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(54) Title: A HUB-LESS PROPELLER

(57) Abstract: A propeller (100) is disclosed that may include a shell (102) defining an upper opening (102A), a lower opening (102B), an inner surface (102C), and an outer surface (102D). Each of the upper opening (102A) and the lower opening (102B) defines a circular profile along a central axis (AA'). The propeller (100) may further include a plurality of blades (104) attached to the shell (102) on the inner surface (102C) of the shell (102) and extending towards the central axis (AA'), to define a central region along the central axis (AA'). The shell (102) along with the plurality of blades (104) is configured to rotate about the central axis (AA') to generate an air flow via the central region, from the upper opening (102A) towards the lower opening (102B).

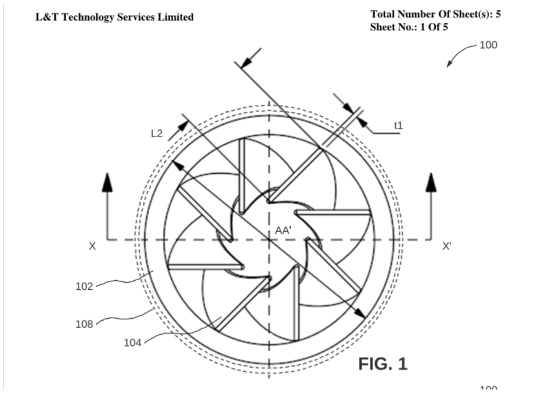

FIG. 1

FORM 2

THE PATENTS ACT 1970
(39 OF 1970)
&
The Patent Rules, 2003

Complete Specification

(See Section 10 and Rule 13)

1. TITLE OF THE INVENTION

A HUB-LESS PROPELLER

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3. PREAMBLE TO THE DESCRIPTION

COMPLETE

The following specification describes the invention and the manner in which it is to be performed

DESCRIPTION

Technical Field

[001] This disclosure relates generally to propellers, and more particularly to a hub-less propeller, i.e. a propeller including blades which are not attached to a central hub.

BACKGROUND

[002] Propellers may be used for creating a fluid flow, and therefore are used in various different application areas. For example, the application areas may include aircrafts and marine vehicles where the propellers are used for generating an air flow and water flow to thereby generate thrust to drive the vehicle aircrafts and marine vehicles. Other examples application areas include cooling zones where the air flow created by the propellers may be used for providing cooling to equipment like computer systems, servers, or providing cooling for household purposes.

[003] Typical propellers include a central hub and multiple bales attached to the central hub. The central hub is further attached to a rotation source like an electric motor or an internal combustion engine to thereby rotate the blades which upon rotation cause turbulence in the surrounding fluid like air or water. However, the central hubs in these propellers may limit the application of these propellers, due to the design thereof. For example, in unmanned aerial vehicles (UAVs), it may be advantageous to implement propellers without such central hubs, to obtain a higher flow rate and therefore more efficient operation of the UAV.

[004] Therefore, there is a need for a propeller in which the blade profile is detached from central hub of rotation, the blade profile that has a larger area of contact at starting point.

1.0 SUMMARY OF THE INVENTION

[005] In an embodiment, a propeller is disclosed. The propeller may include a shell defining an upper opening, a lower opening, an inner surface, and an outer surface. Each of the upper opening and the lower opening may define a circular profile along a central axis. A diameter of the upper opening may be greater than a diameter of the lower opening. The propeller may further include a plurality of blades attached to the shell on the inner surface of the shell and extending towards the central axis, to define a central region along the central axis. The shell along with the plurality of blades may be configured to rotate about the central axis to generate an air flow, from the upper opening towards the lower opening.

[006] In an embodiment, a flying object is disclosed. The flying object may include a body and a set of propellers. Each of the set of propellers may be positioned at an associated location on the body. Further, each of the set of propellers may include a shell defining an upper opening, a lower opening, an inner surface, and an outer surface. Each of the upper opening and the lower opening may define a circular profile about a central axis. A diameter of the upper opening may be greater than a diameter of the lower opening. Each of the set of propellers may further include a plurality of blades attached to the shell on the inner surface of the shell and extending towards the central axis, to define a central region along the central axis. The shell along with the plurality of blades may be configured to rotate about the central axis to generate an air flow from the upper opening towards the lower opening, to thereby impart upwards thrust to the flying body.

2.0

3.0 <u>BRIEF DESCRIPTION OF THE DRAWINGS</u>

[007] The accompanying drawings, which are incorporated in and constitute a part of this disclosure, illustrate exemplary embodiments and, together with the description, serve to explain the disclosed principles.

[008] **FIGs. 1, 2, 3A-3B** illustrate a top view, a sectional front view (along a line XX' of FIG. 1), a sectional perspective view (along the line XX' of FIG. 1), and a perspective view of a propeller, respectively, in accordance with some embodiments of the present disclosure.

[009] **FIG. 4** illustrates a front view of a blade of the propeller, in accordance with some embodiments of the present disclosure.

[010] **FIGs. 5-6** illustrate a top view and a sectional side view (along a line YY' of FIG. 5) of a propeller, in accordance with some embodiments of the present disclosure.

[011] **FIG. 7** illustrates a schematic diagram showing a top view of a flying object 700, in accordance with an embodiment of the present disclosure.

[012] **FIG. 8** illustrates a flowchart of a method of manufacturing a propeller, in accordance with an embodiment of the present disclosure.

4.0

5.0 <u>DETAILED DESCRIPTION OF THE DRAWINGS</u>

[013] Exemplary embodiments are described with reference to the accompanying drawings. Wherever convenient, the same reference numbers are used throughout the drawings to refer to the same or like parts. While examples and features of disclosed principles are described herein, modifications, adaptations, and other implementations are possible without departing from the spirit and scope of the disclosed embodiments. It is intended that the following detailed description be considered as exemplary only, with the true scope and spirit being indicated by the following claims. Additional illustrative embodiments are listed.

[014] Referring now to **FIGs. 1, 2, 3A-3B**, a top view, a sectional front view (along a line XX' of FIG. 1), a sectional perspective view (along the line XX' of FIG. 1), and a perspective view of a propeller 100, respectively are illustrated, in accordance with some embodiments of the present disclosure. As shown in FIGs. 1, 2, 3A-3B, the propeller 100 may include a shell 102. The shell 102 may be a hollow structure having a circular profile throughout its vertical length. As shown in FIG. 2, the shell 102 may define an upper opening 102A, a lower opening 102B, an inner surface 102C, and an outer surface 102D. Each of the upper opening 102A and the lower opening 102B may define a circular profile along a central axis AA'. In other words, both the upper opening 102A and the lower opening 102B may be circular in shape and concentric about the central axis AA'. In some embodiments, a diameter D1 of the upper opening 102A may be greater than a diameter D2 of the lower opening 102B, i.e. the upper opening 102A may be larger in size than the lower opening 102B.

[015] In some embodiments, the shell 102 may be manufactured from a rigid material selected from a metal, an alloy, a polycarbonate, etc. By way of an example, the diameter D1 of the upper opening 102A may be 260 millimetres (mm). Further, the vertical height of the shell between the upper opening 102A and the lower opening 102B may be 200 mm.

[016] By way of an example, the diameter (D1) of the upper opening 102A may be 260 millimetres (mm) and the diameter (D2) of the lower opening 102B may be 110 mm. As such, a ratio of the diameter (D1) of the upper opening 102A and the diameter (D2) of the lower opening 102B is 2:1. It should be noted that a ratio of the diameter of the upper opening 102A and the diameter of the lower opening 102B may be selected from a range of 1.5:1 to 2.5:1. Therefore, various values of the diameters of the upper opening 102A and the lower opening 102B are possible, with the ratio (of the diameters of the upper opening 102A and the lower opening 102B) being selected from within the range of 1.5:1 to 2.5:1.

[017] In some embodiments, the shell 102 may be a hollow structure defining a space within. Further, in some embodiments, a thickness of the shell 102 along the upper opening 102A may be greater than a thickness of the shell 102 along the lower opening 102B. This design, as will be discussed later in detail, allows for positioning a coil within the space defined by the shell 102, while ensuring a compact shape of the shell 102. Further, the design (i.e. thickness of the shell 102 along the upper opening 102A being greater than the thickness of the shell 102 along the lower opening 102B) provides an aerodynamic advantage to the propeller for applications in drone and other flying objects.

[018] The propeller 100 may further include a plurality of blades 104. As shown in FIGs. 1, 2, 3A-3B, each of the plurality of blades 104 may be attached to the shell 102 on the inner surface 102C of the shell 102. Each of the plurality of blades 104 may extend towards the central axis AA’ to thereby define a central region along the central axis AA’. As will be understood, the central region may be vacant in contrast to a conventional propeller in which a hub is positioned in the corresponding central region.

[019] In some embodiments, the plurality of blades 104 may be formed into the shell 102, i.e. the plurality of blades 104 may be manufactured together with and as part of the shell 102, for example, via casting, three-dimensional (3D) printing, etc. Alternately, the plurality of blades 104 may be manufactured separate from the shell 102 and later attached to the shell 102. For example, each of the plurality of blades 104 may attached to the shell 102 via welding or using fasteners. Further, in some embodiments, the plurality of blades 104 may be manufactured from rigid material, for example, selected from a metal, an alloy, or a polycarbonate. The blades 104 are further explained in conjunction with FIG. 4.

[020] The shell 102 along with the plurality of blades 104 may be configured to rotate about the central axis AA’ to generate an air flow via the central region, from the upper opening 102A towards the lower opening 102B. In particular, the rotation of the blades 104 may cause the air flow via the central region from the upper opening 102A towards the lower opening 102B. This air flow can be used for various applications. For example, the air flow can be used for generating a thrust to thereby propel a drone (upwards and back-forth). Further, the air flow can be used for providing a focussed air cooling, for example, for computing devices, or for use at home.

[021] In some embodiments, in order to cause the rotation of the propeller, the shell 102 may include the one or more coils 106 (as shown on FIG. 2). The one or more coils 106 may be positioned within the shell 102. In particular, the one or more coils 106 may be positioned in the space defined in the hollow structure of the shell 102. Further, the one or more coils 106 may be configured to electromagnetically engage with a magnetic field which may be created in proximity to the shell 102. Further, the shell 102 may be electrically coupled to an electrical supply to receive an electric current in the one or more coils 106. Upon the one or more coils 106 receiving the electric current, electromagnetic forces are generated which further generate a torque to cause the shell 102 to rotate along with the plurality of blades 104 about the central axis AA’.

[022] In some embodiments, the propeller 100 may further include an enclosure 108. The shell 102 may be configured to be positioned within the enclosure 108. The enclosure may act like a housing inside which the shell 102 may be positioned. The enclosure 108 may be configured to remain stationary when the shell 102 rotates. The enclosure 108 may define an upper opening, a lower opening, an inner surface, and an outer surface. The inner diameter of the upper opening of the enclosure 108 may be greater than the diameter of the upper opening 102A of the shell 102, so as to allow the shell 102 to be positioned inside the enclosure 108. By way of an example, the enclosure 108 may be made from a rigid material selected from a metal, an alloy, or a polymer.

[023] In some embodiments, the enclosure 108 may include a magnet which may be configured to generate the magnetic field in proximity to the shell 102. For example, the magnet may be a permanent magnet which may be formed or embedded into the enclosure. In alternate examples, the magnet may be an electromagnet which may be configured to generate a magnetic field using electricity. As such, the one or more coils 106 may electromagnetically engage with this magnetic field. The electromagnetic forces may be generated which may further generate a torque to cause the shell 102 to rotate along with the plurality of blades 104 about the central axis AA'.

[024] Referring now to **FIG. 4**, a front view of a blade 104 (of the plurality of blades 104) is illustrated in accordance with some embodiments of the present disclosure. As shown in FIG. 4, the blade 104 may define a first edge 104A, a second edge 104B, a third edge 104C, and a fourth edge 104D. The blade 104 may be configured to be attached to the shell 102 along the inner surface 102C of the shell 102 via the third edge 104C.

[025] Further, the blade 104 may define four corners viz. a first corner C1, a second corner C2, a third corner C3, and a fourth corner C4. The first edge 104A may be defined between the first corner C1 and the fourth corner C4, the second edge 104B may be defined between the fourth corner C4 and the third corner C3, the third edge 104C may be defined between the third corner C3 and the second corner C2, and the fourth edge 104D may be defined between the second corner C2 and the first corner C1.

[026] In the above example embodiment, a thickness (t1) of the blade along the fourth edge 104D may be 4.74 mm. Further, in the above example embodiment, a height (H2) of the blade 104 may be 172.35 mm. In other words, a distance between the second edge 104B and the fourth edge 104D may be 172.35 mm.

[027] The first edge 104A may define a first curved profile. The third edge 104C may define a second curved profile corresponding to the profile of the inner surface 102C of the shell 102. The second edge 104B and the fourth edge 104D may define a straight profile. Further, it should be noted that in some embodiments, a length (L2) of the fourth edge 104D may be greater than a length (L1) of the second edge 104B. For example, in the above example embodiment, the length (L1) of the second edge 104B (i.e. distance between the fourth corner C4 and the third corner C3) may be 13.39 mm. Further, in the above example embodiment, a length (L2) of the fourth edge 104D (i.e. distance between the second corner C2 and the first corner C1) may be 77.21 mm. in general, a ratio of the length (L2) of the fourth edge 104D and the length (L1) of the second edge 104B may range between 5:1 to 7:1.

[028] Further, in the above example embodiment, the third corner C3 may be offset from the second corner C2 along the horizontal by a length (L3). In the above example embodiment, the third corner C3 may be offset from the second corner C2 along the horizontal by 44 mm (i.e. L3 = 44 mm). Furthermore, the fourth corner C4 may be offset from the first corner C1 be a length (L4). In the above example embodiment, the fourth corner C4 may be offset from the first corner C1 be 19.42 mm (i.e. L4 = 19.42 mm).

[029] Further, in the above example embodiment, a vertical height (H1) of the shell 102 between the upper opening 102A and the lower opening 102B may be 200 mm. In general, a ratio of the vertical height (H1) of the shell 102 and the diameter (D1) of the upper opening 102A may be selected from a range of 1:1 to 1:2 (i.e. H1:D1::1:1 to H1:D1::1:2).

[030] Further, in the above example embodiment of FIGs. 1, 2, 3A-3B, as mentioned above, the diameter (D1) of the upper opening 102A may be 260 mm. Further, in such an embodiment, the length (L2) of the fourth edge 104D of the blade 104 may be 77.21 mm. In general, a ratio of the diameter (D1) of the upper opening 102A of the shell 102 and the length (L2) of the fourth edge 104D of the blade 104 may be selected from a range of 3:1 to 5:1 (i.e. D1:L2::3:1 to D1:L2::5:1).

[031] It should be noted that the above dimensions may depend upon an overall diameter and height of outer space. As per the availability of space, the dimensions can be modified proportionate to outer diameter and height.

[032] Referring now to **FIGs. 5-6**, a top view and a sectional side view (along a line YY' of FIG. 5) of a propeller 500 (corresponding to the propeller 100) are illustrated in accordance with some embodiments of the present disclosure. As shown in FIGs. 5-6, the propeller 500 may include a shell 502 which may be a hollow structure with a circular profile throughout its vertical length. The shell 502 may define an upper opening 502A, a lower opening 502B, an inner surface 502C, and an outer surface 502D. Further, each of the upper opening 502A and the lower opening 502B may define a circular profile along a central axis AA'. In other words, both the upper opening 502A and the lower opening 502B may be circular in shape and concentric about the central axis AA’. Further, a diameter (D3) of the upper opening 502A may be same as a diameter of the lower opening 502B.

[033] In an example embodiment, the diameter D3 of the upper opening 502A as well as of the lower opening 502B may be 154 mm. Further, in the above example embodiment, a vertical height (H3) of the shell 502 between the upper opening 502A and the lower opening 502B may be 25 mm.

[034] In some embodiments, the shell 502 may be a hollow structure defining a space within. Further, in some embodiments, a thickness (t2) of the shell 502 along the upper opening 502A may be same as thickness of the shell 502 along the lower opening 502B. For example, in the embodiment as shown in FIG. 5, the thickness (t2) of the shell 502 (along the upper opening 502A and the lower opening 502B) may be 17.61 mm.

[035] The propeller 500 may further include a plurality of blades 504. As shown in FIG. 5, each of the plurality of blades 504 may be attached to the shell 502 on the inner surface 502C of the shell 502. Each of the plurality of blades 504 may extend towards the central axis AA’ to thereby define a central region along the central axis AA’. The central region may be vacant in contrast to a conventional propeller in which a hub is positioned in the corresponding central region.

[036] The shell 502 along with the plurality of blades 504 may be configured to rotate about the central axis AA’ to generate an air flow via the central region, from the upper opening 502A towards the lower opening 502B. In particular, the rotation of the blades 504 may cause the air flow via the central region from the upper opening 502A towards the lower opening 502B.

[037] In some embodiments, in order to cause the rotation of the propeller, the shell 502 may include the one or more coils (not shown in FIGs. 5-6) which may be positioned within the shell 502. In particular, the one or more coils may be positioned in the space defined in the hollow structure of the shell 502. Further, the one or more coils may be configured to electromagnetically engage with a magnetic field in proximity to the shell 502. Further, the shell 502 may be electrically coupled to an electrical supply to receive an electric current in the one or more coils. As a result, electromagnetic forces are generated which further generate a torque to cause the shell 502 to rotate along with the plurality of blades 504 about the central axis AA’.

[038] Similar to the propeller 100, in some embodiments, the propeller 500 may further include an enclosure (not shown in FIGs. 5-4), with the shell 502 being configured to be positioned within the enclosure. The enclosure may be configured to remain stationary when the shell 502 rotates. The enclosure may define an upper opening, a lower opening, an inner surface, and an outer surface. In some embodiments, the enclosure may include a magnet configured to generate the magnetic field in proximity to the shell 502. For example, the magnet may be a permanent magnet or an electromagnet which may be configured to generate a magnetic field using electricity. As such, the one or more coils may electromagnetically engage with this magnetic field, and electromagnetic forces may be generated which may further generate a torque to cause the shell 502 to rotate along with the plurality of blades 504 about the central axis AA'.

[039] As shown in FIG. 5, each blade 604 may define a first edge 504A, a second edge 504B, a third edge 504C, and a fourth edge 504D. Each blade 504 may be attached to the shell 502 along the inner surface 502C of the shell 502 via the first edge 504A.

[040] The first edge 504A may define a first curved profile corresponding to the profile of the inner surface 502C of the shell 502. The second edge 504B and the fourth edge 504D may define a straight profile. The third edge 504C may define a second curved profile. Further, it should be noted that in some embodiments, a length (L5) of the fourth edge 504D may be greater than a length (L6) of the second edge 504B. For example, in the given embodiment, the length (L5) of the fourth edge 504D may be 58.96 mm, and the length (L6) of the second edge 504B may be 17.61 mm.

[041] It should be noted that the above dimensions may depend upon an overall diameter and height of outer space. As per the availability of space, the dimensions can be modified proportionate to outer diameter and height.

[042] As shown in FIG. 6, the length of each of the plurality of blades 504 may be aligned to the vertical at an angle ($\theta 2$) selected from 65° to 85°. In the embodiment as shown in FIG. 6, the angle ($\theta 2$) may be 75°. In other words, the length of each of the plurality of blades 504 may be aligned to the horizontal at an angle of 25° (i.e. Angle of Attack is 25°). In some embodiments, the number of blades 504 may be ten. However, it should be noted that the number of blades 504 can be varied as per the size of the propeller 500 and the air flow required.

[043] In another implementation of the present disclosure, a flying object is disclosed. For example, the flying object may be an unmanned aerial vehicle (UAV) also known as drone. In another example, the flying object may be any aircraft capable of carriage and transportation of passenger or cargo.

[044] Referring now to **FIG. 7**, a schematic diagram showing a top view of a flying object 700 (also, referred to as unmanned aerial vehicle (UAV) 700 or drone 700) is illustrated, in accordance with an embodiment of the present disclosure. The UAV 700 may include a body 702. As will be appreciated, the body 702 may be shaped and sized in accordance with the already known UAVs in the art. The UAV 700 further includes a set of propeller assemblies 704. For example, as show in FIG. 7, the UAV 700 includes a set of four propeller assemblies 704. Each of the set of propeller assemblies 704 may be positioned at an associated location with respect to the body 702. For example, as shown, the four propeller assemblies 704 may be positioned on four corners of the body 702.

[045] Each propeller assembly 704 (of the set of propeller assemblies 704) may include an enclosure 706 and a propeller 708. In some embodiments, each enclosure 706 may be formed into the body 702 (i.e. enclosure 706 is inseparable from the body 702). As such, the propeller 708 is configured to be positioned within the enclosure 706. In an alternate embodiment, the enclosure 706 is separately attached to the body 702. Accordingly, the propeller 708 is configured to be attached to the enclosure 706, upon attaching the enclosure 706 to the body 702. In yet another embodiment, an assembly of the enclosure 706 and the propeller 708 may be manufactured and provided separately. Accordingly, the assembly of the enclosure 706 and the propeller 708 may be attachable to the body 702.

[046] It should be noted that the propeller 708 may be implemented as the propeller 100 or the propeller 500, as discussed above. As such., each propeller 708 may include include a shell 102, 502. The shell 102, 502 may be a hollow structure with a circular profile along its vertical length. Further, the shell 102, 502 may define an upper opening 102A, 502A a lower opening 102B, 502B an inner surface 102C, 502C and an outer surface 102D, 502D. Further, each of the upper opening 102A, 502A and the lower opening 102B, 502B may define a circular profile along a central axis.

[047] Further, in some embodiments, a diameter of the upper opening (i.e. 102A) may be greater than a diameter of the lower opening (i.e 102B). However, in some alternate embodiments, the diameter of the upper opening (i.e. 502A) may be the same as the diameter of the lower opening (i.e. 502B). The shell 102, 502 may be manufactured from a rigid material selected from a metal, an alloy, a polycarbonate, etc.

[048] In some embodiments, the shell 102, 502 may be a hollow structure defining a space within. Further, in some embodiments, a thickness of the shell 102 along the upper opening (102A) may be greater than a thickness of the shell 102 along the lower opening (102B). In some alternate embodiments, the thickness of the shell 502 along the upper opening (502A) may be the same as the thickness of the shell 102 along the lower opening (502B).

[049] Each propeller 708 may further include a plurality of blades 104, 304. Each of the plurality of blades 104, 304 may be attached to the shell 102, 502 on the inner surface 102C, 502C of the shell 102, 502. Each of the plurality of blades 104, 304 may extend towards the central axis AA' to thereby define a central region along the central axis AA'. The central region may be vacant in contrast to a conventional propeller in which a hub is positioned in the corresponding central region.

[050] In some embodiments, the plurality of blades 104, 304 may be formed into the shell 102, 502, i.e. the plurality of blades 104, 304 may be manufactured together with and as part of the shell 102, 502, for example, via casting, three-dimensional (3D) printing, etc. Alternately, the plurality of blades 104, 304 may be manufactured separate from the shell 102, 502 and later attached to the shell 102, 502. For example, each of the plurality of blades 104, 304 may attached to the shell 102, 502 via welding or using fasteners. Further, in some embodiments, the plurality of blades 104, 304 may be manufactured from rigid material, for example, selected from a metal, an alloy, or a polycarbonate. The blades 104 are already explained in conjunction with FIGs. 4 and 6.

[051] The shell 102, 502 along with the plurality of blades 104, 304 may be configured to rotate about the central axis AA' to generate an air flow via the central region, from the upper opening 102A, 502A towards the lower opening 102B, 502B. This air flow may generate a thrust to thereby propel the UAV 700, upwards and back-forth.

[052] In some embodiments, in order to cause the rotation of the propeller 708, the shell 102, 502 may include the one or more coils (not shown on FIG. 7). The one or more coils may be positioned within the shell 102, 502. In particular, the one or more coils may be positioned in the space defined in the hollow structure of the shell 102, 502. Further, the one or more coils may be configured to electromagnetically engage with a magnetic field in proximity to the shell 102, 502. Further, the shell 102, 502 may be electrically coupled to an electrical supply to receive an electric current in the one or more coils. As a result, electromagnetic forces are generated which further generate a torque to cause the shell 102, 502 to rotate along with the plurality of blades 104, 304 about the central axis AA'.

[053] The propeller 708 (i.e. the shell 102, 502 of the propeller 708) is configured to be positioned within the enclosure 706. The enclosure 706 acts like a housing inside which the propeller 708 may be positioned. As such, the enclosure 706 remains stationary when the propeller 708 rotates. The enclosure 706 may define an upper opening, a lower opening, an inner surface, and an outer surface. The inner diameter of the upper opening of the enclosure 706 may be greater than the diameter of the upper opening 102A, 502A of the shell 102, 502 so as to allow the propeller 708 to be positioned inside the enclosure 706. By way of an example, the enclosure 706 may be made from a rigid material selected from a metal, an alloy, or a polymer.

[054] In some embodiments, the enclosure 706 may include a magnet which may be configured to generate the magnetic field in proximity to the propeller 708. For example, the magnet may be a permanent magnet which may be formed into the enclosure, or an electromagnet which may be configured to generate a magnetic field using electricity. The one or more coils may electromagnetically engage with this magnetic field, as a result of which electromagnetic forces are generated which may generate a torque to cause the propeller 708 to rotate.

[055] Referring now to **FIG. 8**, a flowchart of a method 800 of manufacturing a propeller 100, 500 is illustrated, in accordance with an embodiment. The method 800 may be performed by way of additive manufacturing, using a three-dimensional (3D) printing machine.

[056] At step 802, a 3D model of the propeller 100, 500 may be received. The 3D printing machine may include a printing head configured to dispense an additive manufacturing material. For example, the manufacturing material may be a polymer, etc. The propeller 100,500 may include a shell 102, 502 defining an upper opening 102A, 502A, a lower opening 102B, 502B, an inner surface 102C, 502C, and an outer surface 102D, 502D. Each of the upper opening 102A, 502A and the lower opening 102B, 502B may define a circular profile along a central axis AA'.

[057] Further, in some embodiments, a diameter of the upper opening (i.e. 102A) may be greater than a diameter of the lower opening (i.e 102B). However, in some alternate embodiments, the diameter of the upper opening (i.e. 502A) may be the same as the diameter of the lower opening (i.e. 502B). The propeller 100, 500 may further include a plurality of blades 104, 304 attached to the shell 102, 502 on its inner surface 102C, 502C and extending towards the central axis AA', to define a central region along the central axis AA'. The shell 102, 502 along with the plurality of blades 104, 304 may be configured to rotate about the central axis AA' to generate an air flow via the central region, from the upper opening 102A, 502A towards the lower opening 102B, 502B.

[058] At step 804, the additive manufacturing material may be dispensed via the printing head, starting from creating one of the upper opening 102A, 502A and the lower opening 102B, 502B and progressing towards creating the other of the upper opening 102A, 502A and the lower opening 102B, 502B, thereby simultaneously creating the shell 102, 502 and the plurality of blades 104, 304. In other words, for in one example implementation, the additive manufacturing material may be dispensed starting from creating the upper opening 102A, 502A towards creating the lower opening 102B, 502B, thereby simultaneously creating the shell 102, 502 and the plurality of blades 104, 304. In another example implementation, the additive manufacturing material may be dispensed starting from creating the lower opening 102B, 502B and progressing towards creating the upper opening 102A, 502A, thereby simultaneously creating the shell 102, 502 and the plurality of blades 104, 304.

[059] In another embodiment, a propeller for a marine vehicle is disclosed. The marine vehicle may include at least one propeller that may be implemented as one of the propeller 100 or propeller 500, as described above. The said propeller may replace the conventional propeller in the marine vehicle for propelling the marine vehicle in the water.

[060] In yet another embodiment, a cooling device is disclosed. The cooling device may include at least one propeller. The at least one propeller may be implemented as one of the propeller 100 or propeller 500, as described above. The cooling device may be used for generating air flow for removing heat that is generated from equipment like computing systems, server rooms, etc. Further, the cooling device may be used for common household use, especially in tropical countries in the summer seasons for providing comfortable environment for users.

[061] One of more embodiments of hub-less propellers are described above. The above hub-less propeller includes multiple blades which are attached to a circular periphery ad extend towards the center. As such, the propeller provides for the blade having a larger area of contact at the starting point, that provides more strength to the blade design. Further, by removing the central hub, the above propeller provides for more efficient operation.

[062] It is intended that the disclosure and examples be considered as exemplary only, with a true scope and spirit of disclosed embodiments being indicated by the following claims.

WE CLAIM:

1. A propeller (100) comprising:

a shell (102) defining an upper opening (102A), a lower opening (102B), an inner surface (102C), and an outer surface (102D),

wherein each of the upper opening (102A) and the lower opening (102B) defines a circular profile along a central axis (AA'),

a plurality of blades (104) attached to the shell (102) on the inner surface (102C) of the shell (102) and extending towards the central axis (AA'), to define a central region along the central axis (AA'),

wherein the shell (102) along with the plurality of blades (104) is configured to rotate about the central axis (AA') to generate an air flow via the central region, from the upper opening (102A) towards the lower opening (102B).

2. The propeller (100) as claimed in claim 1,

wherein a diameter (D1) of the upper opening (102A) is greater than a diameter (D2) of the lower opening (102B), and

wherein a ratio of the diameter (D1) of the upper opening (102A) and the diameter (D2) of the lower opening (102B) is selected from a range of 1.5:1 to 2.5:1.

3. The propeller (100) as claimed in claim 1,

wherein a thickness of the shell (102) along the upper opening (102A) is greater than a thickness of the shell (102) along the lower opening (120B).

4. The propeller (100) as claimed in claim 1,

wherein the shell (102) comprises one or more coils (106) positioned within the shell (102), wherein the one or more coils (106) are configured to electromagnetically engage with a magnetic field in proximity to the shell (102), and

wherein the shell (102) is electrically coupled to an electrical supply to receive an electric current in the one or more coils (106), to generate a torque to cause the shell (102) along with the plurality of blades (104) to rotate about the central axis (AA').

5. The propeller (100) as claimed in claim 4 further comprising:

an enclosure (108) defining an upper opening, a lower opening, an inner surface, and an outer surface,

wherein the shell (102) is configured to be positioned within the enclosure (108), and

wherein the enclosure (108) is configured to remain stationary when the shell (102) rotates.

6. The propeller (100) as claimed in claim 5, wherein the enclosure (108) comprises a magnet configured to generate the magnetic field in proximity to the shell (102).

7. The propeller (100) as claimed in claim 1, wherein a length of each of the plurality of blades (104) is aligned to the vertical at an angle selected from 15° to 25°.

8. The propeller (100) as claimed in claim 1,

wherein each of the plurality of blades (104) defines a first edge (104A), a second edge (104B), a third edge (104C), and a fourth edge (104D),

wherein the each of the plurality of blades (104) is attached to the shell (102) along the inner surface (102C) of the shell via the third edge (104C),

wherein the first edge (104A) defines a first curved profile, and wherein the third edge (104C) defines a second curved profile.

9. The propeller (100) as claimed in claim 1,

wherein a length (L2) of the fourth edge (104D) is greater than a length (L1) of the second edge (104B), and

wherein a ratio of the length (L2) of the fourth edge (104D) and the length (L1) of the second edge (104B) is selected from a range of 3:1 to 5:1.

10. The propeller (100) as claimed in claim 1, wherein a thickness (t1) of the fourth edge (104D) is greater than a thickness of the second edge (104B).

11. The propeller (100) as claimed in claim 1, wherein a ratio of the length (L2) of the fourth edge (104D) and the thickness (t1) of the fourth edge (104D) is selected from a range of 15:1 to 25:1.

12. The propeller (100) as claimed in claim 1, wherein a ratio of the diameter (D1) of the upper opening (102A) and the length (L2) of the fourth edge (104D) is selected from a range of 3:1 to 5: 1.

13. A flying object (700) comprising:

a body (702); and

a set of propellers (708), wherein each of the set of propellers (708) is positioned at an associated location on the body (702), wherein each of the set of propellers (708) comprises:

a shell (102) defining an upper opening (102A), a lower opening (102B), an inner surface (102C), and an outer surface (102D), wherein each of the upper opening (102A) and the lower opening (102B) defines a circular profile along a central axis (AA');

a plurality of blades (104) attached to the shell (102) on the inner surface (102C) of the shell (102) and extending towards the central axis (AA'), to define a central region along the central axis (AA');

wherein the shell (102) along with the plurality of blades (104) is configured to rotate about the central axis to generate an air flow via the central region, to thereby impart upwards thrust to the flying body (200).

14. The flying object (700) as claimed in claim 13, wherein a diameter (D1) of the upper opening (102A) is greater than a diameter (D2) of the upper opening (102A); and

15. The flying object (700) as claimed in claim 13 further comprising a set of enclosures (706),

wherein each of the set of enclosures (706) defines an upper opening (204A), a lower opening (204B), an inner surface (204C), and an outer surface (204D),

wherein each of the set of propellers (708) is configured to be positioned and rotate within an associated enclosure (706) of the set of enclosures (706).

16. The flying object (700) as claimed in claim 15,

wherein the shell (102) comprises one or more coils (106) positioned within the shell (102),

wherein the enclosure (706) comprises a magnet configured to a magnetic field in proximity to the shell (102),

wherein the one or more coils (106) are configured to electromagnetically engage with the magnetic field in proximity to the shell (102), and wherein the shell (102) is electrically coupled to an electrical supply to receive an electric current in the one or more coils (106), to generate a torque to cause the shell (102) along with the plurality of blades (104) to rotate about the central axis (AA').

17. A method (800) of manufacturing a propeller (100, 500), the method (800) comprising:

receiving (802), by a three-dimensional (3D) printing machine, a 3D model of the propeller (100, 500), wherein the 3D printing machine comprises a printing head configured to dispense an additive manufacturing material, wherein the propeller (100, 500) comprises:

a shell (102, 502) defining an upper opening (102A, 502A), a lower opening (102B, 502B), an inner surface (102C, 502C), and an outer surface (102D, 502D),

wherein each of the upper opening (102A, 502A) and the lower opening (102B, 502B) defines a circular profile along a central axis (AA'),

a plurality of blades (104, 304) attached to the shell (102, 502) on the inner surface (102C, 502C) of the shell (102, 502) and extending towards the central axis (AA'), to define a central region along the central axis (AA'),

wherein the shell (102, 502) along with the plurality of blades (104, 304) is configured to rotate about the central axis (AA') to generate an air flow via the central region, from the upper opening (102A, 502A) towards the lower opening (102B, 502B); and

dispensing (804), by the 3D printing machine, the additive manufacturing material via the printing head, starting from creating one of the upper opening (102A, 502A) and the lower opening (102B, 502B) and progressing towards creating the other of the upper opening (102A, 502A) and the lower opening (102B, 502B), thereby simultaneously creating the shell (102, 502) and the plurality of blades (104, 304).

Dated this 23rd Day of February 2023

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ABSTRACT

A HUB-LESS PROPELLER

A propeller (100) is disclosed that may include a shell (102) defining an upper opening (102A), a lower opening (102B), an inner surface (102C), and an outer surface (102D). Each of the upper opening (102A) and the lower opening (102B) defines a circular profile along a central axis (AA'). The propeller (100) may further include a plurality of blades (104) attached to the shell (102) on the inner surface (102C) of the shell (102) and extending towards the central axis (AA'), to define a central region along the central axis (AA'). The shell (102) along with the plurality of blades (104) is configured to rotate about the central axis (AA') to generate an air flow via the central region, from the upper opening (102A) towards the lower opening (102B).

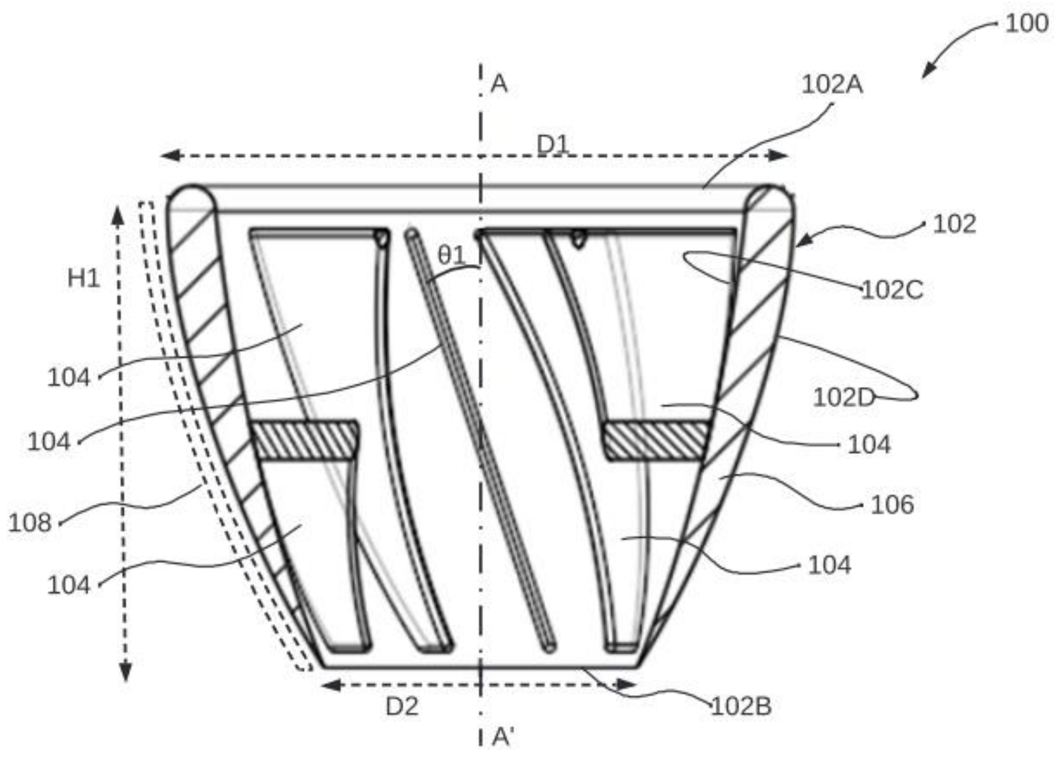

Figure 2

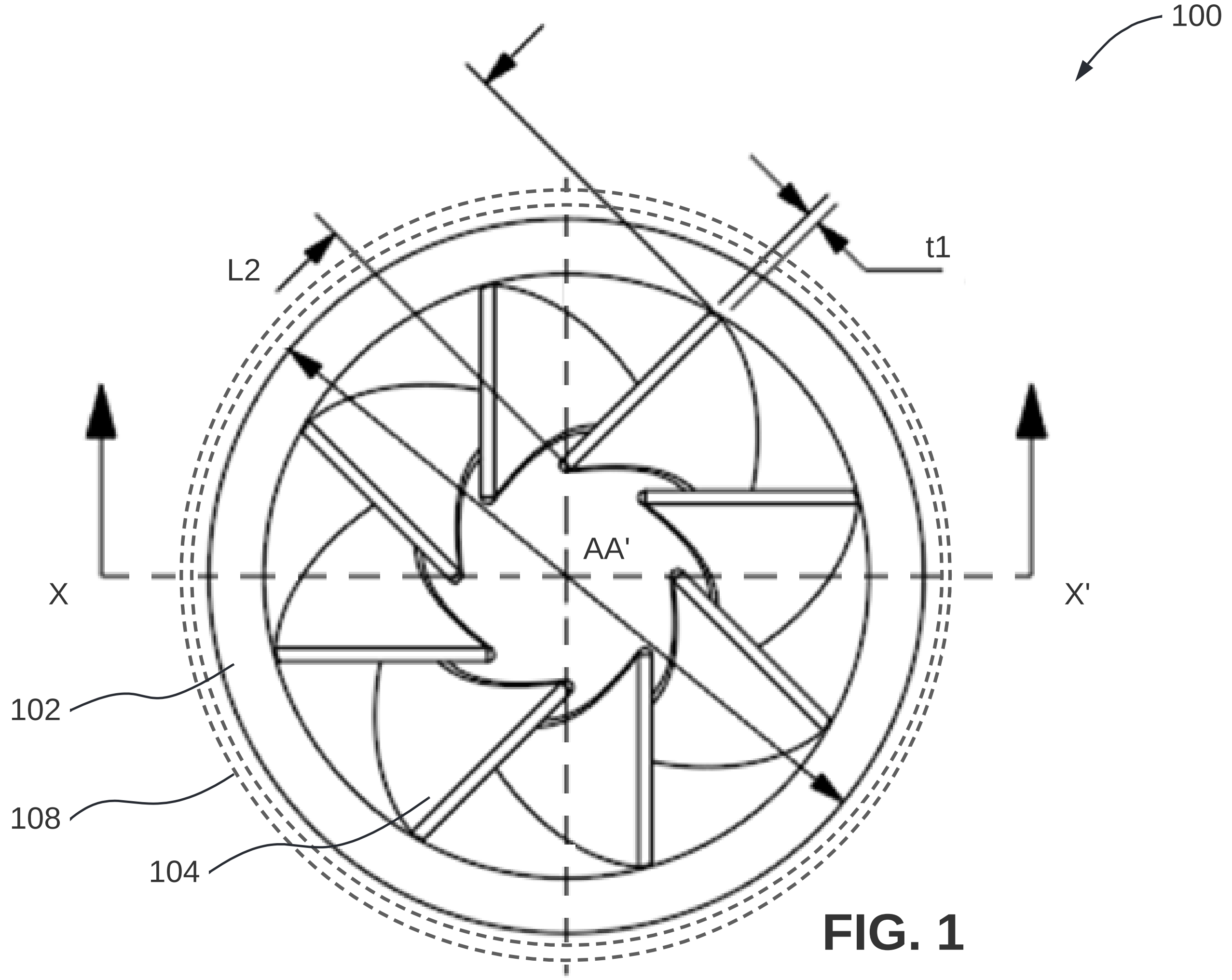

FIG. 1

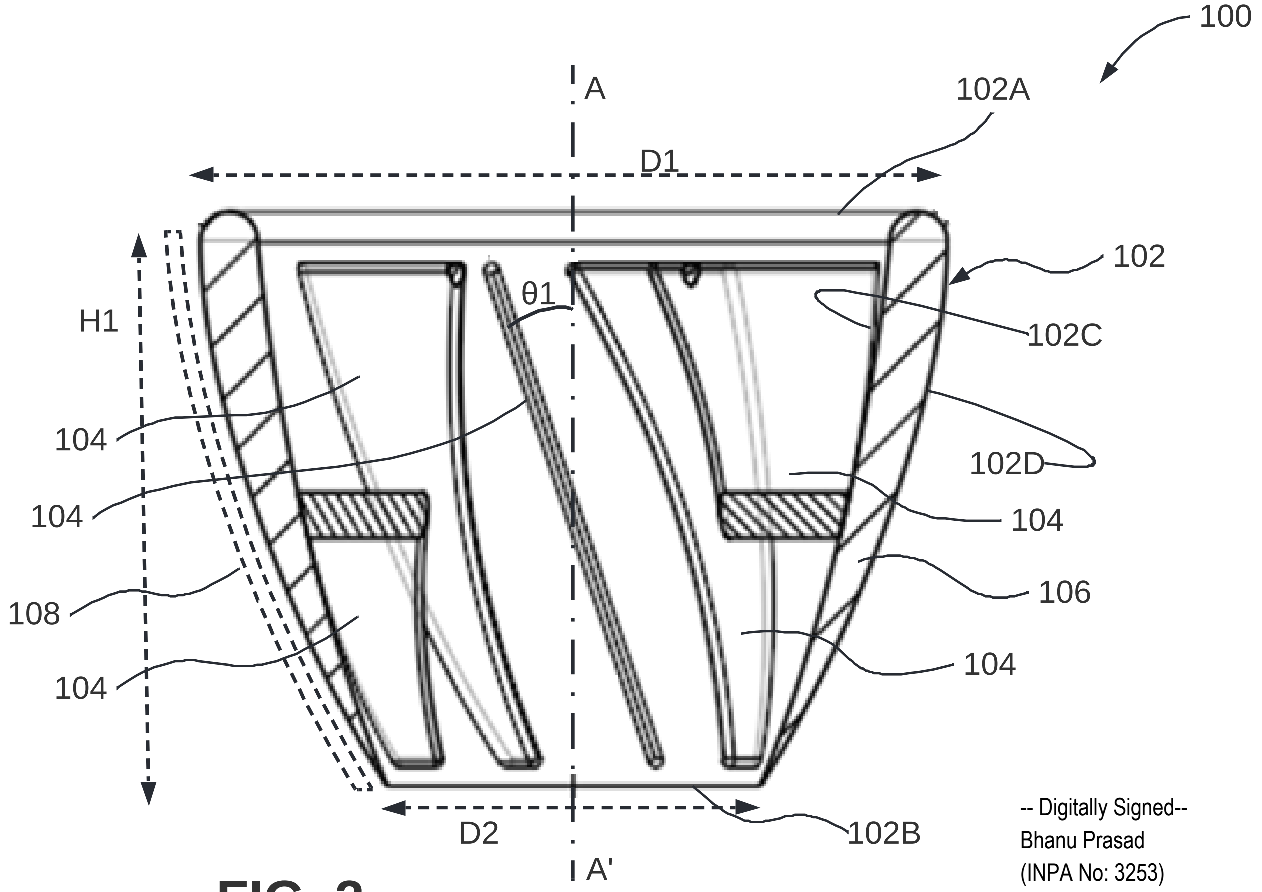

FIG. 2

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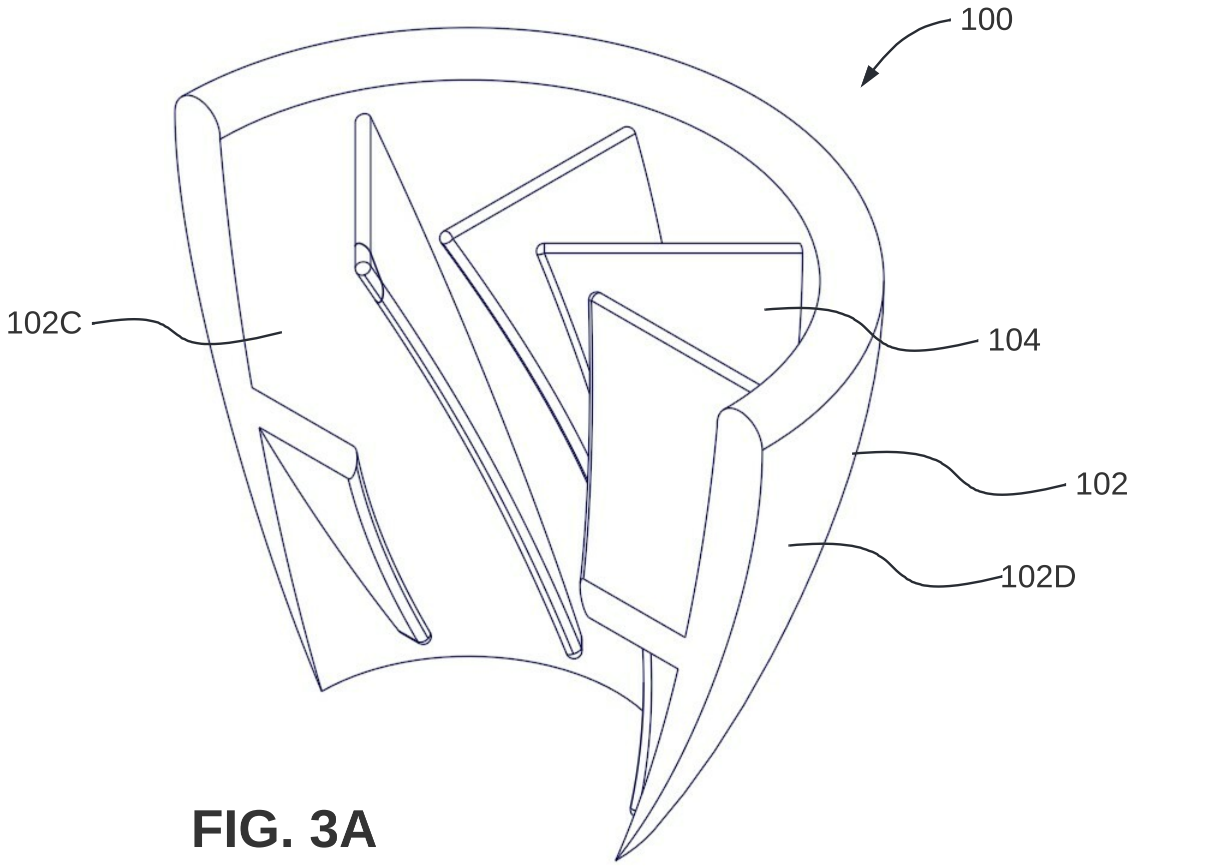

FIG. 3A

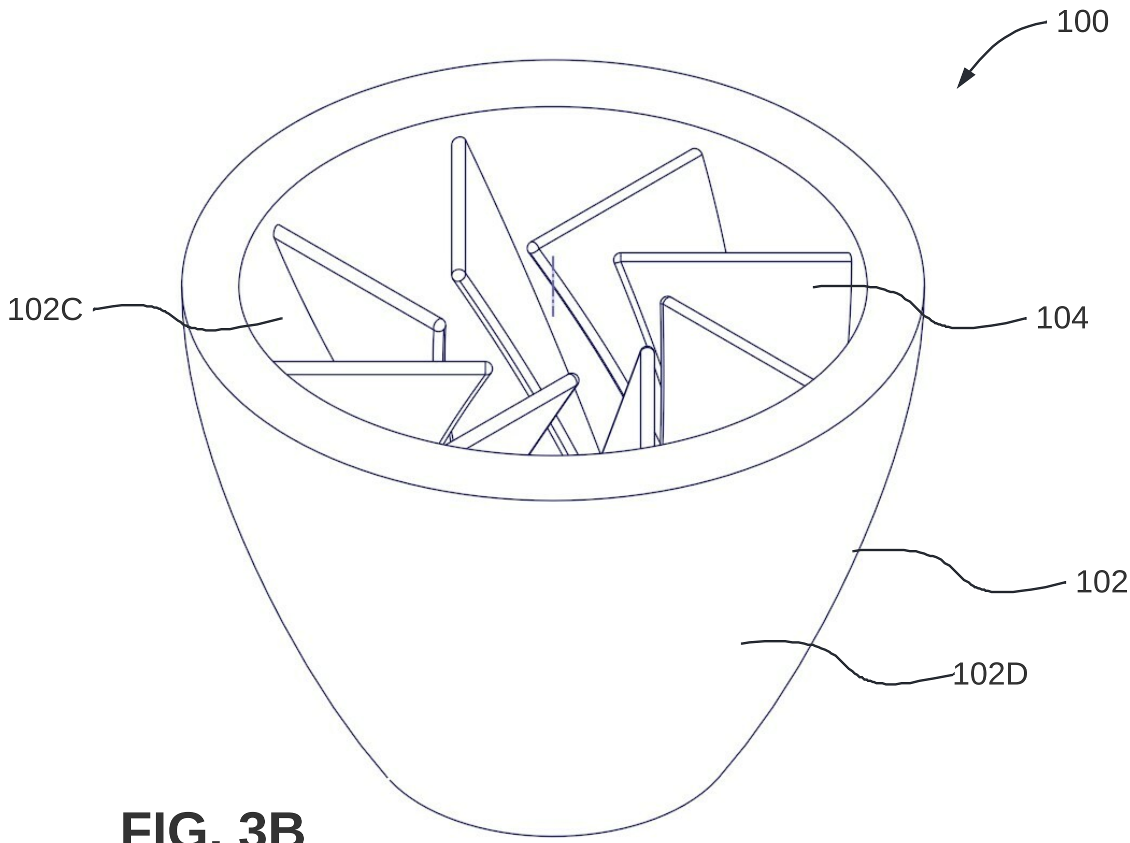

FIG. 3B

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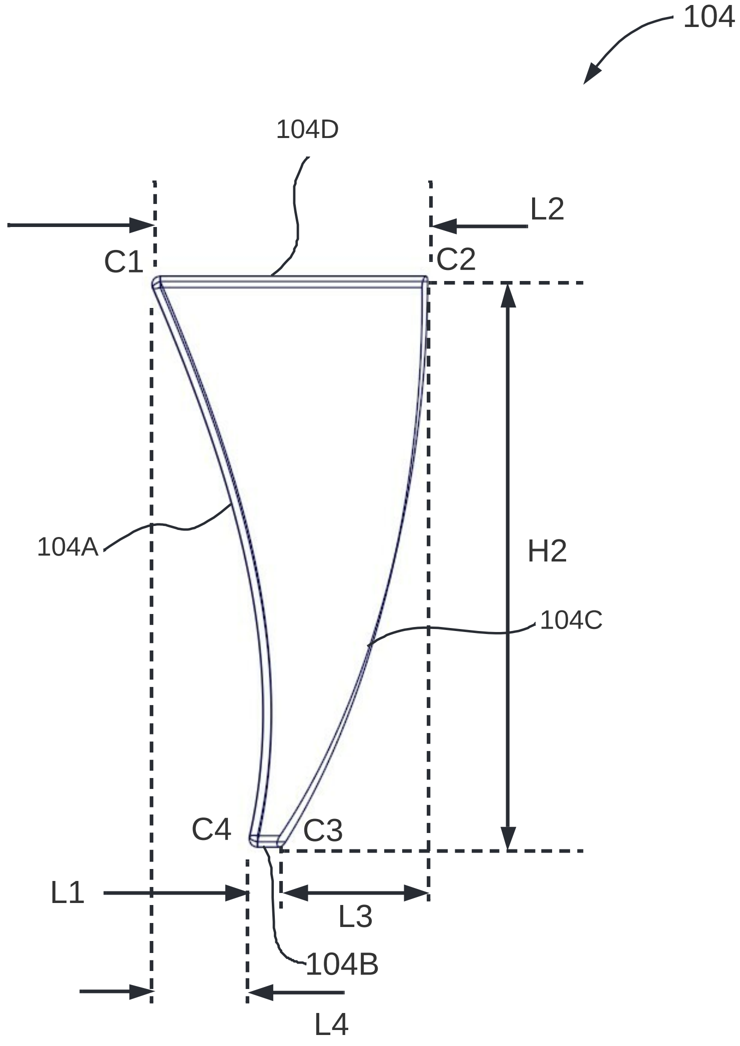

FIG. 4

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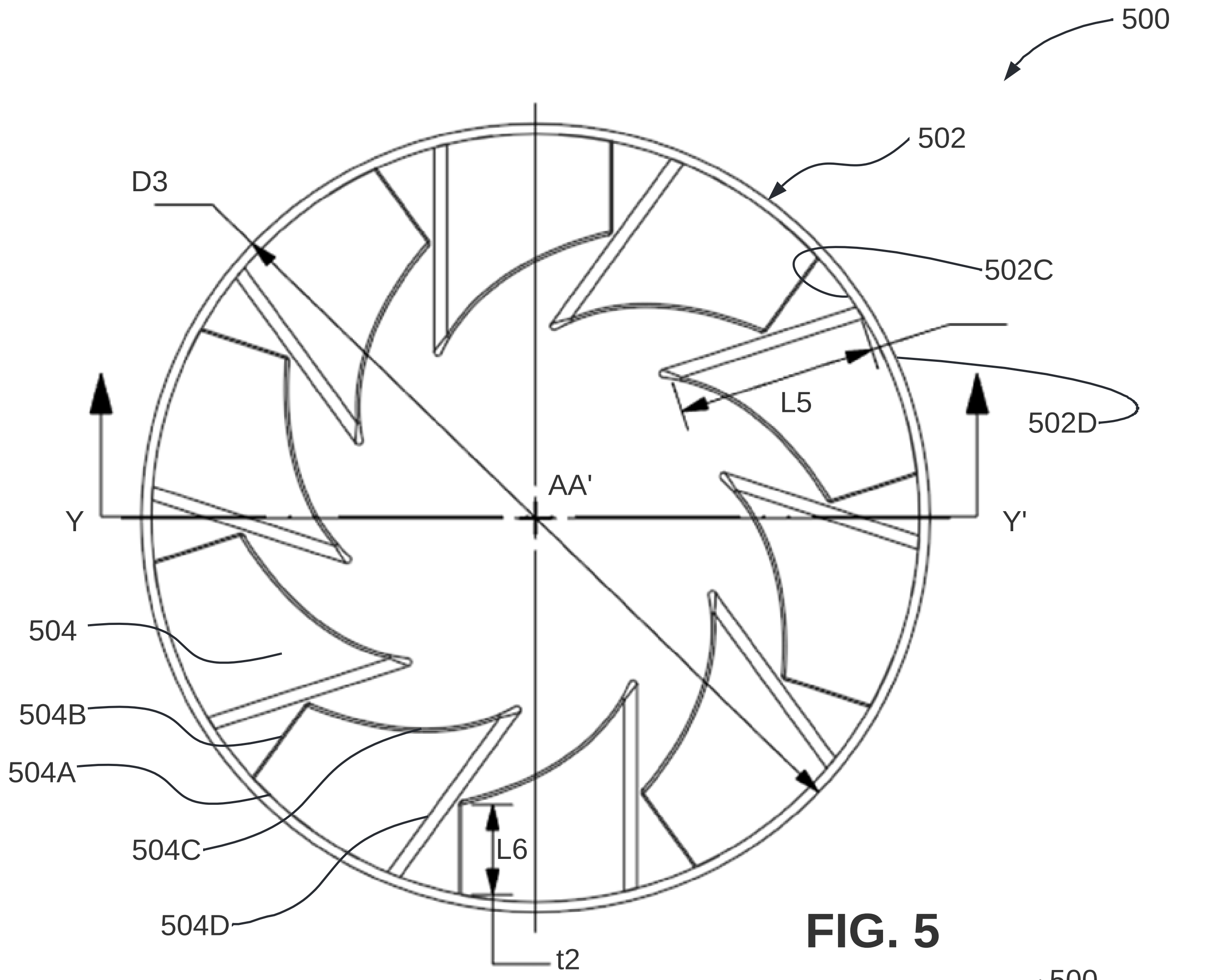

FIG. 5

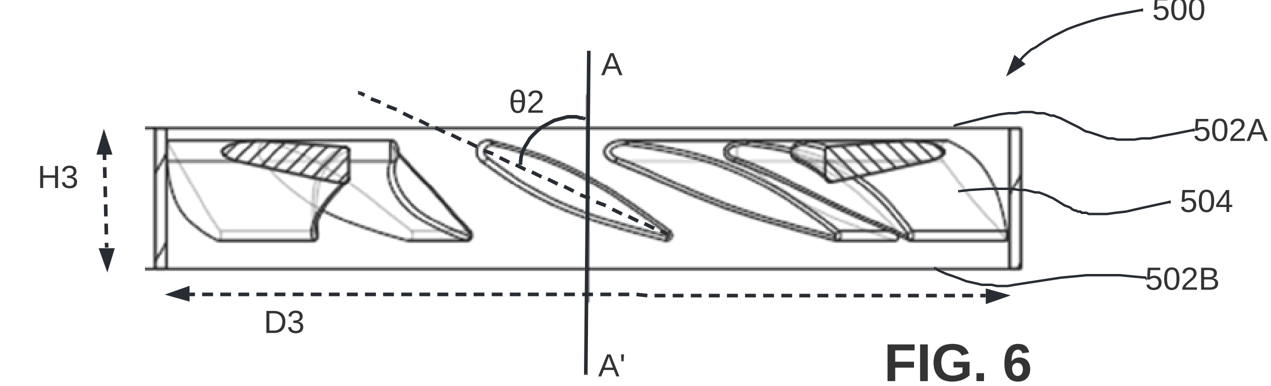

FIG. 6

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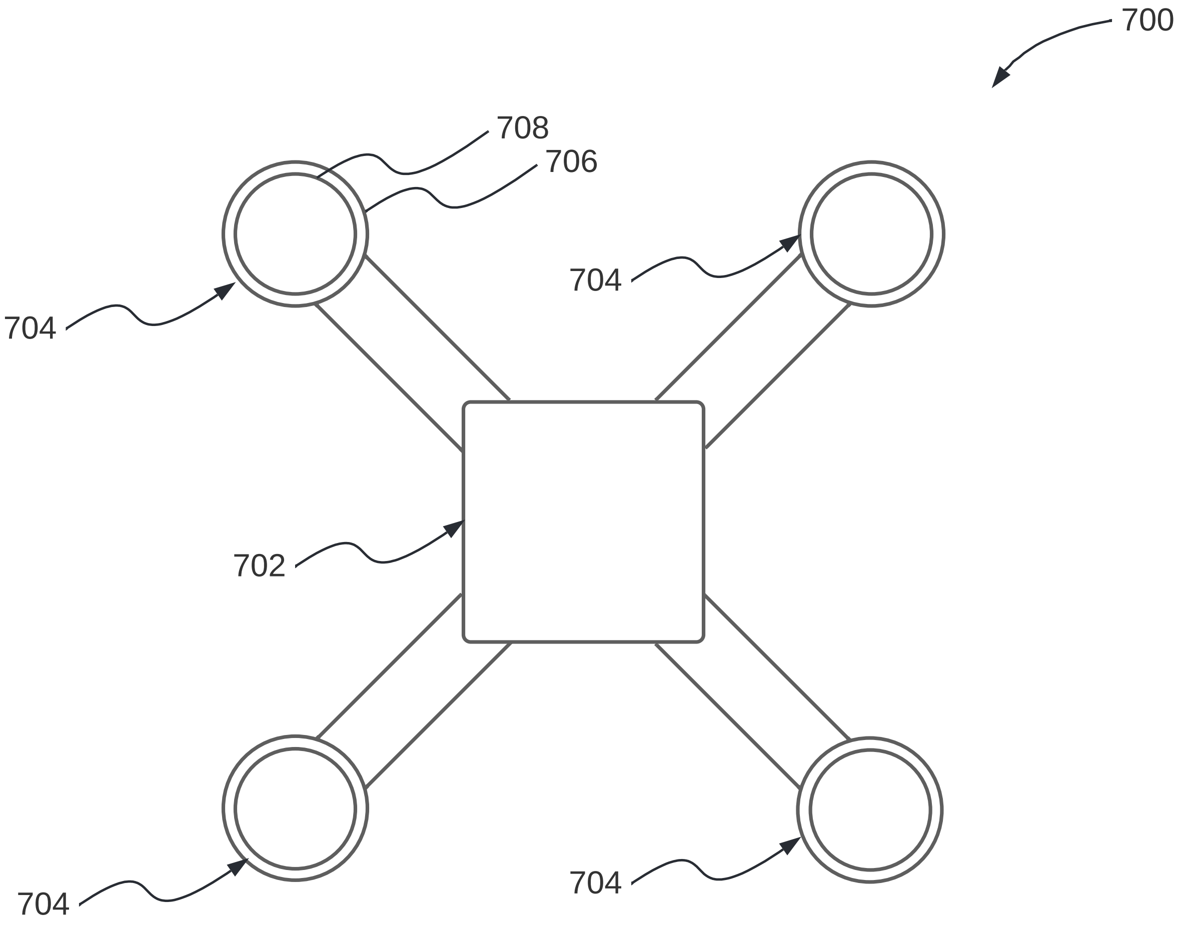

FIG. 7

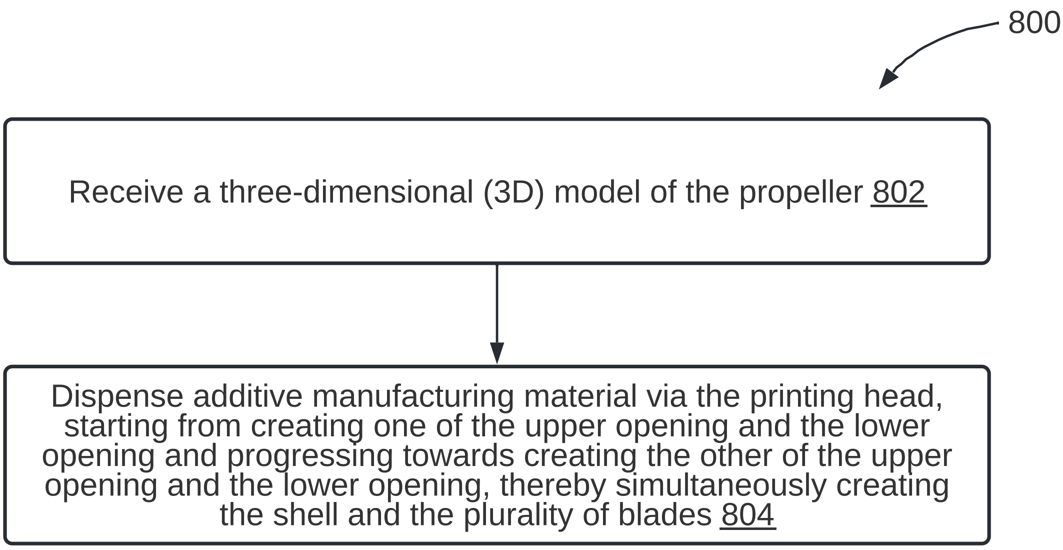

FIG. 8

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