(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
19 March 2009 (19.03.2009)

PCT

(10) International Publication Number
WO 2009/036403 A2

(51) International Patent Classification:
F04D 29/32 (2006.01) *F01P 7/02* (2006.01)

(21) International Application Number:
PCT/US2008/076332

(22) International Filing Date:
13 September 2008 (13.09.2008)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/971,929 13 September 2007 (13.09.2007) US

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL,

[Continued on next page]

(54) Title: FAN WITH STRUCTURAL SUPPORT RING

(57) Abstract: A cooling fan with an integral structural support ring. The fan has a hub member and a plurality of blades extending therefrom. The fan is a one-piece plastic injection structure. The support ring is positioned between the root and tips of the blades.

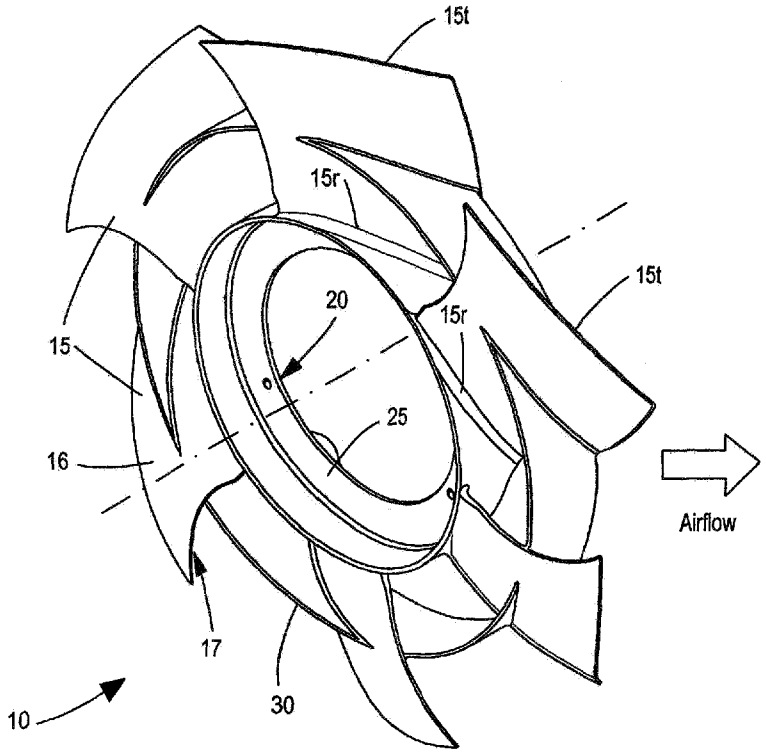


FIG. 1

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NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

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— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

Published:

— *without international search report and to be republished upon receipt of that report*

FAN WITH STRUCTURAL SUPPORT RING

TECHNICAL FIELD

[0001] The present invention relates to cooling fans and more particularly to fans used in cooling systems for vehicles and industrial applications.

BACKGROUND OF THE INVENTION

[0002] The present invention relates to cooling fans such as fans used in connection with an automobile or industrial cooling system. More specifically, the invention pertains to fans with integral blades formed in a molding process, such as an injection molding procedure.

[0003] In most industrial and automotive engine applications, an engine-driven cooling fan is utilized to force air across a coolant radiator. Usually, the fan is driven through a belt-drive mechanism connected to the engine crankshaft.

[0004] A typical cooling fan includes a plurality of blades mounted to a central hub member. The hub member can be configured to provide a rotary connection to the belt drive mechanism, for example. The size and number of fan blades is determined by the cooling requirements for the particular application. For instance, a small automotive fan may only require four blades having a diameter of only 9" (229 mm). In larger applications, a greater number of blades are required. In one typical heavy-duty automotive application, nine blades are included in the fan design, the blades having an outer diameter of 28" (711 mm).

[0005] In addition to the number and diameter of blades, the cooling capacity of a particular fan is also governed by the airflow volume that can be generated by the fan at its operating speed. This airflow volume is dependent upon the particular blade geometry, such as the blade area and curvature or profile, and the rotational speed of the fan.

[0006] As the cooling fan dimensions and airflow capacity increase, the loads experienced by the fan, and particularly the blades, also increase. In addition,

higher rotational speeds and increased airflow through the fan can lead to deformation or twisting of the blades and significant noise problems. In order to address these problems to some degree, certain cooling fan designs incorporate a ring around the circumference of the fan. Specifically, the blade tips are attached to the ring, which provides stability to the blade tips. The ring also helps reduce vortex shedding at the blade tip, particularly when the ring is combined with a U-shaped shroud that follows the circumference of the ring.

[0007] The ring fan design, therefore, eliminates some of the structural difficulties encountered with prior unsupported cooling fan configurations. However, with the increased strength and improved vibration characteristics provided by the ring fan, the nominal operating conditions for these fans has been increased to again push the envelope of the ring fan's capability. The mass inertia of the circumferential ring increases the centrifugal force exerted on the blade-ring interface causing potential failures. Also, the weakest point on molded ring fans is along the outer ring between the blade tips, again limiting the life of the fans.

[0008] Consequently, a need has again developed for ways to improve cooling airflow capacity of fans, while at the same time increasing their strength. This need becomes particularly acute as the operational rotational speeds of the fan increase to meet the increasing cooling demands for large industrial and automotive engines.

[0009] A need also exists for a fan meeting these requirements, but also is less costly and easy to manufacture.

SUMMARY OF THE INVENTION

[0010] To address these needs, the present invention contemplates an engine driven cooling fan for use in an engine cooling system, in which the fan has a structural support ring. The fan includes a central hub and a plurality of fan blades projecting radially outwardly from the hub, each of the blades having a blade root connected to the hub and a blade tip at an opposite end thereof. Each of the blades further defines a leading edge at an inlet side of the fan and a trailing

edge at an outlet side of the fan. The cooling fan also includes an annular support ring positioned on the blades between their roots and tips.

[0011] The support ring provides support and stiffness to the fan blades similar to that provided by ring fans which have circumferential rings connected to the blade tips. However, the fan with a mid-type support ring in accordance with the present invention provides a stronger integral structure for the fan and blades, and also improves the strength of the molded materials. The invention further provides a cooling fan, particularly for large vehicles and heavy duty industrial applications, which can be manufactured in less expensive and uncomplex basic injection molded techniques.

[0012] It is an object of the present invention to provide an improved molded fan, particularly for cooling systems for large vehicles and large industrial applications. It is another object of the present invention to provide a cooling fan with improved strength and ease of manufacture.

[0013] It is a still further object of the present invention to provide a fan with a structural support ring for improved material and operational strength, but with the ring positioned between the fan hub and blade tip and not at the blade tips.

[0014] Other objects and benefits of the present invention in its various embodiments will be appreciated upon consideration of the following written description and accompanying figures.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] FIGURE 1 is a perspective view of a fan in accordance with one embodiment of the present invention..

[0016] FIGURE 2 is a side view of the fan depicted in Figure 1.

[0017] FIGURE 3 is a front view of the fan depicted in Figure 1.

[0018] FIGURES 4 is a cross-sectional view of the fan depicted in Figure 1.

[0019] FIGURES 5 is a rear view of the fan depicted in Figure 1.

[0020] FIGURES 6-9 depict an alternate embodiment of the invention, with Figure 6 being a perspective view, Figure 7 being a front view, Figure 8 being a cross-sectional view, and Figure 9 being a rear view.

DESCRIPTION OF PREFERRED EMBODIMENTS

[0021] For the purposes of promoting an understanding of the principles of the invention, reference will now be made to the embodiments illustrated in the drawings and specific language will be used to describe the same. It will nevertheless be understood that no limitation as to the scope of the invention is thereby intended. The inventions include any alterations and further modifications in the illustrated devices and described methods and further applications of the principles of the invention which would normally occur to one skilled in the art to which the invention relates.

[0022] In the early designs of cooling fans, metal blades were mounted to a metal hub, which hub was then attached to the fan drive. In recent years, high-strength polymer materials have been used to form various components of the fan. The polymer fan design has been found to be capable of withstanding the normal forces and stresses endured by a cooling fan, including in heavy duty automotive and industrial applications. The use of polymer materials also provides a significant reduction in weight of the cooling fan. Moreover, and perhaps most significantly, the use of polymers generates significant benefits in the manufacture of the fan, since materials of this type readily lend themselves to a variety of common molding processes.

[0023] One-piece molded fans eliminate the welds and rivets commonly associated with prior metal fans. In addition, the plastic molding process facilitates the generation of smooth rounded contours, which reduce internal stresses within the fan structure.

[0024] The present invention provides an improved one-piece molded fan structure with improved strength and molding characteristics. The fan structure eliminates an outer ring and its associated molding, manufacturing and durability

issues, such as weld lines on the outer ring between the blade tips. At the same time, the present invention provides a rigid and strong fan structure with an integral structure and excellent air flow characteristics.

[0025] A preferred embodiment of the invention is shown in Figures 1-5. Figure 1 is a perspective view of the fan embodiment, while Figures 3 and 5 are front and rear elevational views. Figure 2 is a side view and Figure 4 is a cross-sectional view. The new fan structure is referred to by the reference number 10.

[0026] The fan structure 10 includes a number of blades 15 mounted on a central hub member 20. The hub member preferably includes a metal mounting bolt ring 25 which can be insert molded into the fan structure when the fan is manufactured.

[0027] The fan 10 further includes a structural support ring 30 which is positioned on the blades 15 between the roots 15r of the blades at the hub member 20 and the tips 15t of the blades. The support ring 30 is preferably positioned approximately midway between the roots and tips of the blades. It is understood, however, that the ring can be positioned at other locations on the blades.

[0028] As indicated, the fan structure 10 is preferably made of a plastic or polymer material and is made by a plastic injection molding process. The locations and positioning of the blades, as well as the shape and positioning of the structural ring, preferably allow molding without expensive moveable mold inserts, slides or other complex molding devices.

[0029] The plastic material used for the fan 10 is preferably a nylon material, although it could also be polypropylene or other resin compositions commonly in use today on plastic molded cooling fans for vehicles. The material also preferably is a glass-filled material which provides improved strength to the fan structure. A 30% glass filled nylon is a preferred type of material for the fan 10.

[0030] Each of the blades 15 include a front face 16 that is the effective inlet to the fan 10. Likewise, each blade includes an opposite rear face 17.

[0031] Each of the blades 15 also can have a swept formed configuration as shown in the drawings. The leading edges 18 and trailing edges 19 of each fan blade are curved in the duration of rotation of the fan structure. In this regard, the direction of rotation of the fan structure 10 is indicated by the arrows 100 in Figures 3 and 5.

[0032] The swept forward structure of the fan blades is only used in the preferred embodiments, but is not essential to the invention. Blades without any curved structure or even a reverse curved structure can be utilized in accordance with the present invention, as shown, for example, in Figures 6-9.

[0033] The cross-sections of the blades 15 also are preferably curved as shown to provide air-foil type configurations. The curvatures and varying thicknesses of the blades are selected to provide maximum airflow when the fan is operated within its standard rotational speed operational range.

[0034] Six blades 15 are shown in the embodiment depicted in the drawings. However, the precise number of blades depends on the use and airflow characteristics needed for the cooling application. For example, a fan structure with five, seven or more blades could be utilized within the scope of the present invention.

[0035] Also, as shown in the drawings, the blades 15 do not overlap one another in the axial direction of the fan structure. This allows use of an uncomplex injection molding operation for manufacture of the fans.

[0036] The width W and thickness T of the structural support ring 30 (see Figure 4) are selected based on the desired use and operation characteristics of the fan structure. The width W is preferably less than the overall width OW of the fan structure due to space considerations in the intended use of the fan. The thickness T is selected based on the strength needed for the use and operation characteristics of the fan.

[0037] The ring 30 is provided to provide the requisite rigidity and strength of the blades as needed based on the operating conditions for the fan.

[0038] The cross-sectional shape of the structural ring 30 can be flat (as shown in the drawings) or curved in some manner. Many circumferential rings on ring fans are curved or have various shapes to improve the air flow around the outer edges of the fans and the centrally located support ring 30 used with the present invention could also have similar configurations if found to improve the airflow and other operational characteristics of the fan structure 10.

[0039] The junction 40 (or blend region) of the hub member 20 between each pair of adjacent blades also has a rounded or radius curvature, as shown in Figures 3 and 5. This eliminates possible points of weakness in the molded fan structure 10.

[0040] Figures 6-9 illustrate an alternate embodiment 90 of the invention. Figure 6 is a perspective view and shows the hub member 102, a plurality of fan blade members 104 and a support ring 106. In this embodiment, the fan blades are not angled in plan view in the direction of the rotation 110 as with the embodiment described above, although the angle of attack of the fan blades relative to the airflow, as shown in Figure 6, is still present. Also as shown in Figure 6, the fan blades have a curved cross-sectional shape.

[0041] The fan embodiment 90 is preferably made from a plastic material, similar to the embodiment described above, and also has a metal mounting support ring 120 which is insert molded into the plastic fan material when it is made.

[0042] The fan embodiment 90 is preferably made from a plastic material, similar to the embodiment described above, and also has a metal mounting support ring 120 which is insert molded into the plastic fan material when it is made.

[0043] While preferred embodiments of the present invention have been shown and described herein, numerous variations and alternative embodiments will occur to those skilled in the art. Accordingly, it is intended that the invention is not limited to the preferred embodiments described herein but instead limited to the terms of the appended claims.

What is claimed is:

1. A fan assembly comprising:

a central hub member;

a plurality of blades extending outwardly from said hub member, each of said blades having a blade root at the junction with said hub member and a blade tip at the distal end thereof; and

an annular supporting ring member, said ring member being positioned between said blade roots and said blade tips of said blades.

2. The fan assembly as described in claim 1 wherein said ring member is positioned substantially midway between said blade roots and said blade tips of said blades.

3. The fan assembly as described in claim 1 wherein said blades and said ring member are positioned to facilitate ease of manufacture of said fan assembly by an injection molding process without the use of moveable mold slides or insert members.

4. The fan assembly as described in claim 1 wherein said fan assembly is a one-piece plastic injection molded structure.

5. The fan assembly as described in claim 1 wherein said fan assembly is made from a glass-filled nylon material.

6. The fan assembly as described in claim 1 further comprising a metal mounting bolt ring positioned in said hub member.

7. The fan assembly as described in claim 6 wherein said metal mounting bolt ring is insert molded into said fan assembly.

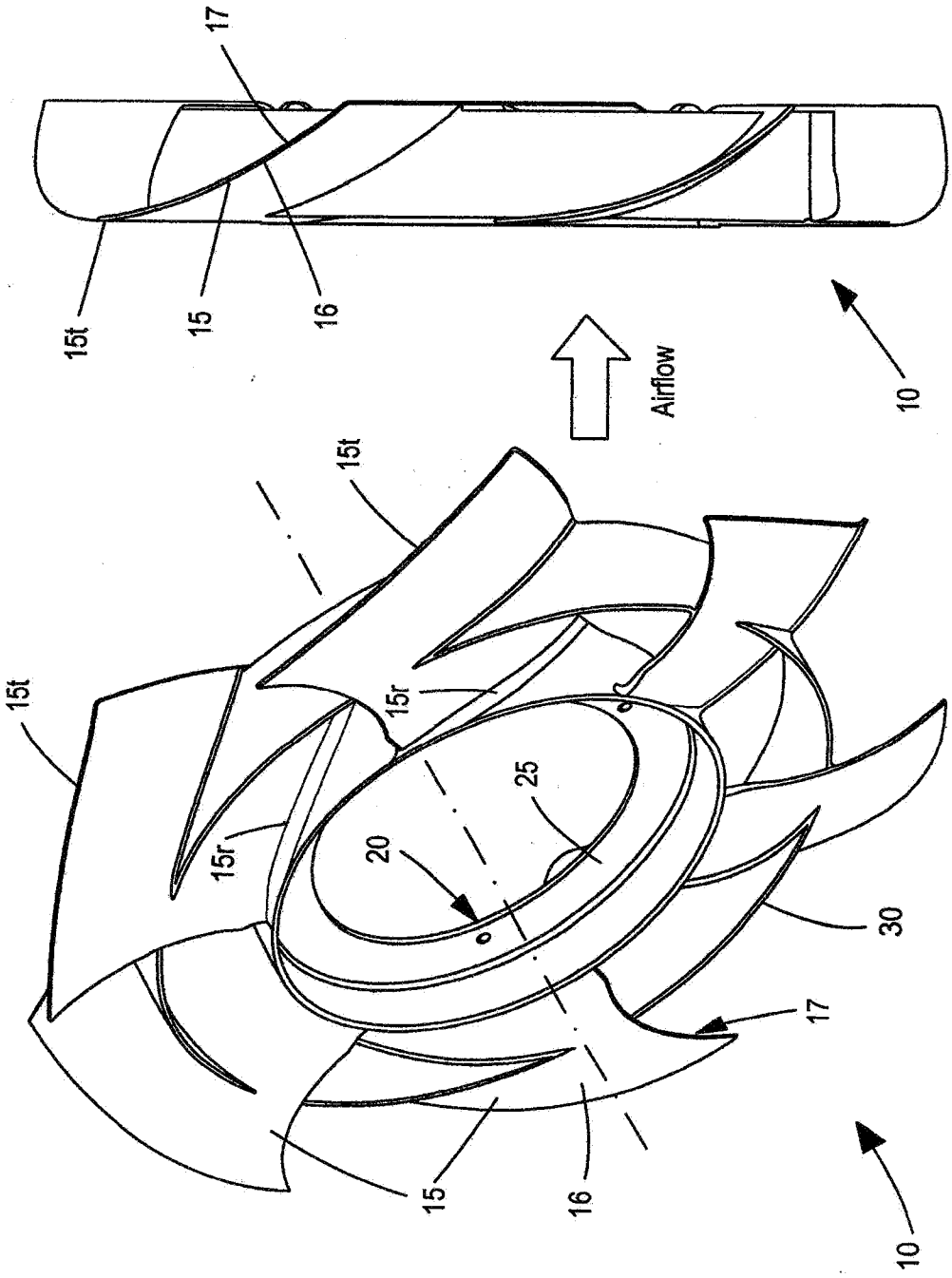


FIG. 2

FIG. 1

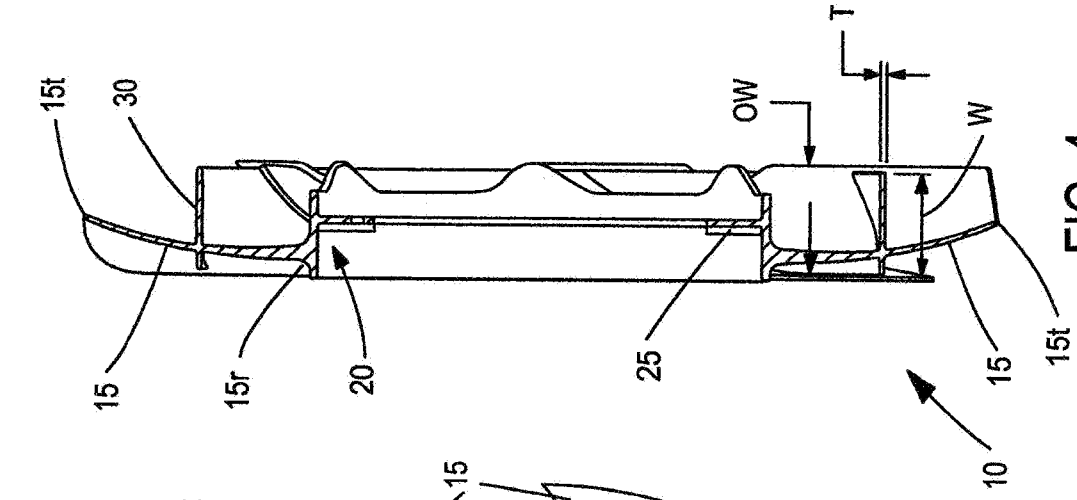

15t
30
15
15r
20
25
OW
T
W
15
15t
10

FIG. 4

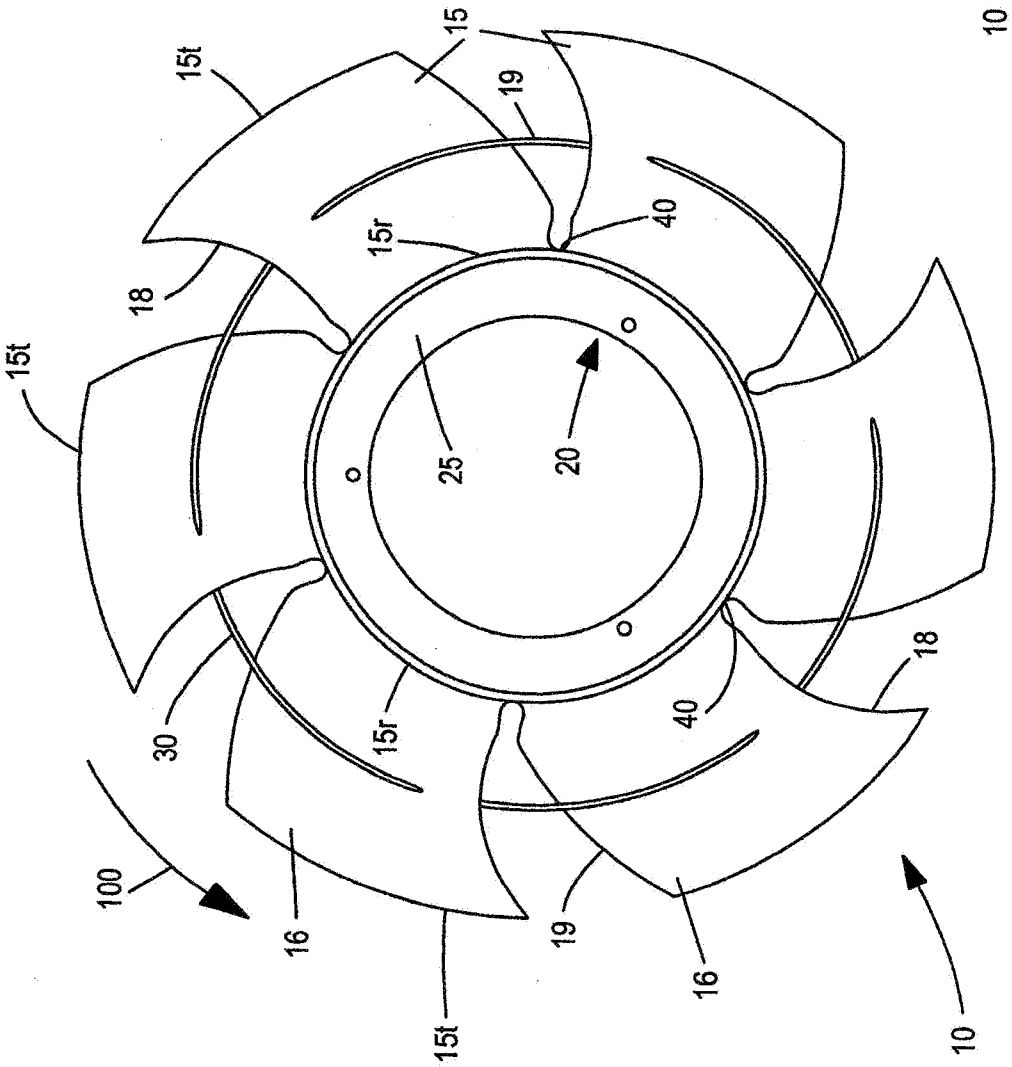

15t
15
19
15r
40
18
25
20
30
100
16
15t
19
16
10

FIG. 3

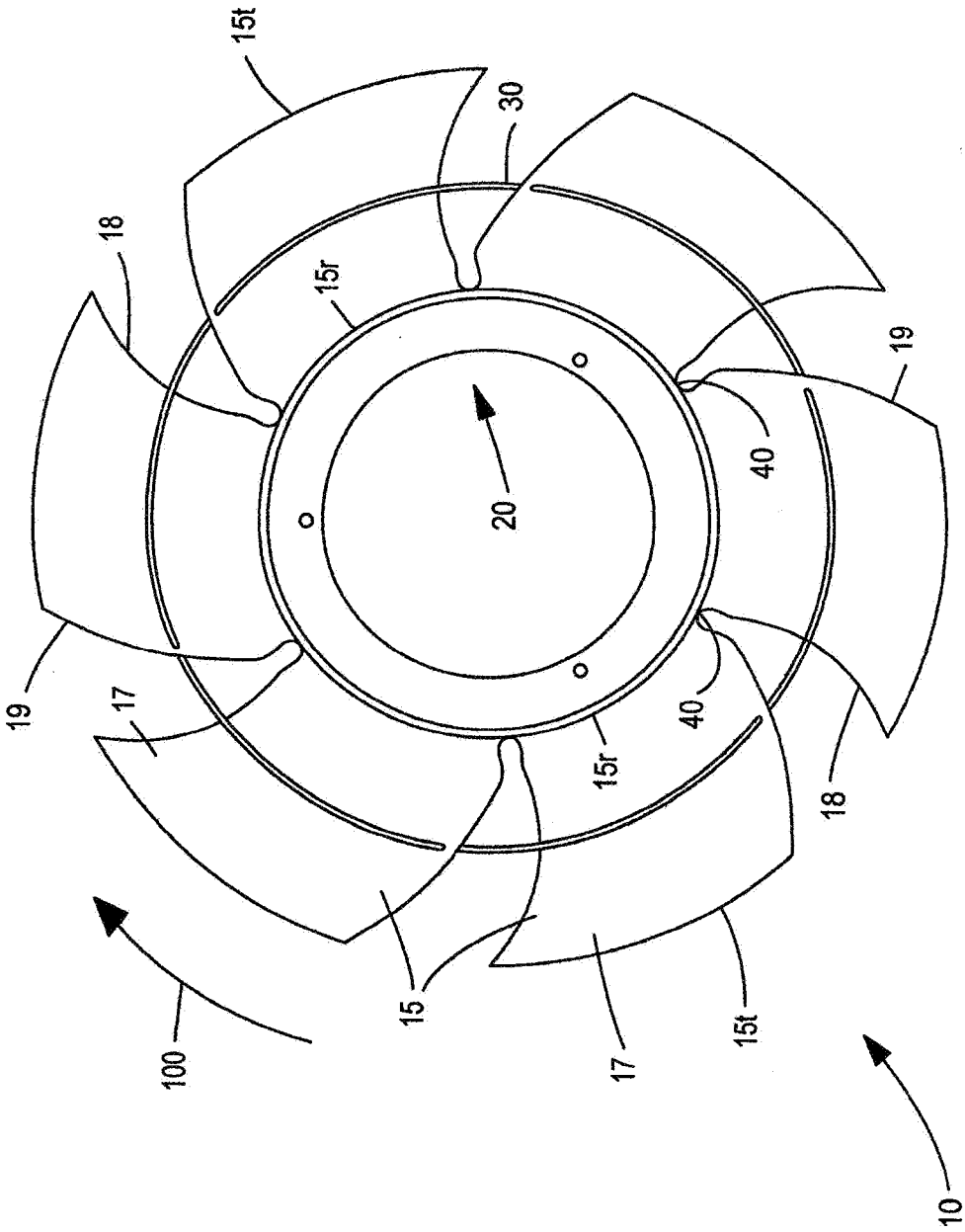


FIG. 5

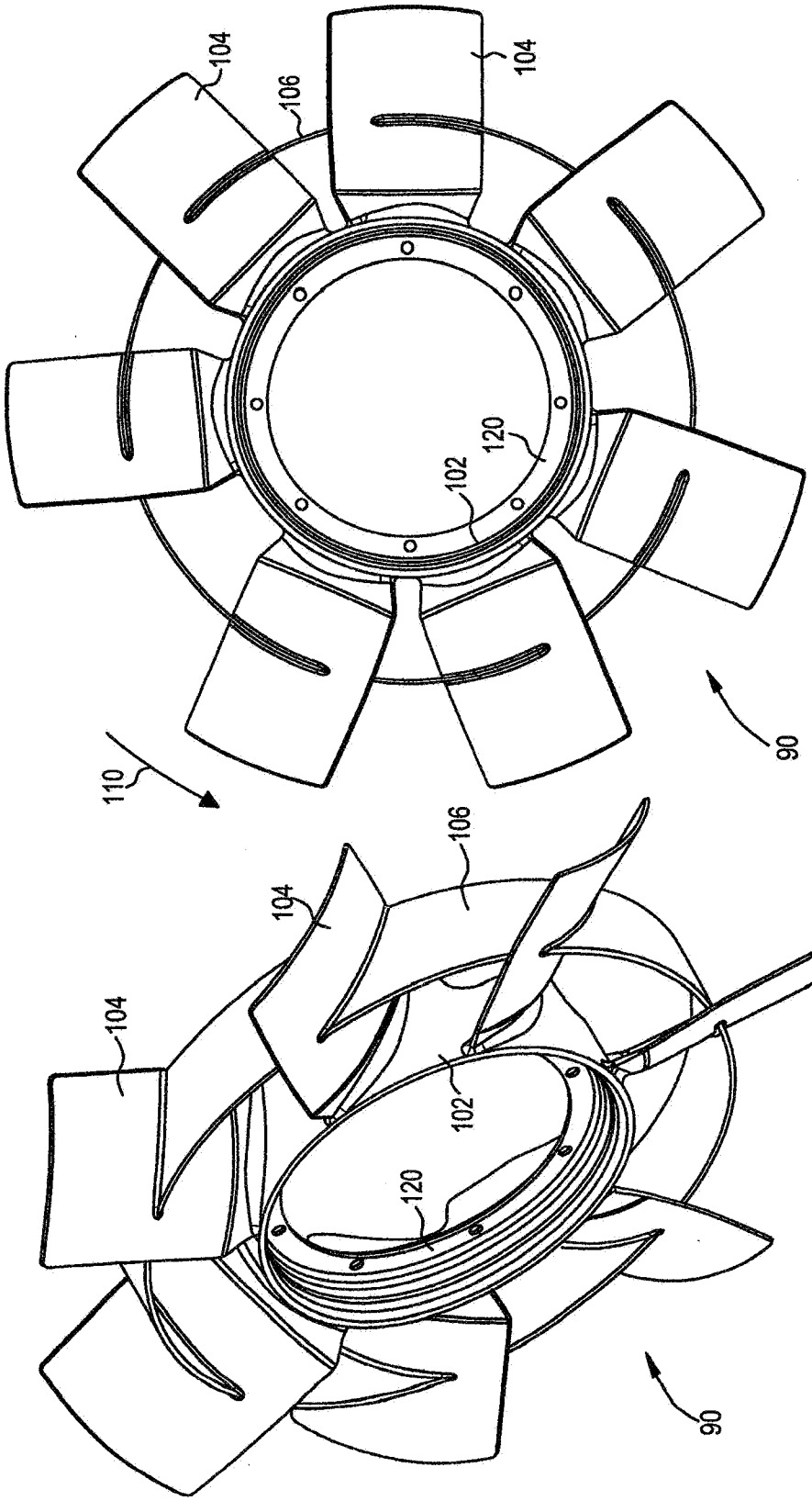


FIG. 7

FIG. 6

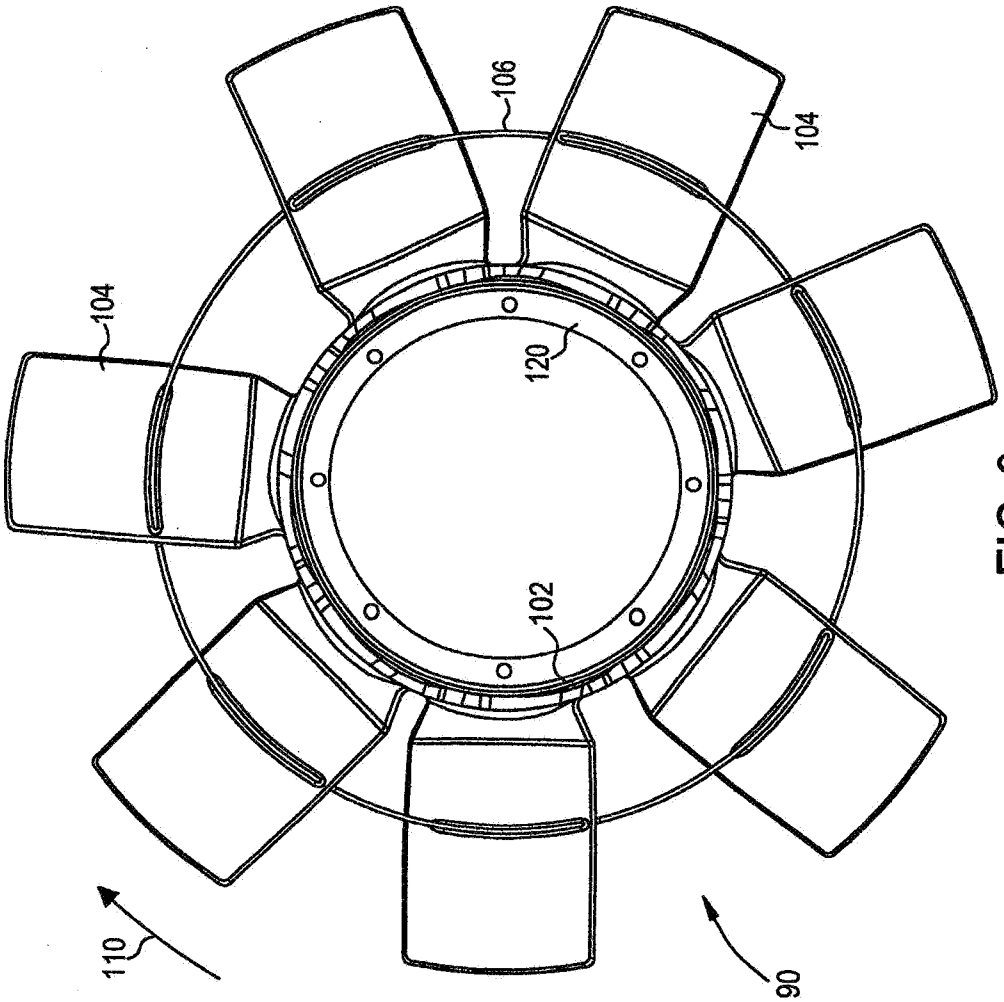


FIG. 9

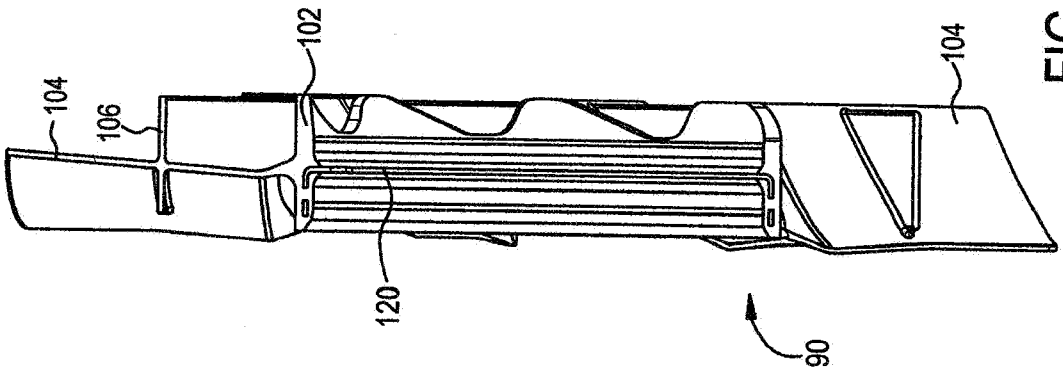


FIG. 8