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(73) Patenthaver: **Sharrow Engineering LLC, 1845 Walnut Street Suite 1601, Philadelphia PA 19103, USA**

(72) Opfinder: **SHARROW, Gregory Charles, 1845 Walnut Street, Suite 1601, Philadelphia, PA 19103, USA**

(74) Fuldmægtig i Danmark: **Zacco Denmark A/S, Arne Jacobsens Allé 15, 2300 København S, Danmark**

(54) Benævnelse: **PROPEL**

(56) Fremdragne publikationer:

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DESCRIPTION

BACKGROUND OF THE INVENTION

[0001] This invention relates to blade apparatuses such as propellers.

[0002] Typically, propellers have been used in devices such as aircraft, watercraft, turbines, and other like apparatuses in a wide variety of configurations for transmitting power by converting rotational motion into thrust or fluid flow.

[0003] A propeller generally consists of two or more blades attached to a central post or hub with the blades curved, twisted, or otherwise shaped to generate a pressure difference between the forward and rear surfaces of a blade to propel a fluid, such as water or air, past the blades. The shape, the pitch, and the twist of the blade all factor in the working efficiency of the propeller.

[0004] There have been numerous attempts at increasing propeller performance by altering blade designs. Such approaches have been successful to a degree but often result in propellers with limiting properties such as limited achievable rake and pitch. There is a need to provide a propeller that exhibits improved properties compared to conventional propellers.

[0005] Further technical background is known from US 467 322 A, WO 2011/081577 A1, US 680 671 A, US 1 868 113 A and US 2004/009063 A1, which refer to propellers.

SUMMARY

[0006] The invention describes a propeller according to claim 1. Preferred embodiments are defined in the dependent claims.

DESCRIPTION OF THE DRAWINGS

[0007]

FIG. 1 is a side view of a schematic representative of a propeller according to an illustrative embodiment of the invention.

FIG. 2 is depicts a propeller with two opposing blades according to an illustrative embodiment of the invention.

FIG. 3A is a side view of a blade in loop form according to an illustrative example which is not part of the claimed invention.

FIGS. 3B and 3C are alternative cross-sectional views of the blade shown in FIG. 3A according to an illustrative example which is not part of the claimed invention.

FIGS. 3D and 3E are alternative views of the blade shown in FIG. 3 according to an illustrative example which is not part of the claimed invention.

FIG. 4 is a cross-sectional view of a propeller with two opposing blades according to an illustrative embodiment of the invention.

FIG. 5 depicts a propeller with uprights attaching the upper and lower blade portions according to an illustrative embodiment of the invention.

FIG. 6A shows a three-loop propeller according to an illustrative example which is not part of the claimed invention.

FIG. 6B depicts a side view of a three-loop propeller according to an illustrative example which is not part of the claimed invention.

FIG. 7A depicts a four-loop propeller according to an illustrative embodiment of the invention.

FIG.7B is a side view of a four-loop propeller according to an illustrative embodiment of the invention.

FIG. 8 shows a multiple-loop propeller according to an illustrative embodiment of the invention.

FIG. 9, an illustrative example which is not part of the claimed invention, is an isometric view of a two-loop propeller with unattached bottom blade sections.

FIG. 10 is an isometric view of a stacked propeller according to an illustrative embodiment of the invention.

FIG. 11 depicts a propeller according to an illustrative embodiment of the invention.

FIG. 12 depicts a stacked propeller according to an illustrative embodiment of the invention.

FIGS. 13A-B depict a top view and side view, respectively of a propeller with open-loop blades according to an illustrative example which is not part of the claimed invention.

DETAILED DESCRIPTION OF THE INVENTION

[0008] Generally, the invention comprises a propeller having one or more "blades" wherein the blades are shaped to create an air flow inward from the propeller sides toward the axis of rotation, for example in a plane perpendicular to the axis of rotation, and also to create airflow in the longitudinal direction of the rotational axis, such as from "front" to "back" of the propeller. The blades are shaped so that air is pulled inward by the blades' outer portions, or "supports", and compressed in the vicinity of the propeller's center. Consequently, as the propeller spins, the blades create pressure in the central area, which, in turn, results in greater thrust. Conversely, when spinning in the opposite direction of rotation, the propeller will create reverse thrust. In illustrative embodiments of the invention, the amount of reverse thrust may not equal the amount of thrust generated.

[0009] The term "blade" is used herein merely to designate a component that rotates about an axis to generate a desired airflow, and is not intended to denote a specific shape, such as flat.

[0010] In illustrative embodiments of the invention, the blade includes three portions: top, bottom, and side. As a propeller can be disposed at various angles, an example of the use of the terms is shown in FIG. 1, and it is noted that, for example, if a propeller 102 is rotating in a vertical plane "top" and "bottom" may not correlate with the traditional meaning of those terms. Propeller 102 has two blades 104, 106. Blade 106 has a top portion 108, bottom portion 110 opposing top portion 108, and a side portion 112. Side portion 112 is at a distal end of blade 108 and connects top portion 108 with bottom portion 110. In this particular embodiment, side portion 112 is a general area of the blade between the top portion and the bottom portion. In other embodiments, a blade's side portion can be a discrete portion of the blade such as the side portion 516 in FIG. 5.

[0011] The term "blade angle", measured in degrees, when used herein is defined as the angle between a lateral cross section of a blade and the plane of rotation. The term "pitch" is used herein interchangeably with "blade angle." Embodiments of the invention provide blades having at least one section exhibiting a non-zero blade angle.

[0012] The term "front" when used with respect to a propeller designates the side/face of the propeller, which when viewed will show counter clockwise motion of the propeller. The propeller "back" will be the opposing side. As the propeller spins, the direction of airflow will preferably be from front to back.

[0013] In illustrative embodiments of the invention, the length from the central post to the distal end of the blade's leading edge 114 is greater than the length from the central post to the distal end of the blade's trailing edge 116. This decrease in blade length from the length at the blade's leading distal edge to the length at the blade's trailing distal edge can result in greater compression of air and greater thrust as compared to a comparable propeller design without this feature.

[0014] FIG. 2 is a front view of a propeller according to an illustrative embodiment of the invention. This embodiment comprises two blades in loop form 202, 204, opposing one another. As used herein a "loop" defines a blade with a continuous curved surface. The propeller includes a central post 206 to which the blades are connected. The central post is coincident with the propeller's axis of rotation. It is noted that the term "post", as used herein, does not indicate a particular shape or configuration, but merely indicates a component to which blades are attached or by which they are secured to one another. In this illustrative embodiment, proximal portion 210 of each loop has a width that is less than the width of distal portions 212. An illustrative example of the ratio of widths is approximately 2:1. As drawn, the propeller spins counterclockwise as shown by the curved arrows. This creates an air flow toward the propeller center from all sides as shown for example by the triple arrows on the right and left sides of the diagram. Air also would flow into the page (front to back) for the configuration shown as the propeller spins counterclockwise.

[0015] By providing curved blades, various examples of which are shown in the figures, air flow is more directed as compared to flatter blades. Although the drawings show blades generally in the form of full loops, the blades may be curved to a lesser extent so that a closed loop is not formed, provided that the desired airflow is created.

[0016] FIG. 3A depicts a looped blade according to an illustrative example which is not part of the claimed invention. FIG. 3A depicts blade 302 attached to a central post 306 of a propeller according to an illustrative example which is not part of the claimed invention. The axis of rotation of blade 302 is coincident with the longitudinal axis of central post 306 in this example. Blade 302 has a top portion 308 and a bottom portion 310. The median line blade 302 is defined as the locus of points midway between the blade's leading edge 312 and its trailing edge 314 as shown by the broken line 316 running from the proximal end 318 to the distal end 320 of blade 302. For some blade configurations, the median line will not be continuous from top section through side portion to bottom portion. The median line of blade 302 is curved providing a curved appearance to the blade portions. In other embodiments, blade portions may be cambered or otherwise curved, angular or flat, or a combination thereof. For example, FIG. 5, further discussed below, depicts an embodiment wherein blade portions have substantially linear, and possibly non-continuous median lines.

[0017] Air is compressed in the vicinity of central post 306 as the propeller spins. As seen in FIG. 3B, a gap 342 between bottom portion 310 and top portion 312 of blade 302 allows a larger volume of air to be compressed than if a gap did not exist. Air is caught on the inside surface of blade 302, thus pulling in air and creating the air flow from the sides as described above, while the outside surfaces of blade 302 function to push the air toward the back of the propeller.

[0018] FIGS. 3B and 3C depict cross sections of blade 302 taken along lines 3B-3B and 3C-3C of FIG. 3A, respectively. Cross-section 3B-3B shows an airfoil shape comparable to a cross section of an airplane wing. As shown in FIG. 3C, surface 332 of blade 302 is curved, while the opposing surface 330 is substantially flat. The cross section of blade 302 is tapered laterally so that at a first area 334 it is thinner than at a second, opposing area 336, also comparable to an airplane wing. Other blade configurations are within the scope of the invention, as long as they fall within the scope of the appended claims, and will depend in part on the desired load on the propeller.

[0019] Referring to FIG. 3B, blade 302 intersects central post 306 at a first blade intersection 338 and a second blade intersection 340. In this illustrative example which is not part of the claimed invention, first and second blade intersections 338, 340 intersect central post 306, which can be at about the same angle θ as measured counterclockwise from a line perpendicular to the longitudinal axis of central post 306, wherein the designated reference line appears as a "horizontal" line in FIG. 3B. An illustrative angle of intersection is about 25°, with an illustrative range being about 10° to about 35°. A further illustrative range of angles of intersection is about 15° to about 25°.

[0020] The intersection angle of the bottom portion of the blade with the central post is more extreme than the angle of intersection of the top portion of the blade with the central post. Generally, angles of intersection can be in the range of about 1° to about 89°. By "extreme" it is meant more toward the vertical. An illustrative difference between the angle of intersection of the top portion of the blade as compared to the angle of intersection of the bottom portion of the blade is about 10°. An illustrative range is about 5 ° to about 20 ° and a further illustrative range is about 7 ° to about 15 °. In a particular illustrative example which is not part of the claimed invention, the angle of intersection of the top portion of the blade is about 30 ° and the angle of intersection of the bottom portion of the blade is about 40 °. In a further illustrative example which is not part of the claimed invention, the angle of intersection of the top portion of the blade is about 75 ° and the angle of intersection of the bottom portion of the blade is about 85 °.

[0021] Blade 302 as shown in FIGS. 3A-C exhibits a coarse blade angle, or pitch, near the axis of rotation with the pitch decreasing radially outward from the axis of rotation. Despite this downward gradient, the outermost point of the blade will still exhibit non-zero pitch. In an alternative example which is not part of the claimed invention, the blade may have a more course blade angle at the farthest point from the axis of rotation.

[0022] FIGS. 3D and 3E depict blade 302 as viewed so central post 306 is perpendicular to the page. In FIG. 3D blade 302 would be rotating clockwise and has a leading edge 346 and a trailing edge 344. In FIG. 3E, blade 302 would be rotating counterclockwise.

[0023] In embodiments wherein two blades oppose one another, such as blades 202 and 204 in FIG. 2, the pitches of opposing blade intersections on either side of the axis of rotation differ from each other. So for example, in FIG. 4 you have a first blade 402 having a first blade intersection 404 at angle θ_A and a second blade intersection 406 at an angle θ_B, and an opposing blade would have a first blade intersection angle and a second blade intersection angle of $\theta_{A\pm}x$ and $\theta_B \pm x$, respectively. So in other words, the pitch of opposing blade intersections differs. An illustrative difference in pitch between opposing blade intersections is about 50 °, wherein for example one blade intersection has a 25 ° pitch and the opposing blade has an intersection with a negative 25 ° pitch. Differences can be equally or unequally distribited. A general range of differences between the pitch of opposing blades is about 40° to about 60°. The pitch of opposing blade intersections are not equal from the plane of rotation as in the preceding example.

[0024] FIG. 5 depicts an illustrative embodiment that includes two blades 502, 504 with substantially non-curved median lines. Median line 506 of top portion 508 and median line 510 of bottom portion 512 of blade 502 are substantially linear and are not parallel. Blade 504 also has a substantially linear median line. One or more substantially vertical wing segments 514, 516 connect top portion 508 and bottom portion 510 at intervals radiating from a central post 518 up to but not necessarily including the distal end 520 of blade 502. Blade 504 may have similar or the same vertical segments. Although, the blades are flattened to an extent and would not necessarily be considered a "loop" with a continuous surface, the desired airflow may nonetheless be created with the addition of the wing segments, 514, 516, or both. As the propeller spins, wing segments 514, 516 pull air in from the sides toward central post 518, thus creating the desired airflow.

[0025] In a further embodiment of the invention, such as shown in FIG. 11, top portion 1102 and bottom portion 1104 are not symmetrical. This can be accomplished, for example, by bottom portion 1104 being longer than the top portion 1102, with a side portion 1106 angled toward the front of the propeller to connect to the shorter top portion 1102. This can facilitate the airflow being pulled in from the side section to propel the blade forward. In general, a more extreme angle between the side portion and the top portion of the blade will result in more thrust and a higher forward rake for the top portion of the blade.

[0026] FIGS. 6A and 6B show a propeller with three loop-shaped blades 602, 604, 606, according to an illustrative example which is not part of the claimed invention. FIG. 6A is a view of the propeller rotating so that counterclockwise rotation would cause airflow into the page, and FIG. 6B is a side view of the propeller. Blades 602, 604, 606 radiate from central post 608. Blades 602, 604, 606 are generally coplanar. Any number of loops can be combined to obtain the desired air flow. See for example FIGS. 7A, 7B with four blades and FIG. 8 with eight blades.

[0027] Propellers can be "stacked" so they rotate in different planes. By "stacked" it is not meant that they necessarily abut one another. The stacked propellers can have gaps between them. They can be of uniform size or graduated from smaller to larger in a direction perpendicular to the plane of rotation from back to front, or larger to smaller in that direction. For example, FIG. 10 shows an eight-loop propeller 1002 having a first plane of rotation stacked onto another eight-loop propeller 1004 having a second plane of rotation. The blades of propeller 1002 are attached to central post 1006, and the blades of propeller 1004 are attached to central post 1008. Although FIG. 10 illustrates two discrete central posts 1006 and 1008, propellers may also be stacked on a single central post.

[0028] FIG. 12 depicts a further embodiment of a stacked propeller. Blades are disposed about a central post in a helix fashion.

[0029] FIGS. 7A and 7B depict a propeller having four blades 702, 704, 706, 708, according to an illustrative embodiment of the invention. Blades 702, 704, 706, 708 radiate from a central post 710 wherein of blades 702, 704, 706, 708 would generally spin in the same plane as the others. As can be seen in FIG.7A, in this illustrative embodiment, there is a "gap" 712 between the attachment locations of a top portion of each blade and a bottom portion of each blade along central post 710, with which the axis of rotation is coincident. The term "gap" is used herein to describe the space around the axis of rotation between the center of the blade intersections with a central post created when a blade's top and bottom portion are attached at different longitudinal locations along a central post or axis of rotation. FIG. 3B depicts the location of the gap as shown by line 340. In certain illustrative examples which are not part of the claimed invention, the blade bottom portion may not be attached to the central post, such as shown in FIGS. 9 and 13A-B, in which case the gap is the distance between the center of the top blade portion intersection with the central post and the center of where the bottom blade portion would intersect the central post if it was extended to reach it.

[0030] As the propeller spins, air is pulled towards and compressed in the vicinity of gap 712. Propellers can be designed with various gap sizes. An illustrative gap size range is approximately about 2% to 55% of the length of a propeller's. Another illustrative gap size range is about 20% of a propeller's blade length to about 35% of a propeller's blade. A third illustrative gap size range is about 30% of a propeller's blade length to about 55% of a propeller's blade length. Generally as the gap increases a larger volume of air can be compressed, thus increasing a propeller's thrust capability.

[0031] Whether or not blades have curved or straight median lines, they may be twisted, such as about the median line for example. A twist can be seen for example in FIG. 5. Both top portion 508 and bottom portion 512 of blade 502 have an apparent twist. Curved blades can also be additionally twisted, such as can been seen in FIGS. 7A-B, or as would result from a difference in blade intersection angles θ as shown in FIG. 4. In an illustrative embodiment of the invention, the propeller has a twist forming the curvature of the blades or relative curvature of opposing blades that is approximately 35 degrees. An illustrative range of twist is in the range of about 30 degrees to about 40 degrees. Other degrees of twisting are within the scope of the invention and can create various degrees and directions of airflow.

[0032] FIG. 8 depicts an illustrative embodiment of the invention with eight "blades" 802, 804, 806, 808, 810, 812, 814, 816 made of four circles that are all slightly angled but have no half turn.

[0033] In an exemplary embodiment of the invention, at least the front edges of the loops are thin to cut through the air, but other edge shapes may be beneficial to achieve a desired air flow pattern. In general, the specific shape, quantity and arrangement of the loops can be chosen to create a desired air flow pattern.

[0034] FIG. 9 depicts a propeller having blades 902, 904 in loop form opposing one another wherein the bottom portions 906, 908 of blades 902, 904 are not attached to central post 910. Instead, "brace" 912 flexibly couples bottom portion 906 to top portion 914. Similarly, brace 916 flexibly couples bottom portion 908 to top portion 918. A "brace" as used herein is a blade component used to flexibly couple disparate blade portions. A brace can be made of steel, aluminum, composite materials such as carbon and fiber glass, or any other suitable blade material. Braces 912, 916 are angled with respect to the plane of rotation to pull air in toward the axis of rotation as the propeller rotates, thus creating drag. A brace may be angled in the same way as a blade's side portion to achieve the desired air flow. Further, the thickness, length, width, and other such characteristics of a brace are designed to achieve desired operation of a particular blade application, such as by way of an example, flight. Blades 902, 904 are disposed with respect to central post 910 in this manner to provide the flexibility of adjusting their pitches. By way of illustration but not limitation, when used as a propeller in an aircraft, the braces allow for the blades 902, 904 to be manipulated to change pitch during activities such as take-off, flight, or landing. The propeller can include an adjustment mechanism to allow selectable variations in the gap formed between top portions 914, 918 and bottom portions 906, 908 of the blades 902, 904, respectively.

[0035] FIGS. 13A-B depict a top view and side view, respectively of a propeller with open-loop blades according to an illustrative example which does not form part of the claimed invention. This version does not include the braces as provided in FIG. 9. Various embodiments of the propeller defined by the appended claims may be used in various devices, for example, the following illustrative devices: aircraft, watercraft, wind turbines, cooling devices, heating devices, automobile engines, and air circulation devices. Examples of method of manufacturing, which are not part of the claimed invention, include a method of manufacturing an aforementioned propeller; a method of manufacturing a device comprising any of the aforementioned propellers; and a method of manufacturing a product wherein the method includes installing a device containing any of the aforementioned propellers.

[0036] Various embodiments of the invention have been described, each having a different combination of elements. The invention is not limited to the specific embodiments disclosed, and may include different combinations of the elements disclosed or omission of some elements, as long as they fall within the scope of the appended claims.

[0037] While the invention has been described by illustrative embodiments, additional advantages and modifications will occur to those skilled in the art. Therefore, the invention in its broader aspects is not limited to specific details shown and described herein. Modifications, for example, the number of blades and curvature of the blades, may be made without departing from the scope of the appended claims. Accordingly, it is intended that the invention not be limited to the specific illustrative embodiments, but be interpreted within the full scope of the appended claims.

REFERENCES CITED IN THE DESCRIPTION

Cited references

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- WO2011081577A1 [0005]
- US680671A [0005]
- US1868113A [0005]
- US2004009063A1 [0005]

Patentkrav

1. Propel omfattende:
en midterstang, der er sammenfaldende med en rotationsakse;
et eller flere blade, der hver har en distal ende og en proksimal ende;
hvor hvert af det ene eller de flere blade omfatter en topdel, en bunddel og en sidedel, hvor sidedelen er anbragt ved eller mod den distale ende;
hvor topdelen og bunddelen af hvert af det ene eller de flere blade er forbundet ved den nærmeste ende og strækker sig radialt udad fra midterstangen, og hvor topdelen er placeret tættere på propellens forside end bunddelen, og bunddelen er placeret tættere på propellens bagside end topdelen;
et mellemrum mellem midterstang-forbindelserne af overdelen og underdelen af mindst et af det ene eller de flere blade, hvor luft komprimeres ved rotation af propellen; og
hvor det ene eller de flere blade er anbragt og indrettet til at trække luft indad fra bladets sidedel mod propellens rotationsakse og fra propellens forside til dens bagside i længderetningen af rotationsaksen;
hvor mindst et par af blade er over for hinanden omkring rotationsaksen;
hvor topdelen af bladene af parret af blade skærer midterstangen ved et første bladskæringspunkt, og bunddelen af det ene af bladene skærer midterstangen ved et andet bladskæringspunkt, og topdelen af det andet af bladene af parret af blade skærer midterstangen ved et tredje bladskæringspunkt, og bunddelen af det andet af bladene skærer midterstangen ved et fjerde bladskærings-punkt; og
kendetegnet ved at vinklen af det første bladskæringspunkt i forhold til rotationsaksen er forskellig fra vinklen af det tredje bladskæringspunkt i forhold til rotationsaksen, og vinklen af det andet bladskæringspunkt i forhold til rotationsaksen er forskellig fra vinklen af det fjerde bladskæringspunkt i forhold til rotationsaksen; og
ved at, målt fra en linje, der er vinkelret på propellens længdeakse, er vinklen af det andet bladskæringspunkt større end vinklen af det første bladskærings-punkt, og vinklen af det fjerde bladskæringspunkt er større end vinklen af det tredje bladskæringspunkt.

2. Propel ifølge krav 1,
hvor mindst en af bladets topdel, bunddel eller sidedel af mindst et af det ene eller de flere blade har en midterlinje, der er krum.

3. Propel ifølge krav 1 eller 2, hvor en snoning, der danner en krumning af bladene, er i området ca. 30 grader til ca. 40 grader.

DRAWINGS

FIG. 1

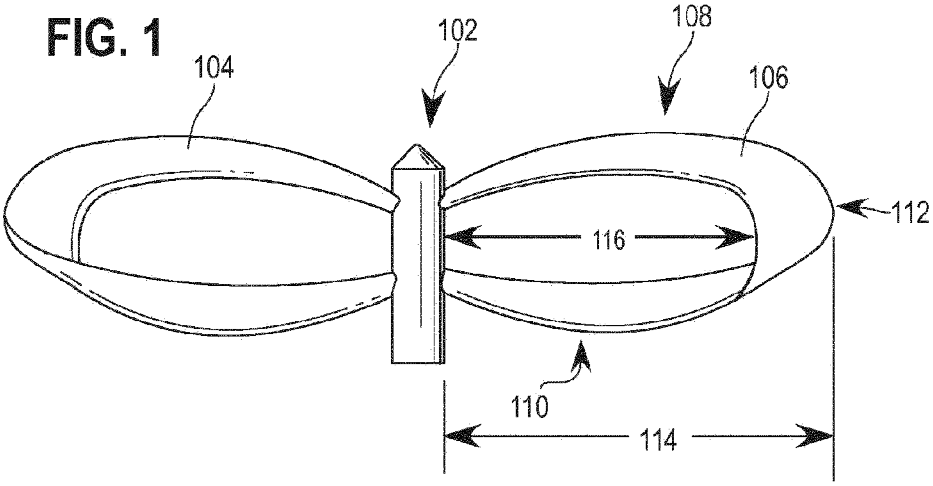

FIG. 2

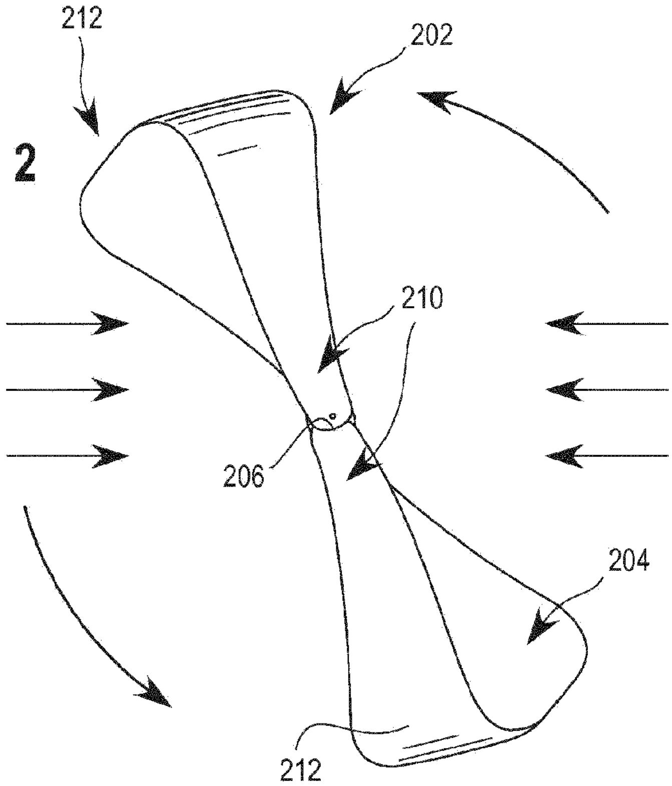

FIG. 3A

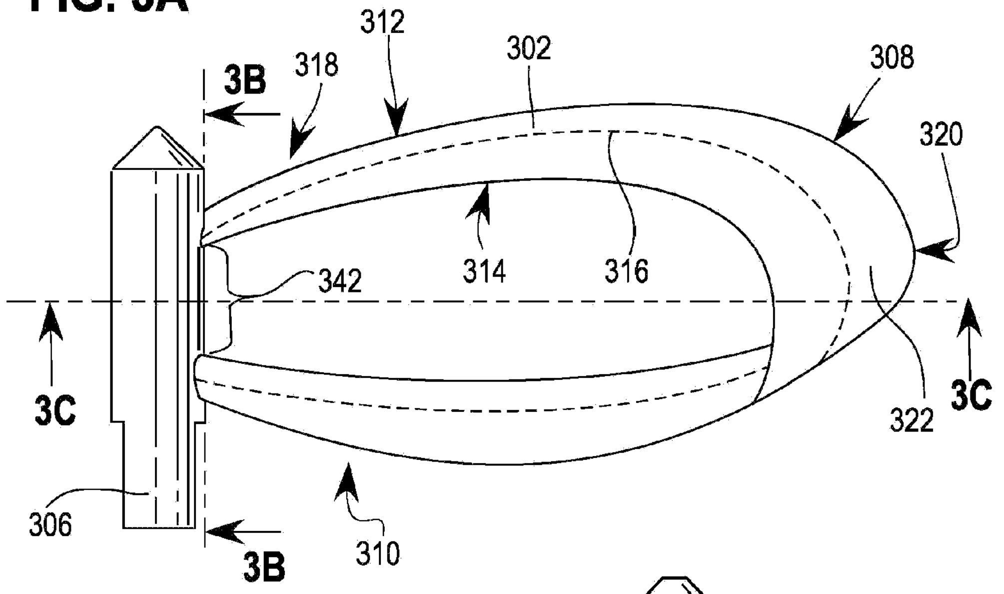
312
302
308
318
3B
320
342
314
316
3C
322
3C
306
3B
310

FIG. 3B

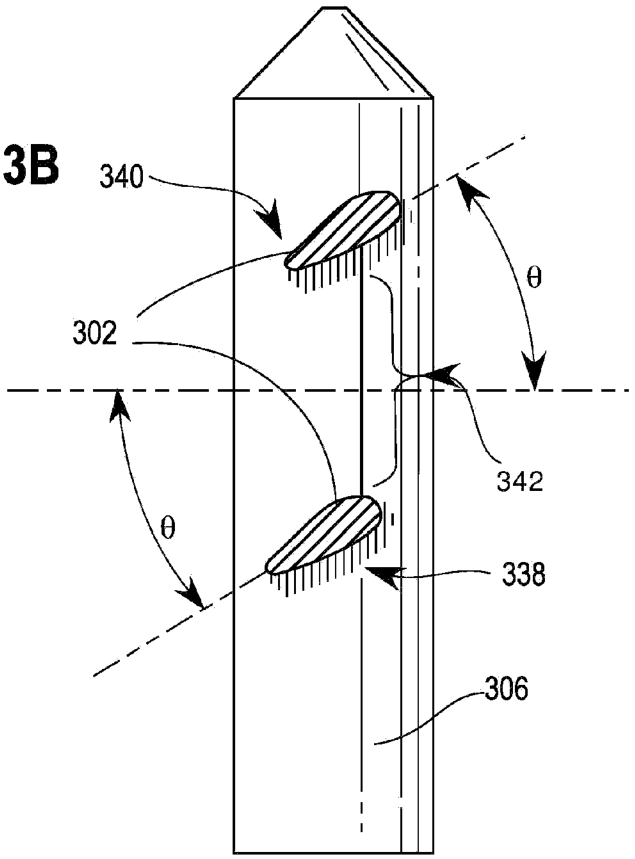
340
θ
302
342
θ
338
306

FIG. 3C

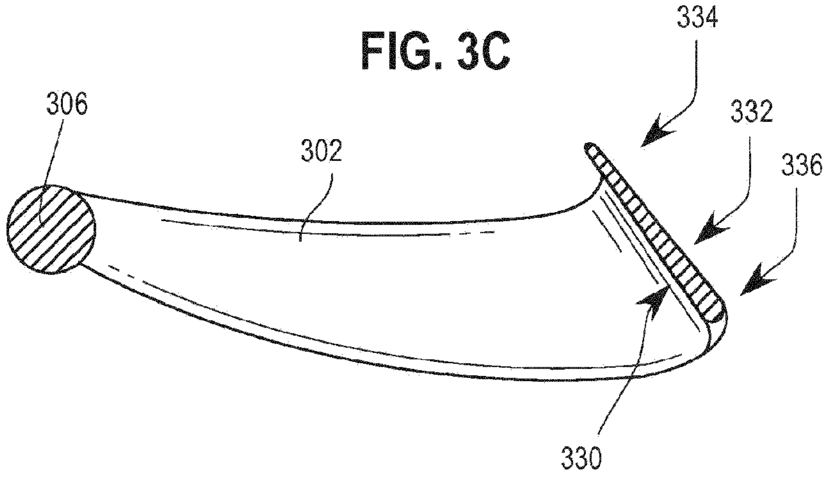

FIG. 3D

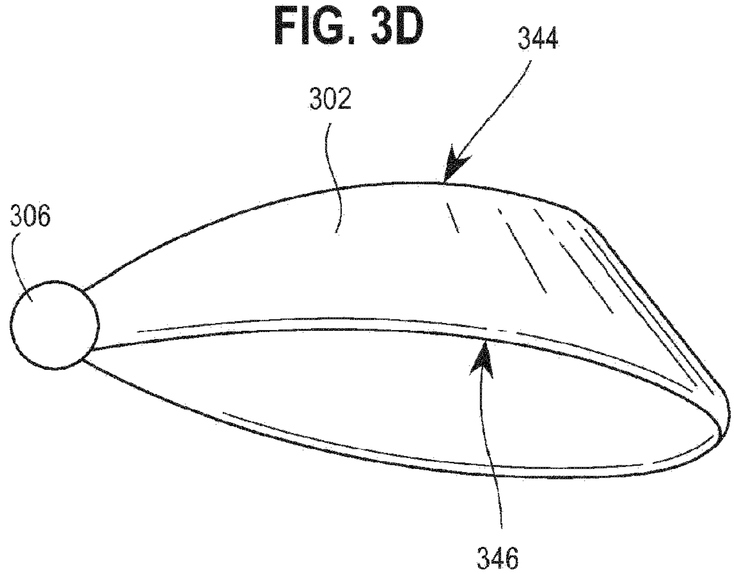

FIG. 3E

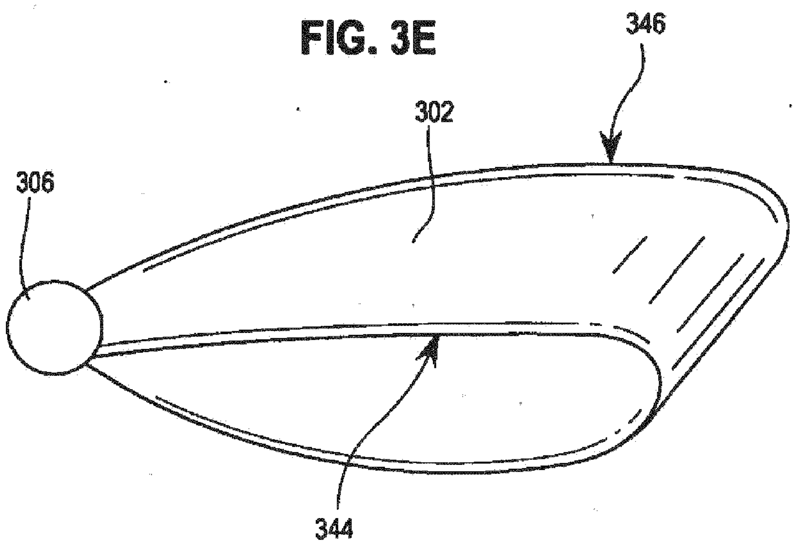

FIG. 4

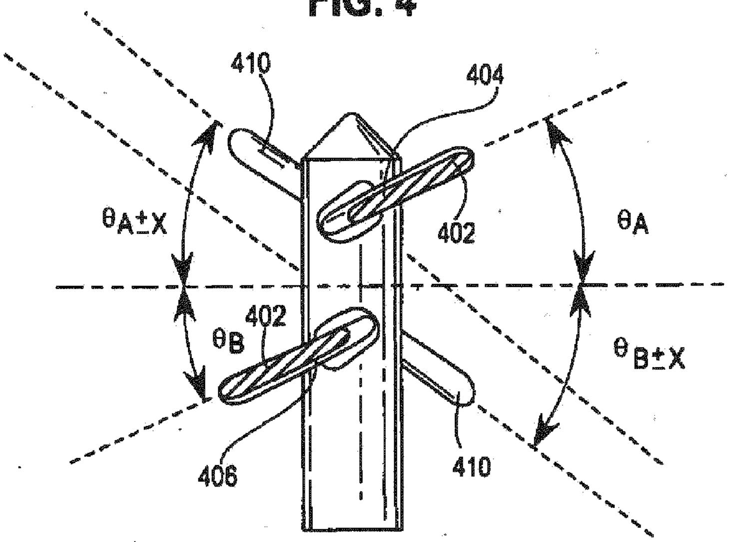

FIG. 5

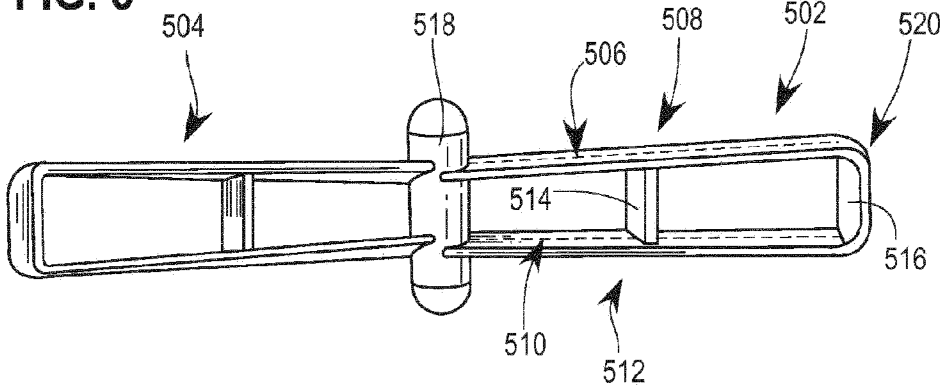

FIG. 6A

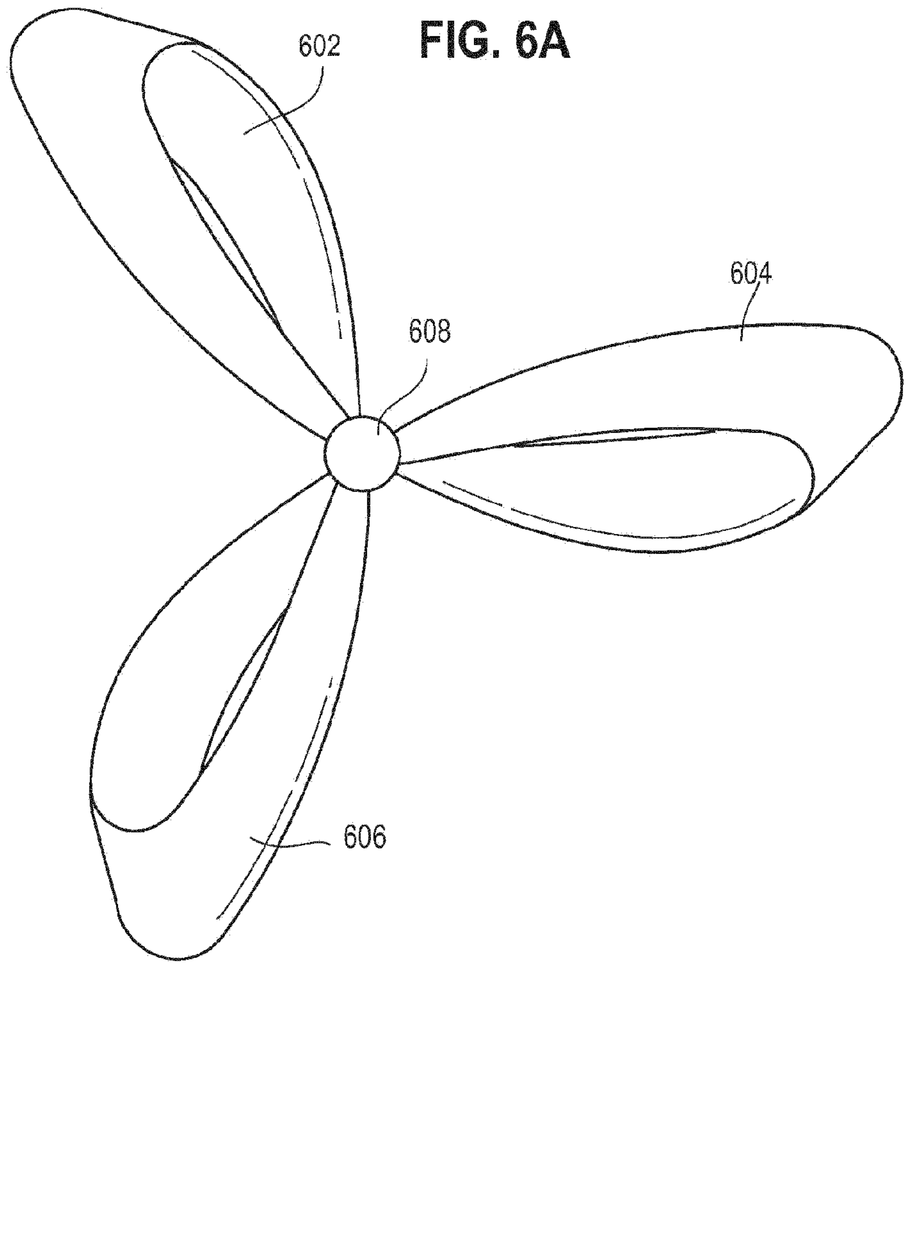

FIG. 6B

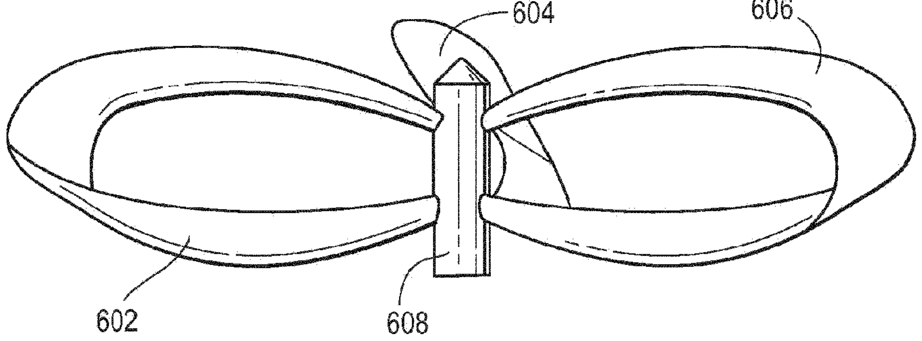

FIG. 7A

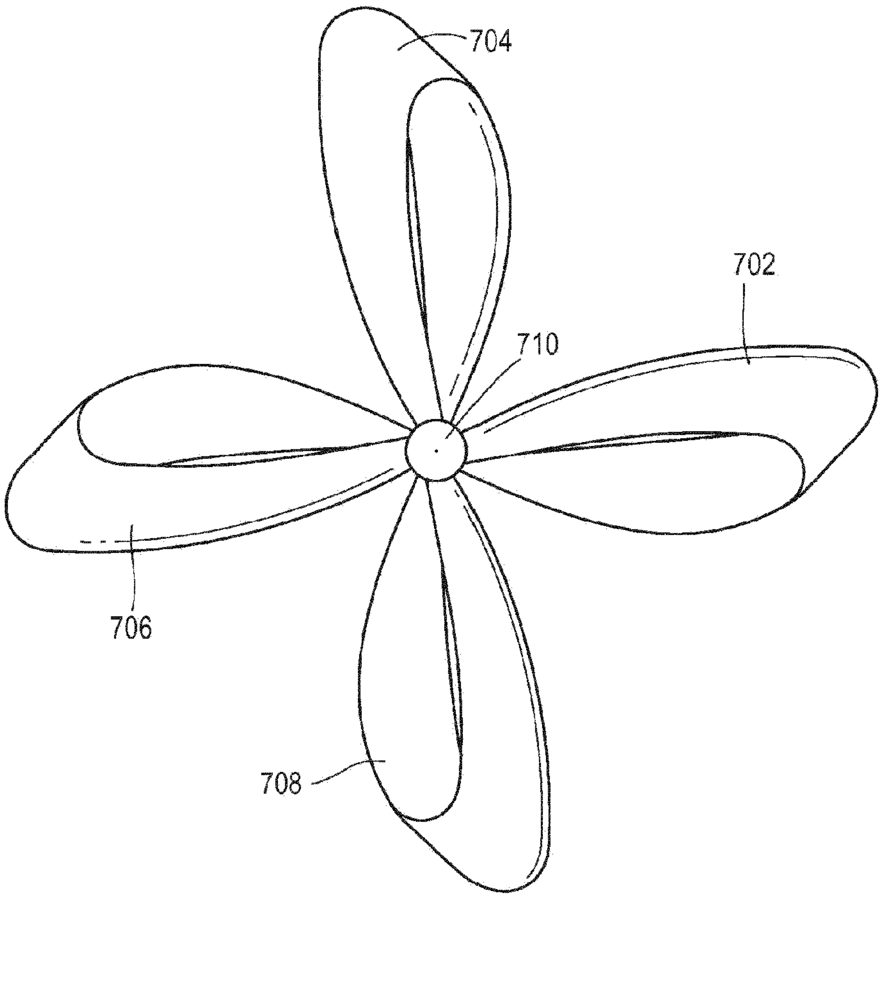

FIG. 7B

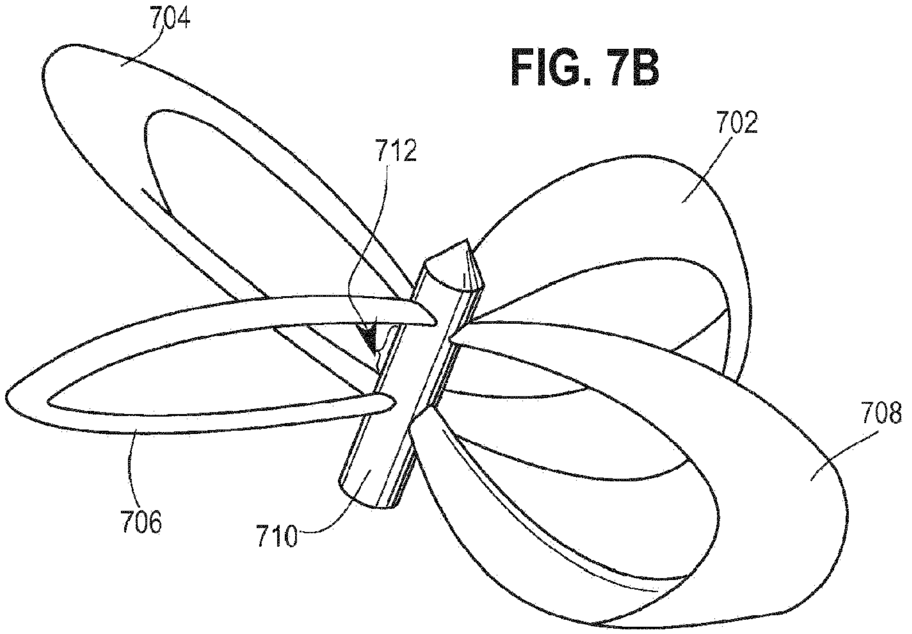

FIG. 8

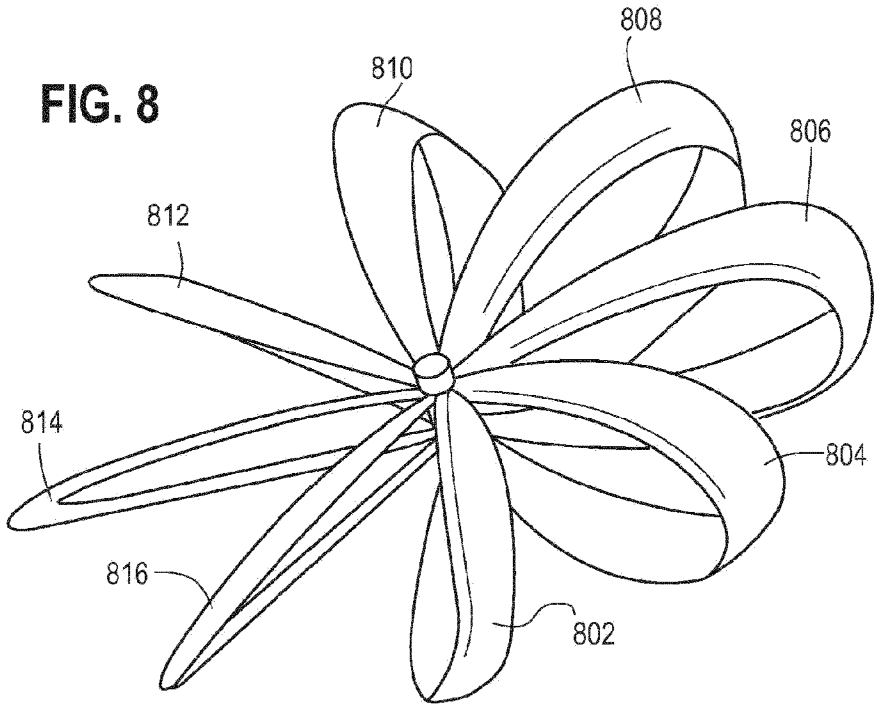

FIG. 9

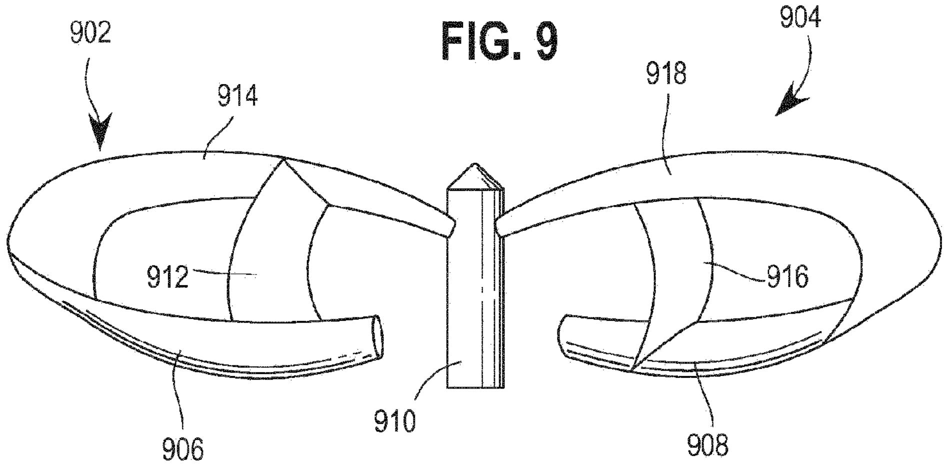

FIG. 10

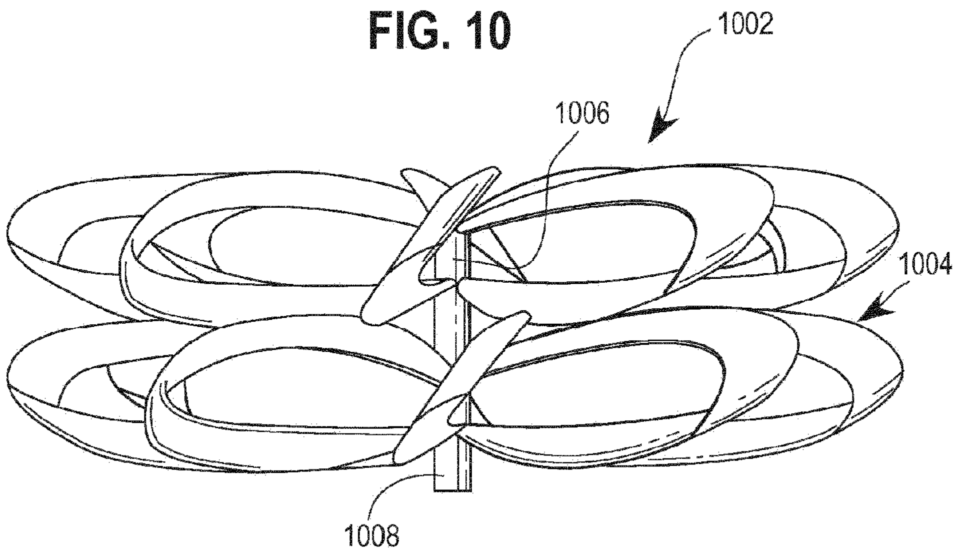

FIG. 11

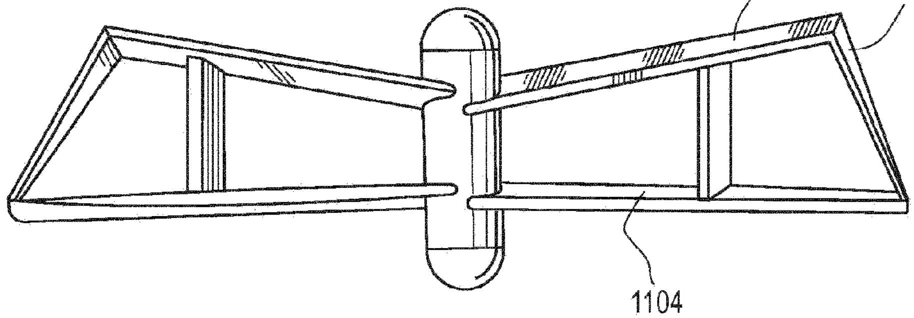

FIG. 12

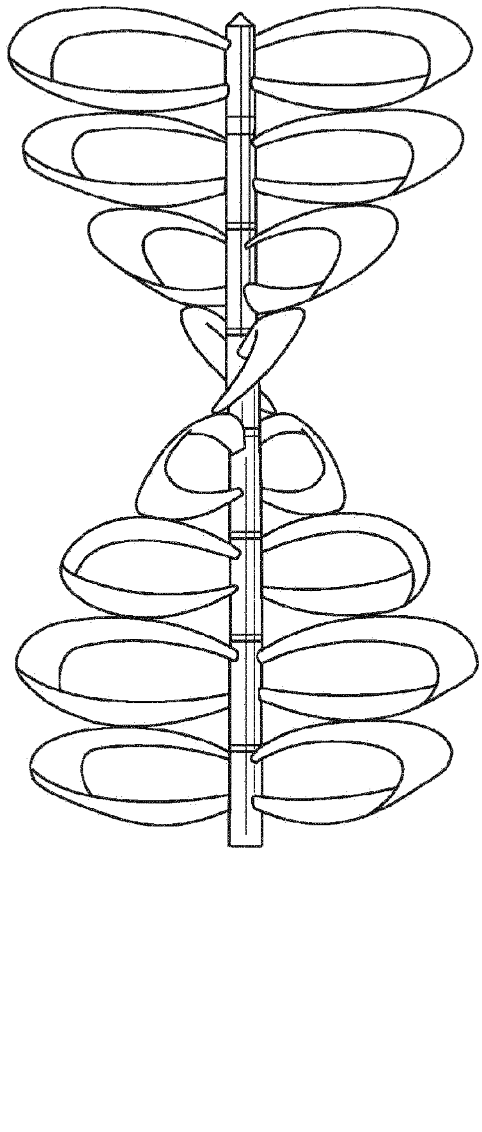

FIG. 13A

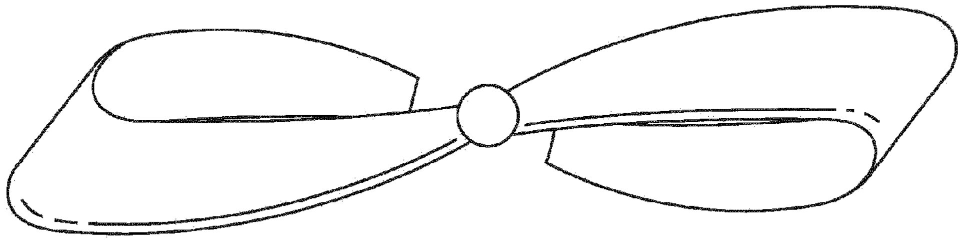

FIG. 13B