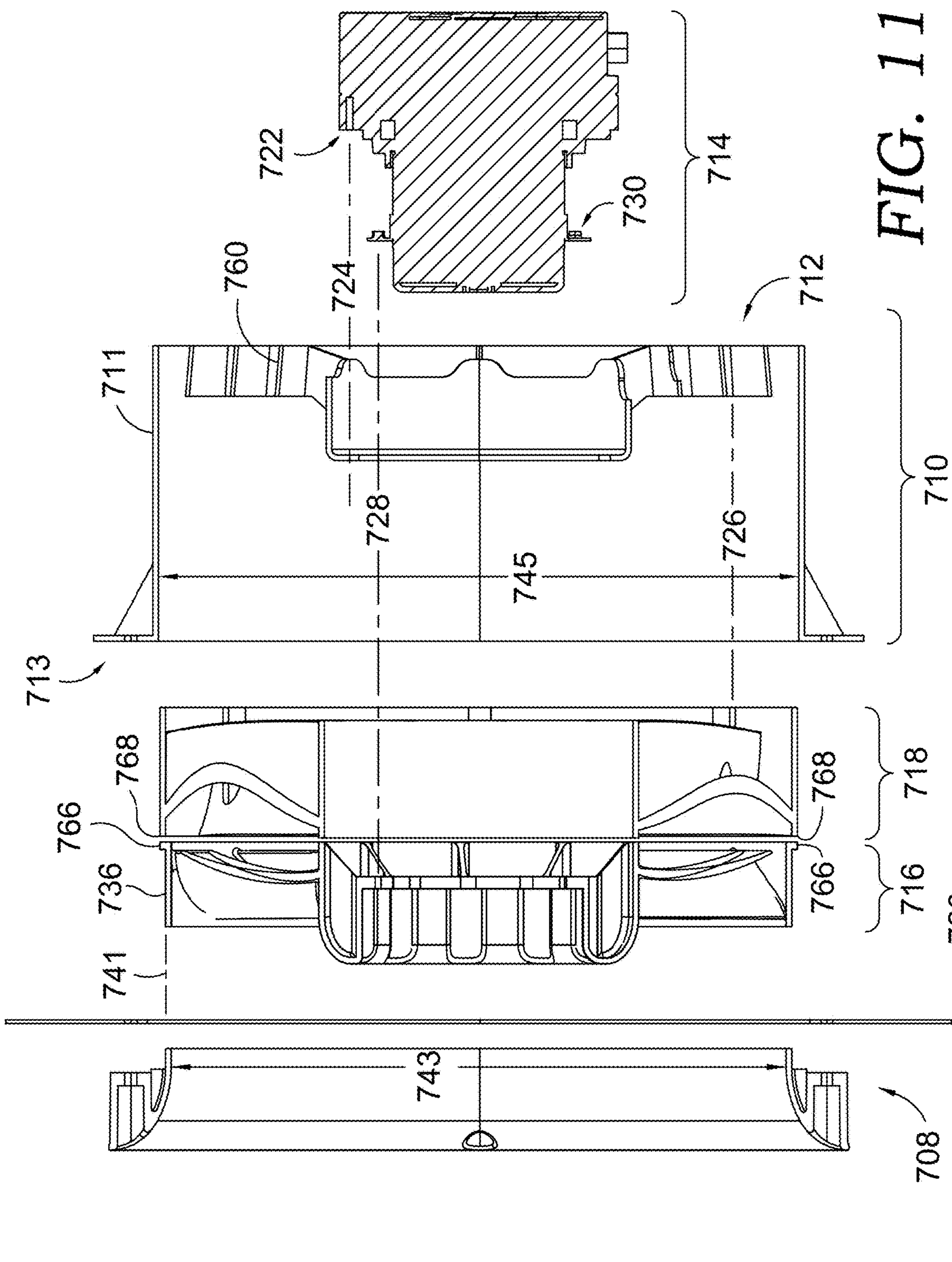

722
724
730
714
760
712
711
728
726
710
745
713
768
768
718
766
736
766
716
741
720
743
708

FIG. 11

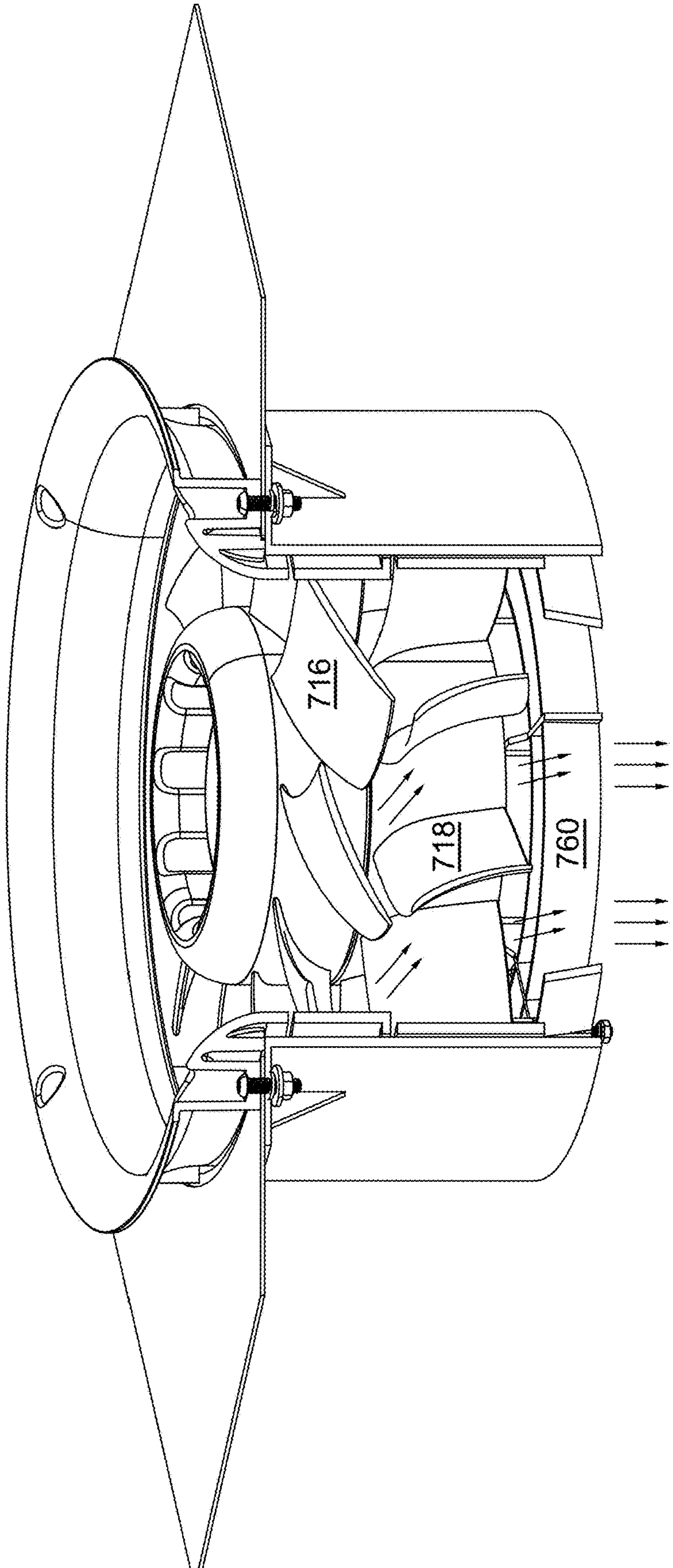


FIG. 12

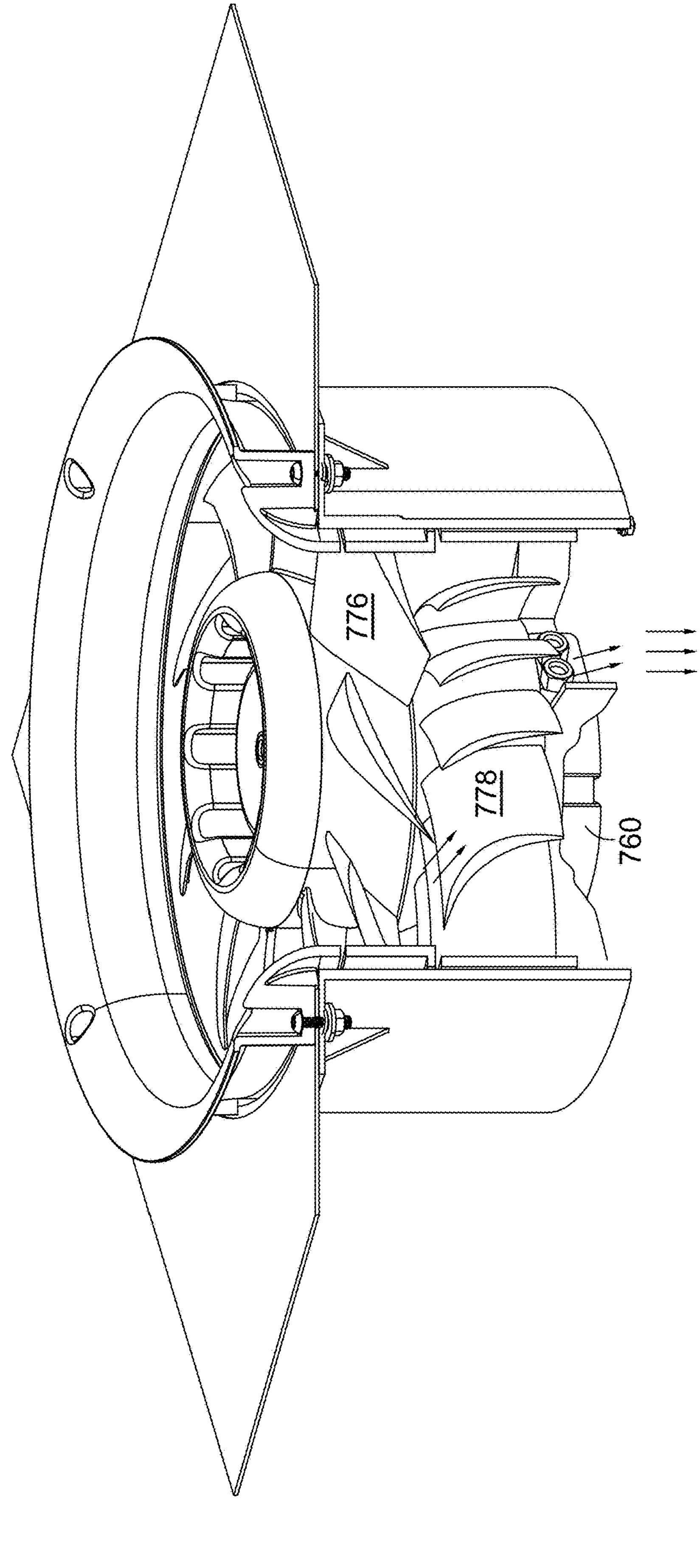


FIG. 13

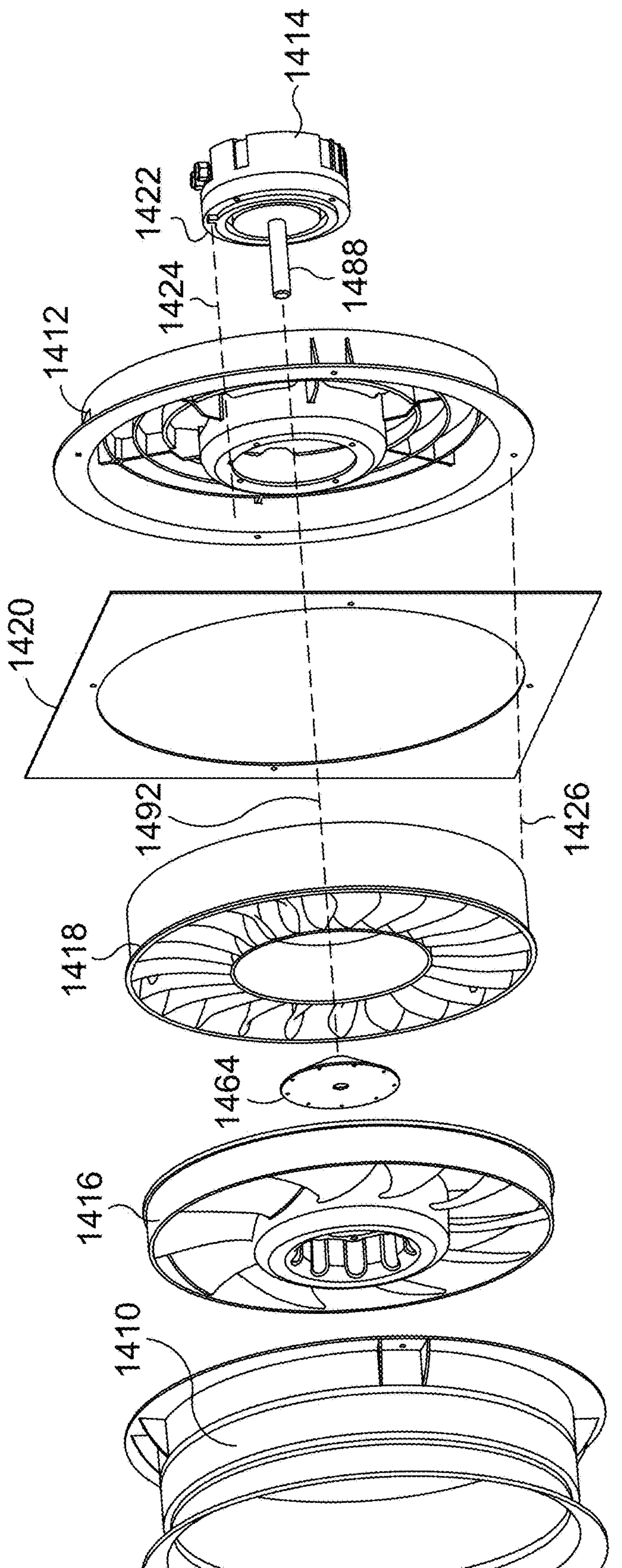


FIG. 14

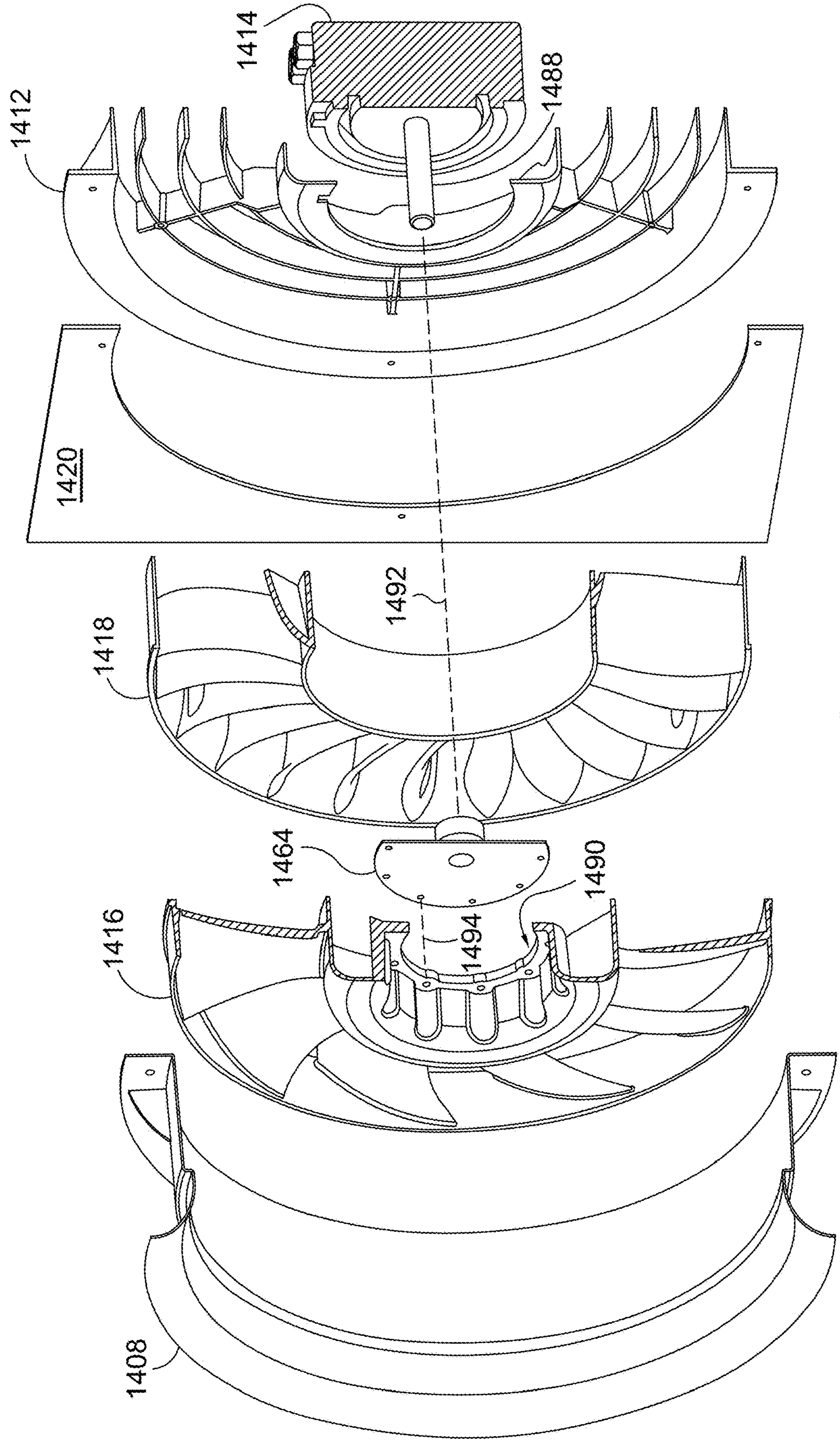


FIG. 15

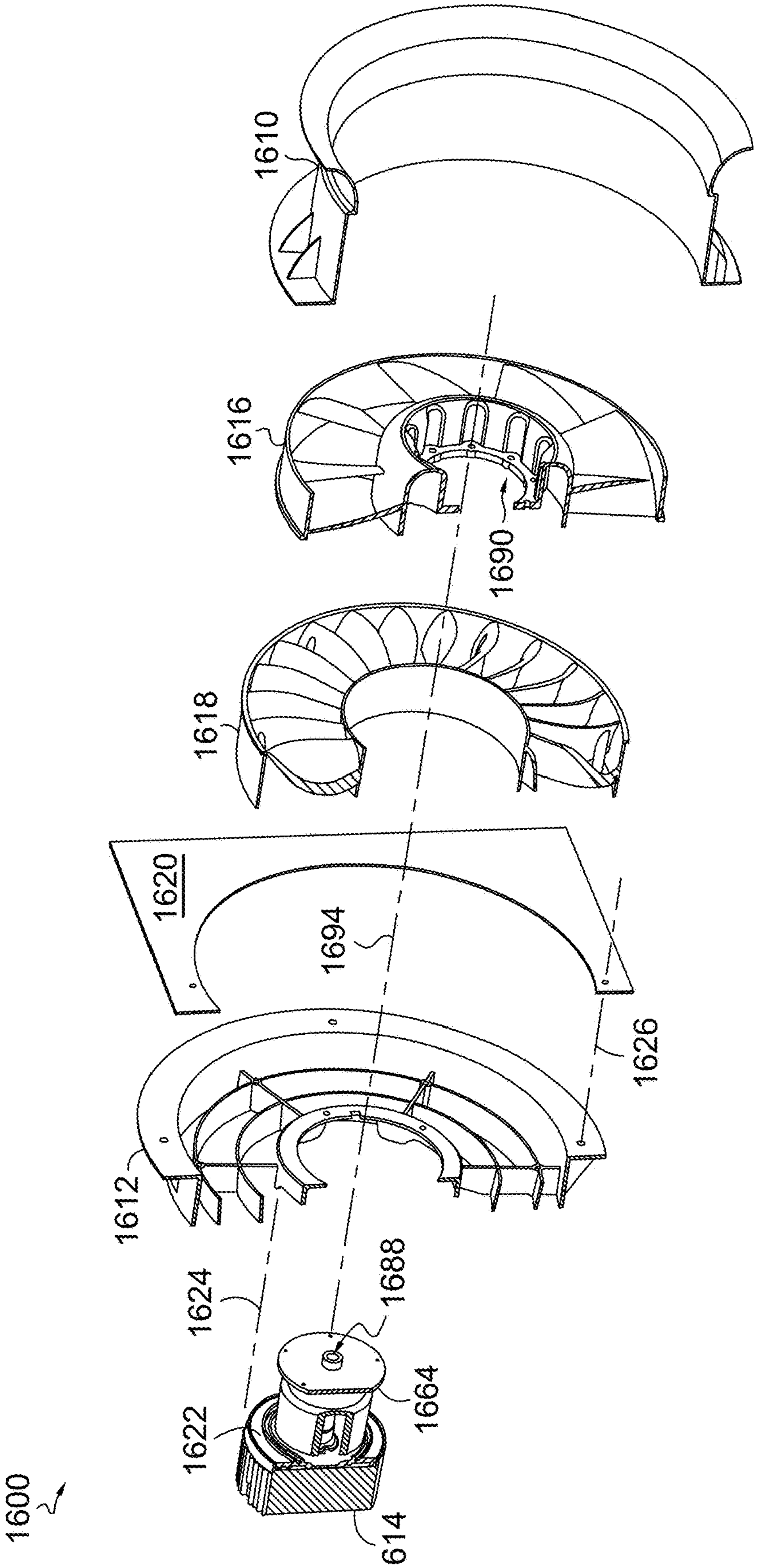

1610
1616
1690
1618
1620
1694
1626
1612
1624
1688
1664
1622
1600
1614

FIG. 16

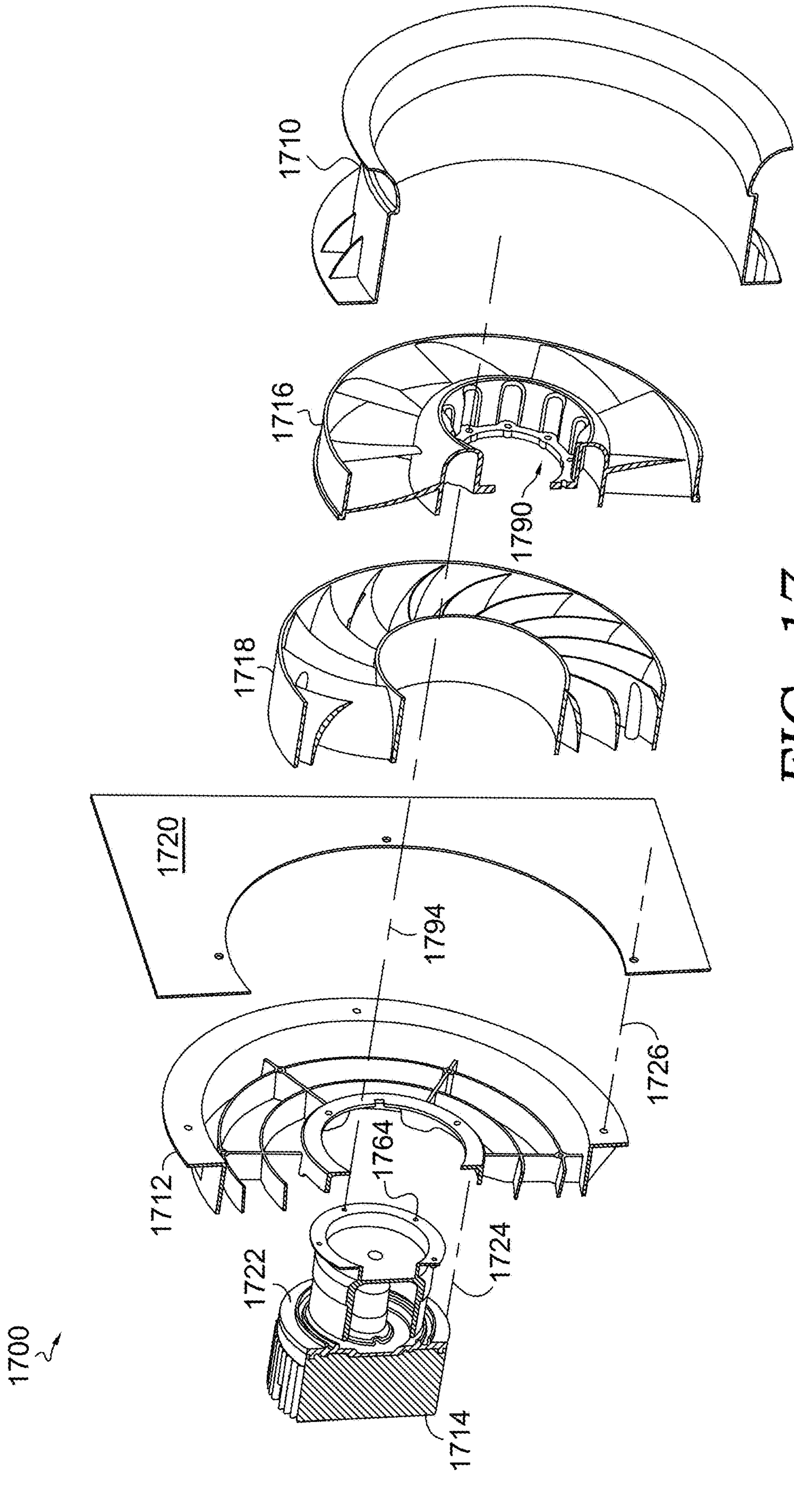

1700
1710
1716
1790
1718
1720
1794
1726
1712
1764
1724
1722
1714

FIG. 17

COMPACT VANE-AXIAL FAN WITH MODULAR COMPONENTS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Application No. 63/551,428 (filed Feb. 8, 2024). The aforementioned application is hereby incorporated by reference in its entirety.

BACKGROUND

[0002] Vane-axial fans are used in various applications and industries, including heating, ventilation, and air conditioning (HVAC) systems. Vane-axial fans typically consist of a housing with a rotating impeller (e.g., a rotor) and with downstream, stationary vanes, which can help direct airflow. In addition, some conventional fans can be associated with lower efficiency and louder noise.

BRIEF DESCRIPTION OF DRAWINGS

[0003] Subject matter of the present disclosure associated with a compact vane-axial fan with modular components is described in detail below with reference to these figures.

[0004] FIG. **1** depicts a perspective of an inlet side of a first vane-axial fan based on an example of this disclosure.

[0005] FIG. **2** depicts a perspective of an outlet side of the first vane-axial fan, in accordance with examples of this disclosure.

[0006] FIG. **3** depicts an exploded view of the first vane-axial fan, in accordance with examples of this disclosure.

[0007] FIG. **4** depicts a cross section associated with FIG. **3**, in accordance with examples of this disclosure.

[0008] FIG. **5** depicts another cross section of the first vane-axial fan, in accordance with examples of this disclosure.

[0009] FIG. **6** depicts another cross section of the first vane-axial fan, with the housing omitted to not obstruct the view of the impeller, vane insert, and stator assembly, in accordance with examples of this disclosure.

[0010] FIG. **7** depicts a perspective of an inlet side of a second vane-axial fan based on an example of this disclosure.

[0011] FIG. **8** depicts a perspective of an outlet side of the second vane-axial fan, in accordance with examples of this disclosure.

[0012] FIG. **9** depicts an exploded view of the second vane-axial fan, in accordance with examples of this disclosure.

[0013] FIG. **10** depicts a cross section associated with FIG. **9**, in accordance with examples of this disclosure.

[0014] FIG. **11** depicts another cross section of the second vane-axial fan, in accordance with examples of this disclosure.

[0015] FIG. **12** depicts yet another cross section of the second vane-axial fan, in accordance with examples of this disclosure.

[0016] FIG. **13** depicts a cross section of the second vane-axial fan with a different configuration of the impeller, vane insert, and stator assembly, in accordance with examples of this disclosure.

[0017] FIG. **14** depicts an exploded view of a third vane-axial fan based on an example of this disclosure.

[0018] FIG. **15** depicts a cross section associated with FIG. **14**, in accordance with examples of this disclosure.

[0019] FIG. **16** depicts an exploded, cross-sectional view of a fourth vane-axial fan based on an example of this disclosure.

[0020] FIG. **17** depicts an exploded, cross-sectional view of a fifth vane-axial fan based on an example of this disclosure.

DETAILED DESCRIPTION

[0021] This detailed description is related to a compact vane-axial fan with modular components, which is associated with improved efficiency and can operate with a variety of differently configured impellers and vanes to allow for customization to a particular application. The fan can include a base set of components, including a fan housing with motor and stator (e.g., with or without stator vane), and in some examples, the base set of components can be modularly assembled with an impeller and a vane insert, which is positioned inline between the impeller and the stator. Stated differently, the same base set of components can be used with different sets of impellers and vane inserts, such that the same base set of components could be installed in two or more different use scenarios, while the impeller and vane insert can be switched to achieve desired performance objectives and functionality (e.g., specific to the use scenario).

[0022] In examples, the configuration(s) of the impeller, the vane insert, and/or the stator contribute to a compact design. In addition, configurations of the impeller and the vane insert can be tailored to one another to contribute to improved performance. Furthermore, a variety of different combinations of impellers and vane inserts can be selectively assembled with the base set of components to tailor fan operations for a use case and still achieve high efficiency. In some examples, the variety of different combination of impellers and vane inserts can decrease noise associated with the fan. As such, the vane-axial fane of the present disclosure is customizable to the needs of the user.

[0023] In examples of the present disclosure, a vane-axial fan can be used in any system configured to move some volume of air, such as for conditioning purposes or ventilation/venting (e.g., heating, ventilation, and/or cooling (HVAC) system). In some instances, a vane-axial fan can be housed in a cabinet or other structure with one or more surrounding walls. In some instances, a vane-axial fan can be free-standing, without being housed in a cabinet.

[0024] In contrast to the present invention, conventional vane-axial fans tend to be less versatile, less efficient, and noisier. In some instances, vanes of many conventional vane-axial fans are often fixed and not interchangeable. Furthermore, in many conventional vane-axial fans, the impeller is mounted further away from the motor, which can contribute to a less compact overall assembly. In some examples, conventional vane-axial fans can include a control ring that is intended to prevent airflow losses when the fan gets deadheaded, keeping the static pressure and stall factor level. However, the control ring by itself can fail to provide desired efficiencies and is less customizable to correspond with impeller blade configurations.

[0025] In contrast to conventional solutions, the vane-axial fan described herein is more compact, more efficient, more versatile, and can be less noisy. For example, instead of including an external motor that sits down below the impeller like many conventional vane-axial fans, the vane-axial fan described herein includes an external rotor that is positioned closer to the center of the impeller, pushed forward instead of sitting down below. Not only does this design allow the impeller to be positioned deeper on the mounting surface, but this design saves overall space, allowing the vane-axial fan to be more compact than conventional designs.

[0026] In examples of the present disclosure, the positioning of the vanes directly adjacent the impeller (e.g., without a control ring in between) can lend to a more compact design of the presently described vane-axial fan. Instead of including a control ring, the present solution achieves improved performance with various other features, such as with impeller-vane alignment. Some examples of the present disclosure address stall issues by handling roughly a 30-50% stall factor while still maintaining fine function (e.g., no decrease in power and/or efficiency), showcasing improved performance without having to integrate a 1½ to 2 inch gap between the leading or upstream edges of the blades (e.g., and vanes) and a leading or upstream edge of the shroud and without utilizing a control ring. In examples, this functionality is achieved by the present design, which includes leading edges of vanes of the vane insert (e.g., and blades of the impeller) that are positioned closer to the leading edge of the shroud, because the present design ensures that the direction of the airflow as it comes off the faces of the impeller blades aligns with the direction of the airflow as it engages the vanes of the vane insert. The airflow path, as it comes off of the impeller blades, flows more directly (e.g., as compared to prior solutions) into the vanes of the insert, as compared to when a gap is included (e.g., such as a 1½ to 2 inch gap between the blades and the vanes and/or between the blades and a leading edge of the shroud) in which there are more opportunities for the airflow to get trapped in the gap.

[0027] Moreover, when a conventional vane-axial fan stalls out, it typically pulls more energy (e.g., greater than 10% normal energy) and pushes less air. In contrast, if the present vane-axial fan stalls, the fan may still draw more energy (e.g., less than 10% normal energy), but the fan does not lose airflow while maintaining roughly 30-50% static change. Thus, the present vane-axial fan maintains its power (e.g., its output) at this condition, but conventional vane-axial fans typically lose power during these conditions.

[0028] In at least some examples, while the vanes of conventional vane-axial fans are typically fixed and not interchangeable, the vanes of the present solution include module components that are interchangeable depending on the desired output of a user. For example, vane inserts and impellers can be interchanged to achieve greater efficiency, less noise production, lower stall, and more. In addition to the versatility of the present design, the present vane-axial fan also includes more blades (e.g., vanes) than conventional solutions, which allows the present vane area to be smaller, leading to a more compact and efficient design. In addition to having more blades in general, the present disclosure also incorporates more efficient secondary blades. Secondary blades (e.g., blades located on the stator instead of the impeller or vane insert) of conventional solutions typically are not angled, which can allow exhaust air to expand by about 20-21 degrees. In contrast to conventional vane-axial fans, the secondary blades of the present solution are angled (e.g., inward towards the axis) such that the expansion of the exhaust is reduced, improving the efficiency (e.g., as compared to conventional solutions). As such, because the present solution boasts more blades and includes angled secondary blades, the present design reduces the air expansion as compared to previous designs.

[0029] Referring now to FIG. **1** through FIG. **6**, a first vane-axial fan **100** is depicted based on examples of this disclosure. The fan **100** includes a housing **110** (or casing) that circumferentially aligns with a stator **112**. In addition, the fan includes a motor **114** (e.g., internal motor or axially aligned motor). Alternatively, the fan **100** can include a belt-drive arrangement (e.g., external motor). In at least some examples, the same concepts apply to the fans with either an internal motor (e.g., such as motor **114**) or an external motor (e.g. such as a belt-drive arrangement). Stated differently, at least some of the features of the fan **100**, such as the impeller **116**, the vane insert **118**, and/or the stator **112** can be used with a belt-drive motor or other eternal motor. In at least one example, any one or more of the housing **110**, the stator **112**, and the motor assembly **114** can be part of a base set of components that can be operatively coupled with additional fan components, which can be tailored and customized for a given use case or application. Additional components can also be included in the base set of components, such as a mounting plate **120**.

[0030] In at least some examples, the fan **100** can include an impeller **116** and a vane insert **118** that can be assembled with the base set of components (e.g., the housing **110**, the stator **112**, the motor assembly **114**, and the mounting plate **120**). The impeller **116** and the vane insert **118** are one example, and the fan **100** can include other impellers and/or vane inserts having different configurations, which can be tailored or customized for a particular use case or application.

[0031] The fan **100** can be assembled in various manners. For example, the stator **112** (e.g., stator vane) can be affixed to a base **122** of the motor assembly **114** (e.g., as indicated by the reference line **124** in FIG. **4** showing alignment of mounting apertures). In operation (e.g., when the impeller **116** is rotating via the motor **114**), the base **122** and the stator **112** attached to the base **122** can remain in a fixed position. In at least some examples, the vane insert **118** can be fastened to the stator **112** (e.g., as indicated by the reference line **126**), and similar to the stator **112** and the base **122**, the vane insert **118** can also remain stationary and fixed relative to the rotation of the impeller **116**. In examples, the impeller **116** can be fastened (e.g., as indicated by the reference line **128**) to a mounting flange **130** (e.g., radial mounting flange) of the motor assembly **114**, and the rotation of the mounting flange **130** can operationally rotate the impeller **116**.

[0032] In at least some examples, the stator **112** can be fastened to the housing **110** and to the mounting plate **120** (e.g., as indicated by the reference line **132**). The various parts can be assembled in various orders. In some examples, the stator **112**, the vane insert **118**, the impeller **116** and the motor assembly **114** can be removably coupled together in a first subassembly. The impeller **116** and the vane insert **118** can then be moved through the central opening of the mounting plate **120**, so that the mounting plate **120** is flush with the outer, radial flange **134** of the stator **112**. The housing **110** can then be maneuvered into position around the impeller **116** and the vane insert **118** and fastened to the mounting plate **120** and the stator **112** (e.g., via the flange **134**).

[0033] In some examples, the housing **110** can include a single piece. In other examples, the housing **110** can include multiple pieces (e.g., reference view **111**). Whether the housing **110** includes a single piece or multiple pieces, the inlet-side edge of the housing **110** includes a bell inlet lip **108**.

[0034] The fan **100** can include various features that contribute to improved performance. In at least one example, the impeller **116** includes a shroud **136** (e.g., FIG. **4**). In addition, the housing **110** includes a radial wall **138** that circumscribes the shroud **136** when the fan **100** is assembled. In at least some examples, the radial wall **138** includes a shoulder **140** that transitions from a first portion **142** with a first diameter **143** (e.g., FIG. **5**) to a second portion **144** with a second diameter **145**, which is larger than the first diameter **143** (e.g., the housing **110** comprises a shoulder that transitions from a first narrower portion to a second wider portion). In this respect, the second portion **144** of the radial wall **138** is recessed relative to the first portion **142**. In addition, the first diameter **143** is smaller than an outer diameter **146** associated with the shroud **136**, while the second diameter **145** is larger than the outer diameter **146** of the shroud **136**. As such, the shoulder **140** (e.g., a transitional step or wall extending from the first portion **142** to the second portion **144**) allows the impeller **116** to, during fan assembly, slide into the space of the second portion **144** (e.g., within the second diameter **145**). In other words, the shroud **136** of the impeller **116** is aligned with the shoulder **140** and positioned within the second wider portion of the housing **110**.

[0035] In this respect, arrangement of the first portion **142**, the shoulder **140**, the second portion **144**, and the shroud **136** can contribute to better performance due to less bypass associated with impeller **116** airflow/pressure (e.g., where the shroud **136** is at least partially positioned in the recess formed by the second portion **144** and is at least partially obscured by the shoulder **140**).

[0036] The fan **100** can include other features that reduce bypass. For example, the trailing edge of the shroud **136** of the impeller **116** can include an impeller flange **166** or lip that extends outward and away from a center axis. Similarly, the vane insert **118** can include a vane insert flange **168** or lip (e.g., on the leading edge of the vane insert **118**) that extends outward and away from the center axis and that is circumferentially aligned with the impeller flange **166**. In some examples, the alignment of the impeller flange **166** with the vane insert flange **168** helps diminish bypass. That is, in some conventional fans, some air can get trapped and/or escape between components, which can contribute to inefficiencies. However, in some cases the impeller flange **166** and the vane insert flange **168** can reduce bypass and increase efficiency.

[0037] In examples of the present disclosure, the positioning of the vane insert **118** directly adjacent the impeller **116** (e.g., without a control ring or other structure in between) can lend to a more compact design and achieve improved performance (e.g., as compared with conventional solutions) with various other features, such as with impeller-vane alignment. Some examples of the present disclosure address stall issues by handling roughly a 30-50% stall factor while still maintaining fine function (e.g., no decrease in power and/or efficiency), showcasing improved performance without having to integrate a 1½ to 2 inch gap between the leading edges of the blades (e.g., and vanes) and a leading edge of the shroud **136** and without utilizing a control ring. In some examples, the leading edges of the vanes of the vane insert **118** (e.g., and blades of the impeller **116**) are positioned closer to the leading edge of the shroud **136**, because the present design ensures that the direction of the airflow as it comes off the faces of the impeller **116** blades aligns with the direction of the airflow as it engages the vanes of the vane insert **118**. The airflow path, as it comes off of the impeller **116** blades, flows more directly (e.g., as compared to prior solutions) into the vanes of the vane insert **118**, as compared to when a gap is included (e.g., such as a 1½ to 2 inch gap between the blades and the vanes and/or between the blades and a leading edge of the shroud **136**) in which case there are more opportunities for the airflow to get trapped in the gap.

[0038] In at least some examples, the housing **110** includes an inlet-side edge **148** that is further upstream relative to the impeller **116**. In at least some examples, the inlet-side edge includes the bell inlet lip **108** that includes a convex contour **150** or surface (e.g., convex in the axial direction) and that extends radially around the periphery of the inlet-side edge **148**. In some examples, the convexly contoured surface can extend to the shoulder **140**. The contour of the inlet bell can, in some instances, contribute to improved performance and efficiency by helping to smooth the airflow as it enters the fan, minimize airflow separation at the inlet, and prevent airflow stall.

[0039] In at least some examples, the shapes and contours of the impeller **116**, the vane insert **118**, and the stator **112** can improve efficiency and performance by collectively directing airflow in a desired manner. For example, referring to FIG. **6** (with the housing omitted and a cross section depicted to illustrate some of the more interior structures of the impeller **116**, the vane insert **118**, and the stator assembly **112**), arrows **152** represent a general direction of airflow as it comes off the impeller, and as depicted, the direction can be angled relative to the axial flow direction **154**. For example, while the blades of the impeller **116** curve in a first direction, the vanes of the vane insert **118** curve in a second direction opposite or inversely to the first direction, and as the impeller **116** and the vane insert **118** rotate, the curvature of the blades and the vanes, respectively, align with and follow each other, which offsets the stall factor. In some examples (e.g., such as the example depicted in FIG. **5**), the contours of the impeller **116** blades and the vane insert **118** vanes align closely. For example, while the blades of the impeller **116** include a given contour extending from the leading edge to the trailing edge, the vanes of the vane insert **118** include an inverse contour extending from the leading edge to the trailing edge. Accordingly, the blades and the vanes are inversed so that they are towards each other, which has the effect of diminishing (e.g., and potentially eliminating) the bypass. In examples, the vane insert **118** includes a contour that contributes to axially aligning the airflow so that it is more aligned with the axial flow direction **154** when the air moves from the trailing edge of the vane insert **118** blades. For example arrows **156** are more aligned in the axial direction with the axial flow direction, as compared with the flow represented by arrows **152**. Alignment between the contours of the impeller **116** blades and the vane insert **118** vanes can be described or characterized in various manners. In at least one example, the arrows **152** can represent an orientation or airflow direction that is normal to the face of the impeller **116** blades (e.g., the bottom or underneath side face based on the view in FIG. **6**). In addition, the leading portions of the vane insert **118** vanes (oriented closer to the impeller **116** and upstream) can include an angle or contour (e.g., a convex top face) that is generally aligned with the arrows **152**. The vane insert **118** vanes can, in some cases, gradually transition from the leading portions to trailing portions that are more downstream and that are more axially aligned. This gradual transition from the leading portions that are aligned in a direction normal (e.g., perpendicular) to the face of the impeller blade **116** to the trailing portions that are more axially aligned can operate to effectively, efficiently, and quietly direct the airflow.

[0040] In some examples, the stator **112** (e.g., the stator rings) can further direct the airflow, as represented by arrows **158**, such that when the air exits the trailing edge of the stator **112**, the airflow is further aligned in the axial direction. For instances, the stator **112** can include concentric rings **160** (e.g., secondary rings) and radial ribs **162** (e.g., see also FIG. **5**). The concentric rings **160** and/or the radial ribs **162** can help further guide or direct the airflow. For example, the concentric rings **160** are slightly angled such that the expansion of air leaving the outlet is reduced (e.g., to about 17-18 degrees), improving efficiency (e.g., as compared to conventional vane axial fans). Accordingly, the concentric rings **160** include a slight angle to accommodate expansion of the air as it exits the trail. In some examples, one or more of the concentric rings **160** tapers in the axial direction as it extends from the upstream edge to the downstream edge. That is, the upstream edge of the ring **160** can have a larger diameter than the downstream edge (e.g., FIG. **5** illustrates an example in which the rings **160** comprise the taper/angle). If the concentric rings **160** were not included, or if the concentric rings **160** were not tapered, the air would tend to expand outwards (e.g., naturally expanding by 20-21 degrees) after leaving the outlet, hitting surfaces above and below the fan, and making the fan less efficient. The inclusion of the concentric rings **160** at a slight angle helps to keep the air from immediately expanding, making the fan more efficient (e.g., as compared to conventional solutions). In some examples, the rings **160** can be perpendicular (not illustrated), instead of tapering.

[0041] Various aspects of the impeller **116** (e.g., the blades of the impeller **116**), the vane insert **118** (e.g., the vanes of the vane insert **118**), and/or the stator **112** (e.g., the concentric rings **160** or secondary blades) can be configured to affect a desired airflow. In at least some examples, while the vanes of conventional vane-axial fans are typically fixed and not interchangeable, the vanes of the present solution include module components that are interchangeable depending on the desired output of a user. For example, the leading edge, trailing edge, inner edge, outer edge, leading face, and trailing face can all be configured. In addition, the impeller **116** and the vane insert **118** can be tailored to correspond with one another to achieve a desired performance associated with the fan. For example, vane inserts and impellers can be interchanged to achieve greater efficiency, less noise production, lower stall, and more. In some examples, a user can optimize the end performance of a fan for efficiency purposes at a specific revolutions per minute (RPM), air flow, and/or static pressure. Thus, the vane-axial fan described herein allows a user to tailor the airflow and blade design to achieve a certain range of performance. For example, if a user desires a quieter running fan, a user can configure the fan to run at 1800 RPM with 1½ inches of static and to push 800 cubic feet per minute (CFM). In another example, if a user desires 2 inches of static, the user can change the components of the fan to achieve 2200 RPM; although this change may drop efficiency from 60% to 40%, this may be the desired airflow of the user.

[0042] Furthermore, the set of base components can be universal, such that different impeller and vane insert configurations can be interchangeably removed and installed for specific or targeted use cases. In some examples, it is common amongst all of the potential pairs of impeller and vane insert configurations to have a correspondence between the contours of the impeller blades and the contours of the vanes of the vane inserts. Accordingly, changing one impeller or vane insert for another impeller or vane insert, respectively, entails exchanging the contours associated with the impeller or vane insert for other contours (e.g., different angles) associates with another impeller or vane insert, respectively. In some examples, the number of blades or vanes can be interchangeable for higher or lower airflow and static pressure. For example, the example embodiment illustrated in FIG. **6** is designed for higher airflow and higher static due to the high number of blades (e.g., of the impeller **116**) and the number of vanes (e.g., of the vane insert **118**). In this example, if a user desired lower airflow while still maintaining higher static, the user could exchange the impeller **116** and/or the vane insert **118** for a differently configured impeller or vane insert. For example, impeller **116** could be exchanged with an impeller with a less number of blades, with blades that are more vertical, and/or blades that are wider (e.g., more vertical from tip-to-tip, from the outside ring to the inner ring of the impeller). Further, the vane insert **118** could be exchanged with a vane insert with vanes that are more vertical, because the user in this case (e.g., desiring lower airflow) want to move less air, meaning that the vanes would be wider in width. In some examples, the straighter (e.g., the more vertical and more aligned) the blades and vanes are, the greater the efficiency is for power. As such, different numbers, lengths, and angles of the blades (e.g. for the impeller) and the vanes (e.g., for the vane insert) can be associated with different impellers and vane inserts and can be interchanged to achieve a desired airflow.

[0043] Referring now to FIG. **7** through FIG. **12**, another example vane-axial fan **700** is depicted, based on examples of this disclosure, and the fan **700** is compact with modular components. The fan **700** includes some features that are similar to the fan **100**, and for brevity, features that are similar might not be described again with respect to the fan **700**. But, it is understood that the same description that is associated with the fan **100** can also apply equally to the fan **700**. In some examples, the fans **100** and **700** provide similar advantages over conventional solutions, such as modularity, improved efficiency, improved noise reduction, and a universal set of base components. In addition, the fan **100** might be better suited for installation in one use case (e.g., as part of a first system), whereas the fan **700** might be better suited for installation in a different use case (e.g., a second system having a different setup with different access).

[0044] In an example, the fan **700** includes a housing **710** that is combined with a stator assembly **712**. For example, the housing **710** includes a radial wall **711**, which can be connected to (e.g., integrally formed with) the stator assembly **712**. In addition, the fan **700** includes a bell inlet lip **708** that attaches to the inlet end of the housing **710** (e.g., to the flange **713**, such as with the mounting plate **720** fastened between the flange **713** and the bell inlet lip **708**). In addition, the fan includes a motor **714** (e.g., internal motor or axially aligned motor). Alternatively, the fan **700** can include a belt-drive arrangement (e.g., external motor). In at least some examples, the same concepts apply to the fans with either an internal motor (e.g., such as motor **714**) or an external motor (e.g. such as a belt-drive arrangement). In at least one example, any one or more of the housing **710** with the stator assembly **712**, the bell inlet lip **708**, and the motor assembly **714** can be part of a base set of modular components that can be operatively coupled with additional fan components, which can be tailored and customized for a given use case or application. Additional components can also be included in the base set of components, such as a mounting plate **720**. In this sense, this set of base components can be universal, based on being compatible with a variety of other fan components, such as the impeller **716** and the vane insert **718**.

[0045] The fan **700** can be assembled in various manners. For example, the stator assembly **712** can be affixed to a base **722** of the motor assembly **714** (e.g., as indicated by the reference line **724** in FIG. **11** showing alignment of mounting apertures). In operation (e.g., when the impeller **716** is rotating via the motor), the base **722** and the stator assembly **712** attached to the base **722** can remain in a fixed position. In at least some examples, the vane insert **718** can be fastened to the stator assembly **712** (e.g., as indicated by the reference line **726**), and similar to the stator assembly **712** and the base **722**, the vane insert **718** can also remain stationary and fixed relative to the rotation of the impeller **716**. In examples, the impeller **716** can be fastened (as indicated by the reference line **728**) to a mounting flange **730** (e.g., radial mounting flange) of the motor assembly **714**, and the rotation of the mounting flange **730** can operationally rotate the impeller **716**.

[0046] In at least some examples, bell inlet lip **708** can be fastened to the housing **710** (e.g., the flange **713**) and to the mounting plate **720** (e.g., as indicated by the reference line **732** in FIG. **10**). The various parts can be assembled in various orders. In some examples, the stator assembly **712** with the housing **710**, the vane insert **718**, the impeller **716**, and the motor assembly **714** can be removably coupled together in a first subassembly. The impeller **716** and the vane insert **718** can then be moved through the central opening of the mounting plate **720**, so that the mounting plate **720** is flush with the outer, radial flange **713** of the housing **710**. The bell inlet lip **708** can then be fastened to the mounting plate **720** and the housing **710** (via the flange **713**).

[0047] In some examples, the bell inlet lip **708** and the mounting plate **720** can be omitted.

[0048] The fan **700** can include various features that contribute to improved performance. In at least one example, the impeller **716** includes a shroud **736**. In addition, the housing **710** includes the radial wall **711** that circumscribes the shroud **736** when the fan **700** is assembled. In at least some examples, the radial wall **711** includes an inner diameter **745** that is larger than an outer diameter of the shroud **736**. In some examples, the inlet bell **708** is associated with an inner diameter **743**, which is smaller than the outer diameter associated with the shroud **736**. As such, the wall of the bell inlet lip **708** can be at least partially aligned with the shroud **736**, as indicated by reference line **741**. Alternatively, the shroud **736** could be positioned further radially outward than the wall of the bell inlet lip **708**.

[0049] In examples, this arrangement of shroud **736** relative to the bell inlet lip **708** can contribute to better performance due to less bypass associated with impeller **716** airflow/pressure. For example, the trailing edge of the shroud **736** of the impeller **716** can include an impeller flange **766** or lip that extends outward and away from a center axis. Similarly, the vane insert **718** can include a vane insert flange **768** or lip (e.g., on the leading edge of the vane insert **718**) that extends outward and away from the center axis and that is circumferentially aligned with the impeller flange **766**. In some examples, the alignment of the impeller flange **766** with the vane insert flange **768** helps diminish bypass. The inclusion of the impeller flange **766** and the vane insert flange **768** helps to block bypass and improves the efficiency and the static pressure.

[0050] Referring to FIG. **12**, impeller **716** (e.g., the blades of the impeller **716**), the vane insert **718** (e.g., the vanes of the vane insert **718**), and/or the stator **712** (e.g., concentric rings **760**) can be configured to affect a desired airflow. For example, the leading edge, trailing edge, inner edge, outer edge, leading face, and trailing face can all be configured. In addition, the impeller and the vane insert can be tailored to correspond with one another to achieve a desired performance associated with the fan. For example, it is common amongst all of the potential pairs of impeller and vane insert configurations to have a correspondence between the contours of the impeller blades and the contours of the vanes of the vane inserts. Accordingly, changing one impeller or vane insert for another impeller or vane insert, respectively, entails exchanging the contours associated with the impeller or vane insert for other contours (e.g., different angles) associates with another impeller or vane insert, respectively. In some examples, the number of blades or vanes can be interchangeable for higher or lower airflow and static pressure. For example, the user could exchange the impeller **716** and/or the vane insert **718** for a differently configured impeller or vane insert. For example, impeller **716** could be exchanged with an impeller with a less number of blades, with blades that are more vertical, and/or blades that are wider (e.g., more vertical from tip-to-tip, from the outside ring to the inner ring of the impeller). Further, the vane insert **118** could be exchanged with a vane insert with vanes that are more vertical. As such, different numbers, lengths, and angles of the blades (e.g. for the impeller) and the vanes (e.g., for the vane insert) can be associated with different impellers and vane inserts and can be interchanged to achieve a desired airflow. Furthermore, the set of base components can be universal, such that different impeller and vane insert configurations can be interchangeably removed and installed for specific or targeted use cases.

[0051] As can be seen in the example embodiment illustrated in FIG. **13**, various aspects of the other impeller **776** (e.g., the blades of the other impeller **776**), the other vane insert **778** (e.g., the vanes of the other vane insert **778**), and/or the stator **712** (e.g., the concentric rings **760** or secondary blades) can be configured to affect a desired airflow. The vanes of the present solution include module components that are interchangeable depending on the desired output of a user. For example, the leading edge, trailing edge, inner edge, outer edge, leading face, and trailing face can all be configured. In addition, the other impeller **776** and the other vane insert **778** can be tailored to correspond with one another to achieve a desired performance associated with the fan. For example, vane inserts and impellers can be interchanged to achieve greater efficiency, less noise production, lower stall, and more. In the example depicted in FIG. **13**, the other impeller **776** blades include a flatter blade angle (e.g., as compared to the blades of impeller **716**), and the other vane insert **778** vanes are more vertical (e.g., as compared to the vanes of the vane insert **718**). Exchanging the impeller **716** for the other impeller **776**, as well as exchanging the vane insert **718** for the other cane insert **718**, impacts the airflow of the fan **700**. For example, exchanging the impeller **716** for the other impeller **776**, which includes a flatter blade angle compared to the impeller **716**, decreases the amount of airflow. Furthermore, in the example depicted in FIG. **13**, exchanging the vane insert **718** for the other vane insert **778**, which includes vanes that are more vertical than the vanes of vane insert **718**, increases the static pressure. As such, the modular components of the present disclosure can be configured to affect a desired airflow.

[0052] Referring now to FIG. **14** and FIG. **15**, another example vane-axial fan **1400** is depicted, based on examples of this disclosure, and the fan **1400** is also compact with modular components. The fan **1400** includes some features that are similar to the fan **100** and the fan **700**, and for brevity, features that are similar might not be described again with respect to the fan **1400**. But, it is understood that the same description that is associated with the fan **100** and the fan **700** can also apply equally to the fan **1400**. In some examples, the fans **100**, **700**, and **1400** provide similar advantages over conventional solutions, such as modularity, improved efficiency, improved noise reduction, and a universal set of base components. In addition, the fan **1400** might be better suited for installation in one use case (e.g., as part of a first system), whereas the fan **100** or the fan **700** might be better suited for installation in a different use case (e.g., a second system having a different setup with different access).

[0053] The fan **1400** includes a housing **1410** (or casing) that circumferentially aligns with a stator **1412** (e.g., see FIG. **15**), a motor **1414** (e.g., internal motor or axially aligned motor or an external motor, such as a belt-drive arrangement), an impeller **1416**, and a vane insert **1418** that can be assembled with a base set of components (e.g., the housing **1410**, the stator **1412**, the motor assembly **1414**, and a mounting plate **1420**). The impeller **1416** and the vane insert **1418** is one example, and the fan **1400** can include other impellers and/or vane inserts having different configurations, which can be tailored or customized for a particular use case or application.

[0054] The fan **1400** can be assembled in various manners. For example, the stator **1412** (e.g., stator vane) can be affixed to a base **1422** of the motor assembly **1414** (e.g., as indicated by reference line **1424** showing alignment of mounting apertures). In operation (e.g., when the impeller **1416** is rotating via the motor **1414**), the base **1422** and the stator **1412** attached to the base **1422** can remain in a fixed position. In at least some examples, the vane insert **1418** can be fastened to the stator **1412** (e.g., as indicated by reference line **1426**), and similar to the stator **1412** and the base **1422**, the vane insert **1418** can also remain stationary and fixed relative to the rotation of the impeller **1416**.

[0055] In examples, the impeller **1416** can be fastened to a motor shaft **1488** (e.g., radial motor shaft that protrudes from the base **1422**) of the motor assembly **1414** via attachment of a circular mounting bracket **1464** (e.g., as indicated by the reference line **1494**). In examples, the motor shaft **1488** extends through a radial opening of the vane insert **1418**. In at least some examples, the circular mounting bracket **1464** is attachable to an inner axial flange **1490** of the impeller **1416** (e.g., as indicated by reference line **1494**), and the circular mounting bracket **1464** is attachable to the motor shaft **1488** (e.g., as indicated by reference line **1492**). In some examples, the rotation of the motor shaft **1488** (e.g., when operatively attached to the circular mounting bracket **1464**) can operationally rotate the impeller **1416**.

[0056] In at least some examples, the stator **1412** can be fastened to the housing **1410** (e.g., as indicated by the reference line **1432**). The various parts can be assembled in various orders. In some examples, the stator **1412**, the vane insert **1418**, the impeller **1416** and the motor assembly **1414** can be removably coupled together in a first subassembly. The impeller **1416** and the vane insert **1418** can then be moved through the central opening of the mounting plate **1420**, so that the circular mounting bracket **1464** can attach to the impeller **1416** and to the motor shaft **1488**, holding these components together. The housing **1410** can then be maneuvered into position around the impeller **1416** and the vane insert **1418** and fastened to the mounting plate **1420** and the stator **1412**.

[0057] The fan **1400** can include various features that contribute to improved performance. The impeller **1416** (e.g., the blades of the impeller **1416**), the vane insert **1418** (e.g., the vanes of the vane insert **1418**), and/or the stator **1412** can be configured to affect a desired airflow. The impeller and the vane insert can be tailored to correspond with one another to achieve a desired performance associated with the fan (e.g., like the impellers and vane inserts of the fans **100** and **700**). The counters, amount, lengths, and angles of the blades (e.g. for the impeller) and the vanes (e.g., for the vane insert) can be associated with different impellers and vane inserts and can be interchanged to achieve a desired airflow.

[0058] With reference now to FIG. **16**, another example vane-axial fan **1600** is depicted, based on examples of this disclosure, and the fan **1600** is also compact with modular components. The fan **1600** includes some features that are similar to the fans **100**, **700**, and **1400**, and for brevity, features that are similar might not be described again with respect to the fan **1600**. But, it is understood that the same description that is associated with the fans **100**, **700**, and **1400** can also apply equally to the fan **1600**. In at least some examples, the fan **1600**, and the related disclosure, illustrate and explain that modular features associated with this disclosure, such as a housing, impeller, vane, and stator, can be used across a wide variety of motors, either with or without slight modifications. Among other things, this can contribute to a widely flexible system that is highly effective across a wide variety of use contexts and environments.

[0059] The fan **1600** includes a housing **1610** that circumferentially aligns with a stator **1612**, a motor **1614** (e.g., internal motor or axially aligned motor or, in an alternative arrangement, an external motor, such as a belt-drive arrangement), an impeller **1616**, and a vane insert **1618** that can be assembled with a base set of components (e.g., the housing **1610**, the stator **1612**, the motor assembly **1614**, and a mounting plate **1620**). The impeller **1616** and the vane insert **1618** are one example, and the fan **1600** can include other impellers and/or vane inserts having different configurations, which can be tailored or customized for a particular use case or application, such as modularity, improved efficiency, and improved noise reduction.

[0060] The fan **1600** can be assembled in various manners. For example, the stator **1612** (e.g., stator vane) can be affixed to a base **1622** of the motor assembly **1614** (e.g., as indicated by reference line **1624** showing alignment of mounting apertures). In at least some examples, the vane insert **1618** can be fastened to the stator **1612** (e.g., as indicated by reference line **1626**). In examples, the impeller **1616** can be fastened to a motor shaft **1688** of the motor assembly **1614** (e.g., located within the motor assembly **1614**) via attachment of a circular mounting bracket **1664** (e.g., as indicated by the reference line **1694**) to an inner axial flange **1690** of the impeller **1616** (e.g., as indicated by reference line **1694**). In some examples, the circular mounting bracket **1664** of fan **1600** has a larger diameter than the circular mounting bracket **1464** of fan **1400**. According to examples, the circular mounting bracket **1664** is attachable to the motor shaft **1688**. In some examples, the rotation of the motor shaft **1688** (e.g., when operatively attached to the circular mounting bracket **1664**) can operationally rotate the impeller **1616**. In at least some examples, the stator **1612** can be fastened to the housing **1610**.

[0061] The various parts can be assembled in various orders. In some examples, the stator **1612**, the vane insert **1618**, the impeller **1616** and the motor assembly **1614** can be removably coupled together in a first subassembly. The impeller **1616** and the vane insert **1618** can then be moved through the central opening of the mounting plate **1620**, so that the circular mounting bracket **1664** can attach to the impeller **1616** and to the motor shaft **1688**, holding these components together. The housing **1610** can then be maneuvered into position around the impeller **1616** and the vane insert **1618** and fastened to the mounting plate **1620** and the stator **1612**. The impeller and the vane insert can be tailored to correspond with one another to achieve a desired performance associated with the fan (e.g., like the impellers and vane inserts of the fans **100**, **700**, and **1400**).

[0062] Referring now to FIG. **17**, another example vane-axial fan **1700** is depicted, based on examples of this disclosure, and the fan **1700** is also compact with modular components. The fan **1700** includes some features that are similar to the fans **100**, **700**, **1400**, and **1600**, and for brevity, features that are similar might not be described again with respect to the fan **1600**. But, it is understood that the same description that is associated with the fans **100**, **700**, **1400**, and **1600** can also apply equally to the fan **1700**. In at least some examples, the fan **1700**, and the related disclosure, illustrate and explain that modular features associated with this disclosure, such as a housing, impeller, vane, and stator, can be used across a wide variety of motors, either with or without slight modifications. Among other things, this can contribute to a widely flexible system that is highly effective across a wide variety of use contexts and environments.

[0063] The fan **1700** includes a housing **1710** that circumferentially aligns with a stator **1712**, a motor **1714**, an impeller **1716**, and a vane insert **1718** that can be assembled with a base set of components. The impeller **1716** and the vane insert **1718** is one example, and the fan **1700** can include other impellers and/or vane inserts having different configurations, which can be tailored or customized for a particular use case or application. For example, the impeller and the vane insert can be tailored to correspond with one another to achieve a desired performance associated with the fan (e.g., like the impellers and vane inserts of the fans **100**, **700**, **1400**, and **1600**).

[0064] The fan **1700** can be assembled in various manners, and the various parts can be assembled in various orders. For example, the stator **1712** can be affixed to a base **1722** of the motor assembly **1714** (e.g., as indicated by reference line **1724** showing alignment of mounting apertures). In at least some examples, the vane insert **1718** can be fastened to the stator **1712** (e.g., as indicated by reference line **1726**). In examples, an inner axial flange of the impeller **1716** can be fastened (as indicated by the reference line **1794**) to a mounting flange **1764** (e.g., radial mounting flange) of the motor assembly **1714**, and the rotation of the mounting flange **1764** can operationally rotate the impeller **1716**. In some examples, the mounting flange **1764** of fan **1700** has a larger diameter than the mounting flanges **130** and **730** of fans **100** and **700**, respectively. In at least some examples, the stator **1712** can be fastened to the housing **1710**. The impeller **1716** and the vane insert **1718** can be moved through the central opening of the mounting plate **1720**, so that the circular mounting bracket **1764** can attach to the impeller **1716**, holding these components together. The housing **1710** can then be maneuvered into position around the impeller **1716** and the vane insert **1718** and fastened to the mounting plate **1720** and the stator **1712**. According to aspects, the vane-axial fans described herein (e.g., **100**, **700**, **1400**, **1600**, and **1700**) can be assembled in various manners, and the various parts can be assembled in various orders. However, it will be appreciated by one of ordinary skill in the art that, in some examples, regardless of how each respective fan is assembled (e.g., regardless of how each respective fan connects to its respective motor), the airflow of each respective fan can be configured to affect a desired airflow. For example, the impellers and the vane inserts described herein can be tailored to correspond with one another to achieve a desired performance associated with each respective fan. The counters, amount, lengths, and angles of the blades (e.g. for each described impeller) and the vanes (e.g., for each described vane insert) can be associated with different impellers and vane inserts and can be interchanged to achieve a desired airflow. Furthermore, each fan described herein can be manufactured at different scales (e.g., the same proportions at varying dimensions). For example, the vane-axial fans described herein can be manufactured at varying scales (e.g., larger or smaller in size as compared to other vane-axial fans described herein) for specific use cases associated with varying HVAC systems.

EXAMPLE CLAUSES

[0065] A. A vane-axial fan comprising: a housing comprising a radial wall that circumscribes an axis associated with the vane-axial fan; a stator assembly that is coupled to the housing and that comprises one or more rings; an impeller positioned interior to the radial wall; and a vane insert that is removably coupled to the stator assembly and that is positioned interior to the radial wall and between the impeller and the stator assembly.

[0066] B. The vane-axial fan of Clause A, wherein: the housing further comprises a shoulder that transitions from a first narrower portion to a second wider portion;

and the impeller comprises a shroud aligned with the shoulder and positioned within the second wider portion of the housing.

[0067] C. The vane-axial fan of Clauses A or B, wherein the first narrower portion comprises a bell curve towards the axis.

[0068] D. The vane-axial fan of any of Clauses A through C, wherein the one or more rings of the stator taper towards the axis.

[0069] E. The vane-axial fan of any of Clauses A through D, wherein the vane insert comprises vanes comprising a first contour and the impeller comprises blades comprising a second contour, and wherein the first contour comprises a leading edge that corresponds with a trailing edge of the second contour.

[0070] F. The vane-axial fan of Clause E, wherein the first contour comprises a convex top face oriented towards the impeller and wherein the second contour comprises a convex bottom face oriented towards the vane insert.

[0071] G. The vane-axial fan of Clause E or Clause F, wherein alignment between the first contour and the second contour offsets a stall factor.

[0072] H. The vane-axial fan of any of Clauses A through G, wherein: the impeller comprises a first shroud comprising a first lip that is on a trailing edge of the first shroud; the vane insert comprises a second shroud comprising a second lip that is on a leading edge of the second shroud; and the first lip is aligned with the second lip.

[0073] I. The vane-axial fan of Clause H, wherein alignment of the first lip and the second lip at least partially reduces bypass.

[0074] J. An system for heating, cooling, and/or venting air, the system comprising: a vane-axial fan comprising: a housing comprising a radial wall that circumscribes an axis associated with the vane-axial fan; a stator assembly that is coupled to the housing and that comprises one or more rings; an impeller positioned interior to the radial wall; and a vane insert that is removably coupled to the stator assembly and that is positioned interior to the radial wall and between the impeller and the stator assembly.

[0075] K. The system of Clause J, wherein: the housing further comprises a shoulder that transitions from a first narrower portion to a second wider portion; and the impeller comprises a shroud aligned with the shoulder and positioned within the second wider portion of the housing.

[0076] L. The system of Clauses J and K, wherein the first narrower portion comprises a bell curve expanding away from the housing.

[0077] M. The system of Clause J, wherein the one or more rings of the stator taper towards the axis.

[0078] N. The system of Clause J, wherein the vane insert comprises vanes comprising a first contour and the impeller comprises blades comprising a second contour, and wherein the first contour comprises a leading edge that corresponds with a trailing edge of the second contour.

[0079] O. The system of Clauses J, wherein the first contour comprises a convex top face oriented towards the impeller, wherein the second contour comprises a convex bottom face oriented towards the vane insert, and wherein alignment between the first contour and the second contour at least partially offsets a stall factor.

[0080] P. The system of Clause J, further comprising a second impeller having one or more properties that are different from the impeller, wherein the second impeller is interchangeable in the system with the impeller.

[0081] Q. The systems of Clauses J and P, further comprising a second vane insert having one or more properties that are different from the vane inset, wherein the second vane insert is interchangeable in the system with the vane insert.

[0082] R. The system of Clause J, wherein: the impeller comprises a first shroud comprising a first lip that is on a trailing edge of the first shroud; the vane insert comprises a second shroud comprising a second lip that is on a leading edge of the second shroud; and the first lip is aligned with the second lip, wherein the alignment of the first lip and the second lip at least partially reduces bypass.

[0083] S. The system of Clause J, wherein: a mounting bracket is attachable to an inner axial flange of the impeller; and the mounting bracket being attachable to a motor shaft extending through a radial opening of the vane insert.

[0084] T. A method comprising: replacing, in association with a vane-axial fan, a first vane insert with a second vane insert, which has one or more different properties than the first vane insert; and based on replacing the first vane insert with the second vane insert, changing one or more performance characteristics of the vane-axial fan.

[0085] As used herein, a recitation of "and/or" with respect to two or more elements should be interpreted to mean only one element, or a combination of elements. For example, "element A, element B, and/or element C" may include only element A, only element B, only element C, element A and element B, element A and element C, element B and element C, or elements A, B, and C. In addition, "at least one of element A or element B" may include at least one of element A, at least one of element B, or at least one of element A and at least one of element B. Further, "at least one of element A and element B" may include at least one of element A, at least one of element B, or at least one of element A and at least one of element B.

[0086] The present embodiments are described with reference to the drawings in which like elements are referred to by like numerals. The relationship and functioning of the various elements of this disclosure are better understood from the detailed description. However, the embodiments of the disclosure are not limited to the embodiments illustrated in the drawings. It should be understood that in certain instances, details have been omitted which are not necessary for an understanding of the present disclosure, such as conventional fabrication and assembly.

[0087] This detailed description is provided in order to meet statutory requirements. However, this description is not intended to limit the scope of the invention described herein. Rather, the claimed subject matter may be embodied in different ways, to include different steps, different combinations of steps, different elements, and/or different combinations of elements, similar or equivalent to those described in this disclosure, and in conjunction with other present or future technologies. The examples herein are intended in all respects to be illustrative rather than restrictive. In this sense, alternative examples or examples can become apparent to those of ordinary skill in the art to which the present subject matter pertains without departing from the scope hereof.

[0088] While various embodiments of the invention have been described, the invention is not to be restricted except in light of the attached claims and their equivalents. Moreover, the advantages described herein are not necessarily the only advantages of the invention and it is not necessarily expected that every embodiment of the invention will achieve all of the advantages described.

Claimed is:

1. A vane-axial fan comprising:

a housing comprising a radial wall that circumscribes an axis associated with the vane-axial fan;

a stator assembly that is coupled to the housing and that comprises one or more rings;

an impeller positioned interior to the radial wall; and

a vane insert that is removably coupled to the stator assembly and that is positioned interior to the radial wall and between the impeller and the stator assembly.

2. The vane-axial fan of claim **1**, wherein:

the housing further comprises a shoulder that transitions from a first narrower portion to a second wider portion; and

the impeller comprises a shroud aligned with the shoulder and positioned within the second wider portion of the housing.

3. The vane-axial fan of claim **2**, wherein the first narrower portion comprises a bell curve expanding away from the housing.

4. The vane-axial fan of claim **1**, wherein the one or more rings of the stator taper towards the axis.

5. The vane-axial fan of claim **1**, wherein the vane insert comprises vanes comprising a first contour and the impeller comprises blades comprising a second contour, and wherein the first contour comprises a leading edge that corresponds with a trailing edge of the second contour.

6. The vane-axial fan of claim **5**, wherein the first contour comprises a convex top face oriented towards the impeller and wherein the second contour comprises a convex bottom face oriented towards the vane insert.

7. The vane-axial fan of claim **5**, wherein alignment between the first contour and the second contour offsets a stall factor.

8. The vane-axial fan of claim **1**, wherein:

the impeller comprises a first shroud comprising a first lip that is on a trailing edge of the first shroud;

the vane insert comprises a second shroud comprising a second lip that is on a leading edge of the second shroud; and

the first lip is aligned with the second lip.

9. The vane-axial fan of claim **8**, wherein alignment of the first lip and the second lip at least partially reduces bypass.

10. A system for heating, cooling, and/or venting air, the system comprising:

a vane-axial fan comprising:

a housing comprising a radial wall that circumscribes an axis associated with the vane-axial fan;

a stator assembly that is coupled to the housing and that comprises one or more rings;

an impeller positioned interior to the radial wall; and

a vane insert that is removably coupled to the stator assembly and that is positioned interior to the radial wall and between the impeller and the stator assembly.

11. The system of claim **10**, wherein:

the housing further comprises a shoulder that transitions from a first narrower portion to a second wider portion; and

the impeller comprises a shroud aligned with the shoulder and positioned within the second wider portion of the housing.

12. The system of claim **11**, wherein the first narrower portion comprises a bell curve expanding away from the housing.

13. The system of claim **10**, wherein the one or more rings of the stator taper towards the axis.

14. The system of claim **10**, wherein the vane insert comprises vanes comprising a first contour and the impeller comprises blades comprising a second contour, and wherein the first contour comprises a leading edge that corresponds with a trailing edge of the second contour.

15. The system of claim **14**, wherein the first contour comprises a convex top face oriented towards the impeller, wherein the second contour comprises a convex bottom face oriented towards the vane insert, and wherein alignment between the first contour and the second contour at least partially offsets a stall factor.

16. The system of claim **10**, further comprising a second impeller having one or more properties that are different from the impeller, wherein the second impeller is interchangeable in the system with the impeller.

17. The system of claim **16**, further comprising a second vane insert having one or more properties that are different from the vane insert, wherein the second vane insert is interchangeable in the system with the vane insert.

18. The system of claim **10**, wherein:

the impeller comprises a first shroud comprising a first lip that is on a trailing edge of the first shroud;

the vane insert comprises a second shroud comprising a second lip that is on a leading edge of the second shroud; and

the first lip is aligned with the second lip, wherein the alignment of the first lip and the second lip at least partially reduces bypass.

19. The system of claim **10**, wherein:

a mounting bracket is attachable to an inner axial flange of the impeller; and

the mounting bracket being attachable to a motor shaft extending through a radial opening of the vane insert.

20. A method comprising:

replacing, in association with a vane-axial fan, a first vane insert with a second vane insert, which has one or more different properties than the first vane insert; and

based on replacing the first vane insert with the second vane insert, changing one or more performance characteristics of the vane-axial fan.

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